Discharge Characterisation and Water Pollution Impact Assessment

275 Adams Road, Luddenham NSW 2745

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4Pillars
ENVIRONMENTAL CONSULTING

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Acknowledgement of Country

4Pillars acknowledges the Traditional Owners of the land on which this Site is located, the people of the Dharug nation. We pay our respects to their Elders past and present.

Declaration and limitations of this document

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Executive Summary

Luddenham Operations Pty Ltd operate the quarry Site located at 275 Adams Road, Luddenham, NSW. The Proponent recently took on quarry operations from the previous operator, who had let the Site sit dormant for several years. The Proponent has a short timeframe in which extractive activity can occur, with approval provisions tailing off in late 2024. There is a pressing need to recommence quarry at the Site, to provide shale and clay raw materials for nearby brickmaking facilities, to increase the size of the void for future backfilling and to improve the Site's position in terms of the income base for rehabilitation.

The Proponent has conducted this Surface Water Discharge Characterisation Assessment and Water Pollution Impact Assessment in order to comply with Condition 25 of the Project Approval (SSD No. 315-7-2003) and to support a variation of existing EPL no. 21562, to permit the controlled discharge of water off-Site to nearby Oaky Creek (flows into South Creek and north to the Hawkesbury/Nepean).

The proponent has extensively explored options for managing accumulated water other than discharge. No other options can realistically deal with the extreme rainfall experienced in Sydney over the last two years, and the significant build-up of standing water in the quarry void (approximately 200ML) that has resulted from that. Irrigation and other approaches may be suitable for ongoing maintenance of water levels in normal rainfall scenarios, but they are insufficient for dealing with the volume of water currently in the pit. It is to be noted that the discharge of accumulated quarry water to off-Site Oaky Creek is a short-term approach. Once the quarry void is emptied and the operational activities are resumed, the water in the quarry void (groundwater inflow and runoff water) is intended to be managed through on-Site reuse only. A new application will be made to the EPA if any future discharge is required for ongoing activities.

A thorough assessment has been conducted, over time, of the quality of accumulated water in the quarry pit. Assessment of water up and down stream in Oaky Creek has also been conducted. 4Pillars carried out its own sampling and analysis and supplemented this work with sampling recently conducted by EMM Consulting.

The assessment identified that pit water was generally of a good quality, but exhibited elevated conductivity, some nutrients, and some dissolved metals, compared to default trigger values. When compared to existing water quality in Oaky Creek, only conductivity and Copper was higher in the quarry water. There was no evidence of anthropogenic contaminants in the pit water. The 'toxicants' exceeding criteria are naturally occurring.

All reasonable and feasible options to treat the elevated concentration of conductivity, nutrients and dissolved metals have been explored. The best option, balancing time frame, cost and residual environmental impact is discharge of water to Oaky Creek during periods of flow. 4Pillars has estimated the relevant triggers for discharge that would ensure attenuation of conductivity and other analytes.

Further, continuous, real-time monitoring will occur upstream and downstream of the discharge point, measuring total dissolved solids (TDS), pH and electrical conductivity. This will allow the proponent to take appropriate action if and when trigger levels are exceeded.

We trust that the EPA agrees that surface water discharge is warranted at this Site and are satisfied it can be done with negligible risk of impact on the environment and human health.

We thank the EPA for their consideration and look forward to discussing this application further.

1 Introduction

4Pillars Environmental Consulting Pty Ltd (**4Pillars**) was engaged by Luddenham Operations Pty Ltd (**the Proponent**) to develop a Discharge Characterisation and Water Pollution Impact Assessment for 275 Adams Road, Luddenham, NSW 2745 (**the Site**). The Discharge Characterisation and Water Pollution Impact Assessment is necessary due to condition 25 of the Project Approval (SSD No. 315-7-2003) (**the DA or the Consent**). As per the requirement of condition 25, this discharge characterisation has been prepared by a qualified and experienced person in consultation with EPA and DPE Water. This report includes:

- measures to avoid the need for discharges as far as reasonable and feasible;
- analysis of the frequency and volume of discharges during a range of weather conditions;
- characterisation of the expected quality of proposed discharges;
- assessment of the impacts of discharges to receiving waters; and
- measures to minimise pollution and potential impacts on receiving waters.

1.1 Site details

Table 1: Site details.

Site details	
Street Address	275 Adams Road, Luddenham
Lots	Lot 3 DP 623799
Local Government Area	Liverpool City Council
Zoning	ENZ: Environment and Recreation AGB: Agribusiness
Previous Site use	Agricultural
Development Consent	Development Application No. 315-7-2003 (Modification 5)
EPA Licence	EPL 21562
Mining lease	ML 1816
Site operator	Luddenham Operations Pty Ltd
Total Site area	19 hectares

1.2 Site Context

The Site is bordered to the east by Oaky Creek, which has a total catchment area of 382 hectares (Figure 2). The detail of the Site is presented in *Table 1*. The creek rises approximately 2km south of the Site and flows generally in a northerly direction. The creek continues downstream of the Site for approximately 0.9km before joining Cosgroves Creek. The Site lies adjacent to the future Western Sydney Airport. Commonwealth owned lands which will form part of the airport grounds along the southern and eastern boundaries of the Site.

1.3 Permissibility and Planning Consent

Luddenham Operations Pty Ltd holds Development Consent under *the Environmental Planning and Assessment Act 1979* (see Modification 5 of DA No. 315-7-2003 attached as Appendix 10) (**the Consent**). The Consent (DA No. 315-7-2003) doesn't permit any off-Site discharge of water from the development, except as otherwise approved under an EPL. It also states that discharge must not occur without first conducting a Discharge Characterisation and Water Pollution Impact Assessment in accordance with condition 25 of the Consent (refer to Schedule 4, Condition 23 of the Development Consent). This report is intended to satisfy Condition 25 of the Consent and is a first step towards achieving permission for discharge throughout quarry operations.

1.4 Background to this variation

Initially, a Discharge Characterisation and Water Pollution Impact Assessment (DCWPIA) Report was submitted to the EPA on 9 September 2022 and subsequently received feedback from EPA on 4 October 2022. Further, an updated version of the DCWPIA and Statement of Environmental Effects (SEE) was submitted to the Department of Planning and

Environment (DPE) post-meeting through the Major Projects Portal on 21 March 2023 and feedback was received from DPE on 11 April 2023, including a separate 5 April 2023 letter from the EPA which had further comments. Following their receipt of the assessment, DPE Water also provided comments on 11 April 2023.

The recommendations made within the EPA's response were:

- Consider options for increasing on-Site storage to enable increased reuse and irrigation, reducing groundwater take and avoiding or minimising the need for a discharge;
- Consider options for increasing off-Site reuse to other local projects to avoid or minimise the need for a discharge;
- Characterise the quality of the predicted discharges under typical and worst case-scenarios;
- Assessment of the impact of discharges on the environmental values of the receiving waterways with reference to the relevant guideline values for slightly to moderately disturbed ecosystems;
- Management of quarry water during no or little rainfall scenario
- Assessment of discharge options and justification of a preferred discharge options/s;
- Assessment and management of turbidity in the water management dam
- Details of practical measures proposed to address any residual impacts;
- Consider a conductivity management strategy and
- Demonstrate how the proposal will be designed and operated to:
    - protect the NSW Water Quality Objectives for receiving waters where they are currently being achieved; and
    - contribute towards the achievement of the NSW Water Quality Objectives over time where they are not currently being achieved.

This report seeks to provide the supplementary information requested by the EPA in their response, to allow the EPL variation to be considered. Furthermore, a proposed sampling and analysis regime has been provided, to ensure that the quality of water intended for discharge is appropriate.

1.5 Further EPA meetings and comments

The EPA meeting conducted on 21 February 2023 with 4Pillars Environmental Consulting, the Proponent and the Department of Planning and Environment (DPE) resulted in several matters being discussed. An amended and a revised of the DCWPIA and Statement of Environmental Effects (SEE) was submitted to the Department of Planning and Environment (DPE) post-meeting through the Major Projects Portal on 21 March 2023 and feedback was received from DPE on 11 April 2023, including a separate 5 April 2023 letter from the EPA which had further comments. Following their receipt of the assessment, DPE Water also provided comments on 11 April 2023.

- Additional details on the downstream and upstream monitoring devices with their installation dates.
- Additional details on the diatomix treatment with dosing and mixing process.
- Additional details on the cost documentation of investigated alternatives i.e. reverse osmosis treatment and off-site reuse
- Amendment to the rainfall event required to commence discharge campaign during wet weather.
- Review of the proposed characterisation limits in conjunction with the limits at the discharge point.
- Amendment to the discharge point, discharge campaign and characterisation sample to ensure that the water assessed is representative of the water to exit the Site.
- Review of the dry weather discharge campaign. Data from wet weather discharge will be correlated to validate the modelling for dry weather discharge and further assessment will be provided to the EPA for dry weather discharge as part of the discharge trial. While the information has been retained within this assessment, the dry weather discharge proposal has been put on hold at present and a new application will be made to the EPA at the later stage.

2 Proposal

Luddenham Operations is proposing a licence variation to EPL 21562, which would permit the controlled discharge of water off-Site to a defined discharge point which is Oaky Creek located adjacent to the north-eastern side of the Site (Lot 3 DP 623799). Discharge water will be pumped directly from the quarry pit to Oaky Creek. The location of discharge point with its coordinates is shown in Figure 5. The new discharge point has been proposed by considering the EPA's comment in the 5 April 2023 letter with regard to the concerns of characterisation sample not being representative of water exiting the Site if the characterised water was first pumped to an intermediary dam.

Water discharges from 'Luddenham Quarry' will be controlled and only undertaken when quarry staff are on Site, during the hours of operation nominated by the current EPL[1]. Given the current depth of the shale/clay extraction workings beneath the natural surface level, uncontrolled discharges from the sump are impossible. It is envisaged that, once water levels are under control, discharge will only be necessary following intense or sustained rainfall. Ponded water will be pumped from the quarry sump directly to Oaky Creek situated north-eastern side of the Site. It is proposed that water being discharged from the quarry be pumped directly into the creek via a flexible poly pipe. This discharge pipe will be metered to enable accurate measurement of discharge volumes.

The proposal for discharge and a full assessment of its impacts are presented in a separate Statement of Environmental Effects that accompanies the application to vary EPL 21562.

3 Assessment Framework

3.1 Relevant Legislation

3.1.*1 Protection of the Environment Operations Act 1997*

The NSW Protection of the Environment Operations Act 1997 (POEO) is administered by the NSW Environment Protection Authority (EPA), which is the primary environmental regulator for NSW.

The quarry is a scheduled Premises covered by Environmental Protection Licence, EPL 21562.

3.1.2 *Water Management Act 2000*

The *NSW Water Management Act 2000* (WM Act) is based on the principles of ecologically sustainable development and the need to protect, enhance, and restore the water resources, their associated ecosystems, ecological processes, and biodiversity for the benefit of both present and future generations. It recognises that sustainable and efficient use of water provides socioeconomic benefits to the state of NSW. The WM Act provides a water sharing between water users including environmental, basic landowners' rights and licence holders. The licensing provision of the WM Act apply to those where a water sharing plan (WSP) has commenced.

WSPs define the rules for sharing and managing water resources within the water source areas and these statutory documents apply to one or more water sources.

The WSP related to the Sites are:

- *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011*- the Upper South Creek Management Zone within the Hawkesbury Lower Nepean Rivers Water Source applies to the surface water on the Site's vicinity; and
- *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011*- the Sydney Basin Central Groundwater Source applies to the groundwater in the Site's vicinity.

A 40m buffer zone is maintained along the eastern boundary of Oaky Creek forming the waterfront land of the creek.

[1] Operating hours are between 7am and 6pm on weekdays and 7am to 1pm on Saturdays.

3.2 Water Licence

Water Access Licence (WAL) 43685 and Miscellaneous Work 10MW119330 are held for Luddenham Quarry within the Sydney Basin Central Groundwater Source of the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011. Luddenham Quarry holds entitlement of 2-unit shares within the water source to account for the estimated maximum groundwater inflow into the quarry pit (EMM 2020a).

3.3 Relevant Guidelines

3.3.1 Erosion and Sediment Control Guidelines

Managing Urban Stormwater: Soils and Construction- Volume 1 (Landcom 2004) provides the basic principles for the design, construction and implementation of sediment and erosion control measures to improve stormwater management and mitigate the impacts of land disturbance activities on soils and receiving waters. Further, *Managing Urban Stormwater: Soils and Construction- Volume 2E Mins and Quarries* (DECC 2008) explains specific guidelines, principles, and minimum design standards for proper management practice in erosion and sediment control during construction and operation of quarries.

3.3.2 NSW Water Quality and River Flow Objectives

The NSW Water Quality and River Flow Objectives (DECCW 2006) provides agreed environmental values and long-term programs for water quality and river flow in each catchment in NSW. The objectives are intended to be considered in assessing and managing the potential impacts of activities associated with the waterway.

There are no specified objectives for the Hawkesbury-Nepean catchment where the Site is located but the typical water quality and river flow objective for uncontrolled streams in other catchments in NSW are provide in *Table 2*.

Table 2: Water quality and river flow objectives.

Environmental Value Water Quality Objectives	Objective	Application to the proposed variation
Aquatic ecosystems	Maintaining or improving the ecological conditions water bodies and their riparian zones over the long term	There are aquatic ecosystems downstream of the Site within Oaky Creek. The protection of aquatic ecosystems is the primary water quality objective to be met.
Visual amenity	Aesthetic qualities of water	There is no public views or access to Oaky Creek adjacent to the Site or immediate downstream areas.
Secondary contact recreation	Maintaining or improving the water quality for activities such as boating or wading, where there is a low probability of water being swallowed	There is no public views or access to Oaky Creek adjacent to the Site or immediate downstream areas
Primary contact recreation	Maintaining or improving the water quality for activities such as swimming, where there is a high probability of water being swallowed	There is no public views or access to Oaky Creek adjacent to the Site or immediate downstream areas
Livestock water supply	Protecting water quality to maximize the production of healthy livestock.	Some downstream users may extract water from oaky Creek or downstream water courses for agricultural purposes
Irrigation water supply	Protecting water quality applied to crops or pasture	Some downstream users may extract water from oaky Creek or downstream water courses for agricultural purposes
Homestead water supply	Protecting water quality for domestic uses in homesteads, including drinking, cooking, and bathing.	It is unlikely that any downstream users extract water from oaky Creek for homestead water supply
Drinking water at point of supply-disinfection only	These objectives apply to all current and future licensed offtake points for	Sydney Water provides the town's water supply. The Site is not located

Environmental Value Water Quality Objectives	Objective	Application to the proposed variation
Drinking water at point of supply-clarification and disinfection	town water supply and to the specific section of rivers that contribute to drinking water storages or immediately upstream of town water supply offtake points. The objectives apply to sub-catchments or groundwater used for town water supply.	within the Sydney water drinking catchment. Oaky Creek drains to the Hawkesbury-Nepean system downstream of Warragamba Dam. No water is extracted from downstream of the Site is used for town drinking water supply.
Drinking water at point of supply-groundwater		
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 Oaky Creek or downstream watercourses. However, the trigger values for aquatic foods apply to aquaculture not recreational fishing. The required level of protection will be provided by meeting the objective for aquatic ecosystems.
River Flow Objectives		
Protect pools in dry times	Protect natural water levels in pools of creek and rivers and wetlands during period of no flow	The flow regimes of Oaky Creek and downstream watercourses have been extensively modified by land clearing, agriculture, extractive activities, and urban and industrial development in the catchment, including the Western Sydney Airport development.
Protect natural low flows	Share low flows between environment and water users and fully protect low flows	
Protect important rises in water levels	Protect or restore a proportion of moderate and high flows	
Maintain wetland and floodplain inundation	Maintain or restore the natural inundation patterns and distributions of flood water supporting natura wetland and floodplain ecosystems.	
Maintain natural flow variability	Maintain or mimic natural flow variability in all streams	
Manage groundwater for ecosystems	Maintain groundwater within the natural levels and variability, critical to surface flows and ecosystems.	
Minimize effects of weir and other structures	Minimize the impact of instream structures.	No instream structures

3.3.3 Australian and New Zealand Guidelines for Fresh and Marine Water Quality

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018) provides the guidelines for monitoring, assessing, and managing ambient water quality in a wide range of water resources type and according to specified environmental values such as ecosystems, primary industries, recreation and drinking water.

Environmental values associated with the waterways and water resources surrounding the Site include primary industry, aquatic ecosystems, recreational users, irrigation, and stock watering. The water monitoring results are compared to the default guidelines values (DGVs) recommended by ANZG (2018) for the protection of aquatic ecosystems. When selecting the relevant ANZECC and ANZG assessment criteria, trigger values were selected for fresh waters which were considered slightly to moderately disturbed ecosystems. Specifically, ANZECC (2000) trigger values for receiving waters were defined as ***Lowland River slightly to moderately disturbed catchments in Fresh Water***, as these were determined to be most appropriate for the immediate surroundings. Oaky Creek is considered to be 'moderately disturbed', a consequence of historical and current agricultural and grazing activities including the current development of Western Sydney Airport. The creek is also classified as 'lowland river' as the elevation of the Site is less than 150m.

DGVs are provided by ANZG (2018) for 99%, 95%, 90% and 80% species protection. The levels of species protection assigned for slightly to moderately disturbed systems are the 95% species protection DGV for most toxicants. In terms of

parameters that can potentially bioaccumulate, DGVS for 99% species protection are recommended by ANZG (2018). recommended for slightly to moderately disturbed systems, unless otherwise noted. *Table 3* provides the DGVs for slightly to moderately disturbed water recommended by ANZG (2018). ANZG for metals are based on the 95% species protection value recommended by slightly to moderate disturbed water systems, otherwise noted. It was noted that some contaminants of concern did not have a current benchmark value against which they could be assessed. The NSW Water Quality Objectives (NSW WQOs) describe the environmental values and long-term goals for assessing and managing the potential impacts of proposed discharge from the pit on surface water in the Oaky Creek system.

Table 3: Default guideline values for the assessment of water quality.

Parameter	Units	DGV	Additional information
Electrical Conductivity	µS/cm	125-2200	DGV for lowland river in south-east Australia (Table 3.3.3; ANZECC 2000)
Turbidity	NTU	6-50	DGV for lowland river in south-east Australia (Table 3.3.3; ANZECC 2000)
pH	pH units	6.5-8.5	DGV for lowland river in south-east Australia (Table 3.3.3; ANZECC 2000)
Reactive Phosphorus	mg/L	0.002	DGV for lowland river in south-east Australia (Table 3.3.3; ANZECC 2000)
Total Phosphorus	mg/L	0.05	DGV for lowland river in south-east Australia (Table 3.3.3; ANZECC 2000)
Total Nitrogen	mg/L	0.5	DGV for lowland river in south-east Australia (Table 3.3.3; ANZECC 2000)
NOx	mg/L	0.04	DGV for lowland river in south-east Australia (Table 3.3.3; ANZECC 2000)
Ammonia	mg/L	0.02	DGV for lowland river in south-east Australia (Table 3.3.3; ANZECC 2000)
Aluminium	mg/L	0.055	Moderate reliability DGV for Al (pH>6.5)
Arsenic	mg/L	0.013	Moderate reliability DGV for As (V)
Cadmium	mg/L	0.0002	Very high reliability DGV
Chromium	mg/L	0.001	Very high reliability DGV for Cr (VI)
Selenium	mg/L	0.005	Moderate reliability DGV for 99% species protection level recommended for slightly to moderately disturbed systems due to the potential for bioaccumulation
Copper	mg/L	0.0014	High reliability DGV
Lead	mg/L	0.0034	Moderate reliability DGV

Mercury	mg/L	0.00006	Moderate reliability DGV for 99% species protection level recommended for slightly to moderately disturbed systems due to the potential for bioaccumulation
Nickel	mg/L	0.0111	Low reliability DGV
Zinc	mg/L	0.008	Very high reliability DGV

3.4 Relevant Studies

3.4.1 Updated South Creek Flood Study

The Updated South Creek Flood Study is used to inform floodplain management within the South Creek catchment and was prepared for Penrith, Liverpool, Fairfield, and Blacktown City Councils. The upper portions of the Oaky Creek catchment are currently undergoing earthworks related to the construction of the Western Sydney Airport, changing the local hydrology in the area.

3.4.2 Western Sydney Airport Assessments

Western Sydney Airport which lies adjacent to the Site has prepared assessment of the impacts on surface water hydrology, flooding, and geomorphology (GHD 2016) as part of their environment impact assessment.

4 Existing Environment

4.1 Land Use

The Site is adjacent to the future Western Sydney Airport which is currently in the major earthworks' construction phase (including road infrastructure upgrades). The eastern and southern side of the Site is commonwealth-owned land which will form part of the airport.

The surrounding land use includes:

- Agricultural- grazing and agriculture;
- Rural residences;
- Hubertus Country club and pistol range- immediately west of the Site.

4.2 Topography

The Site is predominantly flat with a gentle sloping relief falling generally from south-west to the north-east. The Site has an elevation of approximately 80m Australian Height Datum (m AHD). Between the western and eastern boundary, there's approximately a 10m across the 500m distance.

4.3 Geology

The Luddenham area lies within the central part of the Sydney Basin, which is comprised of several sedimentary strata including thick coal seams in the greater region and extensive and continuous Hawkesbury Sandstone. The formation of shaly and silty strata (Wianamatta Group) was originated from these sandy sediments and the regional depression of the basin.

4.4 Saline Soils

Soil salinity mapping of Western Sydney (DIPNR 2002) indicates moderate to high salinity potential is associated with the soil landscapes surrounding the Site.

4.5 Climate

For this assessment, the patched point climate data was obtained from the Scientific Information for Land Owners (SILO) for Badgerys Creek McMasters F.Stn Station (BOM station number 67068), which is located 1km north-east of the Site. Key information and statistical data from historical SILO patched point between 1989 and 2021 is presented in Table 4.

Table 4: Key Climate Statistics from 1989 to 2021.

Key Annual Statistics	Units	Rainfall	Evaporation
Average	mm/year	715	1451
Minimum	mm/year	440	1255
5th Percentile	mm/year	442	1289
10th Percentile	mm/year	446	1301
Median	mm/year	652	1453
90th Percentile	mm/year	964	1151
95th Percentile	mm/year	999	1619
Maximum	mm/year	1124	1779

5 Justification for discharge

Prior to preparing this application, Luddenham Operations Pty Ltd has considered alternative options available to avoid or minimise the need for future discharge of water off-Site. These options are discussed in the following sections. The following sections also detail the operational difficulties that the lack of a licenced discharge point is creating.

5.1 Current issues facing intended operations

Luddenham quarry has approval to extract and transport up to 300,000 tonnes per annum of clay and shale product. The Modification 5 of the DA No. 315-7-2003 allows the operator to reactivate and complete the quarrying operations by December 2024. The Proponent recently took on quarry operations from the previous operator, who had let the Site sit dormant for several years. The Proponent has a short timeframe in which extractive activity can occur, with approval provisions tailing off in late 2024. There is a pressing need to recommence quarry at the Site, to provide shale and clay raw materials for nearby brickmaking facilities, to increase the size of the void for future backfilling and to improve the Site's position in terms of the income base for rehabilitation.

Since, the quarry has been inactive for over 3 years, water entering the sump of the quarry has accumulated over the previous 24+ months of exceptionally wet weather, which had been generally preceded by drought conditions. The quarry is the primary location for the extraction of shale and clay and with further extraction intended. However, the presence of a large amount of water (approximately 200ML) within the quarry void means that extraction operations have been unable to operate, owing to issues of both practicality and safety.

To summarise, the main issues faced are:

- Water body in the quarry void prevents extractive activities and future landform rehabilitation;
- Water body in the quarry void prevents the operation of additional quarry equipment; and
- Rehabilitation of the quarry's void cannot take place.

The above issues are exacerbated following periods of wet weather, with additional water accumulating and further preventing activities. The potential to discharge suitably assessed water following these periods would enable the quarry to be dewatered, allowing activities to be undertaken in line with the Project Approval and management plans before the end of quarrying operations until December 2024.

5.2 Increasing re-use on Site

Theoretically, by reducing groundwater take and substituting the required water used on the Premises with that which is proposed for discharge, the amount of water requiring discharge could be reduced. However, this would not be sufficient to use all of the water collected in the quarry void, with excess still requiring discharge. Table 5 shows the number of options assessed by the proponent with their estimated cost, logistics, timeframes, and feasibility.

The combination of weather (comparatively increased rainfall), and the commencement of use of water intercepted during quarrying activities as well as surface water which drains to and collects in the pit, as an alternative source of water. To further utilise the in-pit water, a soil moisture probe is to be installed in the pastureland to the north of the quarry to determine volumetric water content (VWC). Irrigation is permissible when the VMC is below 34% - the estimated field capacity of the soil.

The proponent also explored the option of irrigating the vegetation which lies in the western and eastern boundaries of the Site within the premises. Due to the additional approvals needed, the timeframe for those approvals, the timeframe

for construction, the inadequate capacity of soils to absorb and retain sufficient amounts of water, additional on-site irrigation is not feasible.

The only solutions for managing excess surface water at the Site are:

- Discharge; or
- intercepting and diverting groundwater that currently infiltrates the void; or
- entering a long period of dry weather, so that water outputs exceed water inputs at the Site scale.

The latter two are not realistic options in the short to medium term especially given the limited time remaining on the consent to complete quarrying activities by December 2024.

5.3 Increasing Storage

Currently, the water entering the quarry pit is the water proposed for discharge, as intended activities within this quarry are unable to be carried out while the water is present. The current Water Management Dam (Sediment Basin 2) on the Site with an estimated storage capacity of 4 ML is already fully accumulated with water because of prolonged rainfall event. The only option to increase water storage on the Site to a sufficient capacity would be the construction of a new dam(s) separate to the location of current activities (so as to not impede on quarrying activities). Establishing a significant new dam on the Site is not practical given the restrictions in the consent.

Furthermore, unnecessary excess storage of water on the property could impact downstream users, with less surface water flowing downstream unimpeded and available for use. Discharging accumulated water that is not required for on-Site use would return this water to the watercourse and allow it to be accessed by downstream users, a net benefit from both agricultural and environmental perspectives. The use of any additionally constructed dams for the transfer and holding of water from the quarry would only offer a temporary solution for a very limited period of time. Once they have reached capacity – whether through the transfer of water from the pit, or inputs from rain and surface water flows – they would no longer offer any additional storage potential for excess water that would continue to accumulate in the pit, especially during wet periods. This is likely to lead to a situation where additional excess water would be held on Site, but with no alternative empty void from which to transport water accumulated in the pit where activities are intended, thus increasing the problem. Based on the above points, we do not find the construction of additional dams on Site to increase water storage to be a practical or feasible solution to the current issue.

5.4 Off-site Reuse

The Proponent also explored the options of off-site reuse of the accumulated quarry water to local projects like M12 motorway and Western Sydney Airport. Discussions with representatives of the Western Sydney Airport were held regarding the re-use of the quarry water on their site, however at the time this was found to be unsuitable. According to the Bureau of Meteorology, the nearest weather station is Badgerys Creek AWS (BOM station number: 067108) which shows the mean annual rainfall for 2022 is 1721mm. This implies that as the quarry is accumulated with excess water (nearly 200ML), the neighbouring sites also do not have the ability to accept water. According to the Western Sydney Airport Surface Water Assessment report, Western Sydney Airport has a total of nine sediment basins onsite which enable capture and re-use of surface water. Out of nine, the two sediment basins (Basin 6 and 7) are expected to discharge a total of 899 ML/year and 573 ML/year of its wastewater to Oaky Creek via a tributary in its Stage 1 development. Further, the regional water balance does not allow for these transfers in a timely way and the time and approvals required for infrastructure to transport water to other Sites is prohibitive. Moreover, the estimated cost of transporting the quarry water to other projects such as Western Sydney Airport is estimated to be $1.5 million with a time frame of 3 years to fully discharge the total $200ML of quarry water, which is not feasible.

The options assessed in the above sections have been presented in Table 5.

Table 5: Assessed options with their estimated cost, timeframe, and feasibility.

Result highlighted in green shows the proposed option for managing excess quarry water.

Assessed options	Logistics/Details	Estimated cost	Estimated implementation requirement	Estimated time frame for implementation	Feasibility
Increasing on Site Reuse	• Pumping • Increased irrigation equipment • Dust suppression equipment • Operational cost	$60,000-$100,000	Approvals from DPIE and Council, Construction	6-8 months	Unfeasible
Increasing Storage	• Construction of sediment dams or above ground storage • Operational/ Management costs • DA Modification	$80,00-$120,000	Approvals from DPIE and Council, Construction	8-12 months	Unfeasible
Off-Site Reuse	• Pumping • Transportation cost • Fuel Disposal cost	$1.5M -$2M	Transportation	15 days- 1 months	Unfeasible
Off-Site Discharge	• Pumping • Fuel • Operational/Management cost • Monitoring Devices	$30,000	Approval from EPA	3-6 months	Feasible

6 Water Balance

6.1 Water Management Storage

There are two sediment dams on the Site: Sediment Dam 1 and Sediment Dam 2. Sediment Dam 1 is located adjacent to the north-east of the quarry pit and hasn't been actively maintained for a long time since the inactiveness of the quarry and is overgrown with vegetation, impeding the dam capacity. This dam doesn't form part of the water management storage for the Site as it is planned to be decommissioned in preparation of future development at the Site (not yet approved). Sediment Dam 2 (referred to as Water Management Dam) has an estimated capacity of 4ML with a catchment size of 0.4ha (4000m^3). The quarry pit has an estimated total catchment area of 12.9 hectare.

The diversion channels and drains placed on site divert the clean water around disturbed areas on Site as far as reasonable and feasible. All the sediment-laden runoff is directed to the quarry pit and the sediment dams (internal water management system).

6.2 The Water Balance assumptions and key conclusions

The water balance predicts the frequency, duration, and volumes of water to be discharged under a typical dry, median, and wet year scenario. The water balance takes into account expected precipitation and evaporation, on-Site usage requirements for haul road, dust suppression, amenities etc. EMM Consulting Pty Ltd (2020) prepared a water review

report and a water balance report under dry, median, and wet rainfall scenario as a part of the Surface Water Impact Assessment for Luddenham Quarry (Modification 5) which has been provided in Appendix 13 and Appendix 14. The summary of the water balance report is shown in *Table 6*.

While it is extremely difficult to develop a completely accurate model due to the huge number of variables involved, we believe the water balance prepared is an accurate estimation of expected water movement on the property.

The inputs to the water management system are:

- Direct rainfall on the storage surfaces i.e., quarry pit and Water Management Dam;
- Runoff from contributing catchments as a result of rainfall;
- Groundwater intercepted by the quarry; and
- Potable water used for dust suppression.

The outputs to the water management system are:

- Evaporation;
- Dust suppression for haul roads; and
- Discharges from the water management system to the Oaky creek.

For this assessment, EMM Consulting used the patched data from the Scientific Information for Land Owners (SILO) for Badgerys Creek McMasters F.Stn Station (BOM station number 67068), which is located 1km north-east of the Site. A 31-year stimulation period was adopted for the water balance using daily rainfall and evaporation data between 1889 and 2019. The water storage capacity for the quarry pit was predicted to be 165ML[2] the predicted groundwater quantity by the quarry pit was assumed to be a constant $5m^3$/day, based on the original groundwater assessment prepared for the quarry by Douglas Nicolaisen and Associates in 2003.

Table 6: Summary of annual water balance report. Source: EMM Consulting Pty Ltd 2020.

	Dry (10th Percentile) Rainfall (ML/Year)	Median (50th Percentile) Rainfall (ML/Year)	Wet (90th Percentile) Rainfall (ML/Year)
Inputs			
Rainfall and runoff	10.7	21.6	45.6
Groundwater inflows into the	1.8	1.8	1.8
Potable water supply	13.4	3.7	1.7
Total inputs	25.9	27.1	49.1
Outputs			
Evaporation	1.8	2.9	4.2
Dust Suppression	24.1	19.8	16.7
Discharge to Oaky Creek	0.0	4.4	28.2
Total Outputs	25.9	27.1	49.1

The water balance result shows that the discharge to Oaky Creek is predicted to occur over eight days in a year with a total volume of 4.4 ML/year in a median rainfall scenario. The 131-year stimulation data analysis predicted that the

[2] *Based on nominal minimum volume considered practical within the quarry pit area; however, the volume will vary with the location of the stockpiles and operation of the open pit area.*

discharges are modelled to occur on 3.32% of days with a maximum daily discharge estimated at 8.8ML/day. It showed that approximately 81% of the demand for dust suppression is supplied by harvested catchment runoff under median (50th Percentile) rainfall conditions. Furthermore, the demand of potable water supply for dust suppression is minimised by the utilisation of water captured water in the quarry pit and Water Management Dam.

It is to be noted that the discharge of accumulated quarry water to off-Site Oaky Creek is a short-term approach. Once the quarry void is emptied and the operational activities are resumed, the water in the quarry void (groundwater inflow and runoff water) is intended to be managed through on-Site reuse only. A new application will be made to the EPA if any future discharge is required for ongoing activities.

7 Potential Contaminants of Concern

7.1 Factors relevant to contaminant selection

In determining the target contaminants for the discharge characterisation and water pollution impact assessment, 4Pillars has considered a range of factors, including:

- the nature and composition of the materials received and stored on Site;
- Site processes;
- industry experience and knowledge of monitoring requirements at similar facilities;
- the sensitivity of the receiving environment and its biota and
- the level of data/guidance available for specific contaminants.

7.2 Selected analytes

Table 7 details the list of analytes selected for the Discharge Characterisation and Water Pollution Impact Assessment. The analytes have been chosen based on the expected potential contaminants present in each material type processed on the Site and the risk they would pose if the contaminants were to enter the nearby waterway. Analytes have been selected as they are broad indicators that can be used to identify contamination at a high level, which can be followed up with analyses for specific pollutants or impacts, if needed. While selecting analytes and analytical methods used by the laboratory, we have ensured that the practical quantitation limit (PQL) or limit of reporting (LOR) for each analyte is low enough to allow comparison with the relevant guidelines (e.g., ANZECC and ANZG).

** The PQL is practical quantitation limit and LOR is limit of reporting for the selected analytes.*

Table 7: Selected analytes for the discharge characterisation and water pollution impact assessment

Analyte	Units	PQL/LOR*	Analyte	Units	PQL/LOR*
pH	pH units	0.01	Nickel (total/dissolved)	mg/L	0.001
Electrical Conductivity (EC)	µS/cm	1	Lead (total/dissolved)	mg/L	0.001
Total dissolved solids	mg/L	10	Selenium (total/dissolved)	mg/L	0.01
Turbidity	NTU	0.1	Zinc (total/dissolved)	mg/L	0.005
Alkalinity (as CO_3)	mg/L	1	Boron (total/dissolved)	mg/L	0.05
Hardness	mg/L	1	Iron (total/dissolved)	mg/L	0.05
Chloride	mg/L	1	Mercury (total/dissolved)	mg/L	0.0001
Calcium	mg/L	1	Hexavalent Chromium (total)	mg/L	0.01
Magnesium (total)	mg/L	1	Cyanide (total)	mg/L	0.004
Sodium	mg/L	1	Ammonia	mg/L	0.01
Potassium	mg/L	1	NO_x (NO_2 + NO_3)	mg/L	0.01
Aluminium (total/dissolved)	mg/L	0.01	Total Kjeldahl Nitrogen	mg/L	0.1
Arsenic (total/dissolved)	mg/L	0.001	Nitrogen (total)	mg/L	0.1
Barium (total/dissolved)	mg/L	0.001	Phosphorus (total)	mg/L	0.01
Cadmium (total/dissolved)	mg/L	0.0001	Phosphate	mg/L	0.01
Chromium (total/dissolved)	mg/L	0.001	Oil and grease	mg/L	5
Copper (total/dissolved)	mg/L	0.001	Chemical oxygen demand (COD)	mg/L	10

Cobalt (total/dissolved)	mg/L	0.001	Benzene	µg/L	1
Biochemical oxygen demand (BOD)	mg/L	2	Toluene	µg/L	2
Organochlorine Pesticides (OCP)	µg/L	0.5	Ethylbenzene	µg/L	2
Organophosphorus Pesticides (OPP)	µg/L	0.5	Xylene	µg/L	2
Total recoverable hydrocarbons	µg/L	100	Carbamate Pesticides	µg/L	0.2
Faecal Coliforms	CFU/100mL	1			

8 Water Sampling Plan

8.1 Sampling Locations

This report has been prepared by assessing the water quality of the quarry pit, upstream and downstream of Oaky Creek and adjacent to the eastern side of the Site from the period 2020 to 2023. Water samples were aimed to be taken in different weather scenarios: dry, during or directly after various levels of rainfall. A rainfall event was defined as an event that produced ≥ 10 mm precipitation in any 24-hr period, as per the nearest Bureau of Meteorology weather station (Badgerys Creek AWS). EMM Consulting Pty Ltd collected water samples on 14 October 2020, 12 February 2021, and 31 August 2022 from the quarry pit, upstream and downstream of Oaky Creek whose sampling locations are shown in Figure 4. 4Pillars also conducted water quality sampling on 23 June, 22 July and 16 August 2022 from the quarry pit and Oaky Creek adjacent to the eastern side of the Site. On 13 January 2023, one upstream sample and two downstream samples were collected by 4Pillars Environmental Pty Ltd. These sampling locations were selected depending on the accessibility of the channel as shown in Figure 3. The data from the year 2020 to 2023 has been used to characterise the predicted discharge under typical and worst-case scenario.

To assess the extent to which the water column in the quarry pit is stratified, initially two samples of water within the centre of the quarry's void were collected on 23 June 2022, as shown in Figure 3. During the sampling event, one sample was collected from a depth of 1 metre (Sample ID: S1) and other from a depth of 9.9 metre (Sample ID: D1).

A total of seven samples from the quarry void (Sample ID: QUARRY), four samples from the Oaky Creek upstream (Sample ID: UPSTREAM), five samples from downstream of Oaky Creek (Sample ID: DOWNSTREAM) and two samples from Oaky Creek (Sample ID: CREEK), adjacent to the eastern side of the Site were collected over the assessment period (Figure 3 and Figure 4) and provide for a range of climatic/seasonal and Site operational conditions, so that potential variations in water quality over time can be assessed.

A variety of appropriate laboratory-supplied sampling containers were used for storage of the sample, which were placed into an esky with ice bricks immediately after collection. Upon completion of sampling, the sample was transported directly to the NATA-accredited laboratory and submitted within the required holding time for all analyses, as shown in the attached laboratory reports (Appendix 11). The sample were analysed for a broad suite of analytes, as shown in Table 7.

8.2 Analysis, QA/QC and reporting

Immediately following collection, samples were placed into a cooler with a target temperature of <4°. Samples were then transported to the selected NATA-accredited laboratory for analysis. All chain of custody documentation is included in this report in Appendix 12.

QA/QC field samples, or analysing spike, blank or rinsate samples were not proposed or necessary. The NATA accredited laboratory conducted their own internal standard QA/QC procedures, including sample duplicate analysis, and these results can be found in their report. Due to the small number of samples and the low risk for incorrect procedure, cross-contamination (sampling equipment is discrete for each sampling point and is not re-used), or other means of introducing bias in the field, this approach is appropriate.

9 Result presentation and other parameters

9.1 Results

Results have been displayed in four separate tables in Appendix 2, Appendix 3, Appendix 4, and Appendix 5, Appendix 6, Appendix 7, Appendix 8, and Appendix 9 are later discussed and compared where appropriate in *Section 10.*

9.2 Criteria

All laboratory certificates of analysis have been attached in Appendix 11 and Appendix 12 for all sampling events.

9.3 Toxicants

Toxicants is a term used for chemical contaminants that have the potential to exert toxic effects at concentrations that might be encountered in the environment. As mentioned in Section 2.2.3, trigger values for toxicants (e.g., metals, total recoverable hydrocarbons etc) the ANZECC (2000) default trigger values and ANZG (2018) DGVs were applied for ***Lowland rivers which were Slightly to Moderately Disturbed Ecosystems.***

It is noted that for metals, their toxicity in water is affected by many factors which control the availability of metals to aquatic organisms. The ANZECC guidelines indicate that metals are absorbed strongly onto suspended material and complexed by natural dissolved organic matter. Toxicity is understood to decrease with increased salinity and water hardness reduces metal update and corresponding toxicity. The ANZECC (2000) guidelines provide algorithms in Table 3.4.3 for some metals, where a revised trigger value can be calculated, based off the influence of water hardness and pH.

The use of revised trigger values is encouraged in the ANZECC (2000) guidelines as it supports the current National Water Quality Management Strategy's (NWQM) view to move away from relying solely on chemical guideline values for managing water quality, to the use of integrated approaches, including chemical-specific guidelines coupled with water quality monitoring.

9.4 Physical and chemical stressors

For default trigger values for physical and chemical stressors, thresholds were selected from Tables 3.3.2-3.3.3 from ANZECC (2000) guidelines for slightly disturbed ecosystems in southeast Australia for lowland rivers.

9.5 Weather conditions prior to and during sampling

We have considered that the close and most representative weather monitoring station is located at Badgerys Creek AWS (Station No 067108). We have obtained the statistical values from the Bureau of Meteorology for that station presented in *Table 8*.

Table 8: Daily rainfall from BOM Badgerys Creek (closest BOM weather station) for the months of September 2021 to August 2022. Samples highlighed in green, blue and orange indicate the highest rainfall daily event in the month and sampling dates performed by 4Pillars and EMM Consulting respectively.

Badgerys Creek 2021-2022																				
	2021												2022							
Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	July	Aug
1	0	0	0	0	0.2	0	1	0	0	0.6	0	0.2	0	0	31.4	1.4	0.2	2	0	0.2
2	2.6	34.6	0	0	0.2	0	3.6	0	0	10.6	0	0	0	12	40	0	0.2	0	5.2	0
3	2.2	0.2	0	0	0.2	2	0.2	1.4	0	14.2	0	0	0	0.2	145.6	0	0	0	121.8	0.2
4	1.8	0	0	0	0.2	7.4	0	0	0	0	0	0	0	0	12.6	0	0	0.6	29.6	0
5	11.8	0	0	0	15	0	0	0	9.6	0	41	1	0.2	1.6	1.8	0	0.8	0	75.2	2.0
6	12.8		0	0	14.8	0	0	0	0.2	0	4.8	0	57.8	3.4	79.4	2	0	0	0.6	0.2
7	0.2	2.6	0	1.2	28	0	0	0	0	0	0.2	0.4	13.6	8.4	36.2	32	0.4	0	2.2	0
8	4.2	0.6	0	3	0.4	0	0	0	0	0.6	0.4	4	26.2	0.6	40.8	18.6	0	0	0.2	0
9	0	0.2	0	0	0.2	4.6		0.8	0	0	3.2	4.6	9.2	0	30.8	8.6	0	0	0	0
10	0	0	0	0	0	0.2	6.6	0	0	0	0.6	43.4	1.4	0	0	17.2	1	0	5.8	0
11	0	0	2	0.2	0.2	8.6	0	0	0	9	0.2	6	0.2	0.6	0	0	12.4	0	2.8	0.2
12	0	0	6	0	7.2	0	0.4	0	0	0	0	0.2	0	2	0.6	0.2	13	0	0	0
13	0	18.2	3.4	0	0	0	0	0	0	4.4	0	0	14.4	10.2	0.2	0	7	0	0	4.2
14	0	9	17.4	0	0	0	0	0	4.8	12.2	0	0	24.4	0	0	2.4	0	0	0	0.4
15	0	0	9	0	0	0	0	0	0	14.6	0	0	0.6	0	0	0.2	0.2	0	0	0
16	0	1.4	0	0	0	0.2	2.4	0	0	1	0	2.2	5.2	0	3.8	0	0	0	0	0
17	0	9.8	4.2	0	0	10.8	2.4	0	0	0	0	0.2	0	0	3.4	0	0	0	0	0
18	0	0.6	11.4	0	0	0	0	0	0	0	0	0	0	14.6	0.2	0	0	0	0	0
19	0	10.6	51.2	0	0	2.2	0	0	0	0	0.4	12	11.4	3	8	0	0	0	0	0
20	0.4	0.2	28	0	0	0	0	0	0	1	0	0	2.6	0	1.8	9.4	0	1.6	2.2	0
21	0	0	109.2	0		0.8	0	0	0	1.2	11.4	0.2	1	0.2	0	0.2	9	0	2.2	0
22	0	0	60.2	0	0.2	-	0	0	0	0	10.4	0	0.8	2.4	0	0	3.4	0	16.6	0
23	0	0	48	0	0	-	0.6	0	0	0	1.2	0	0.2	18.6	0	3.4	0	0	8.4	0
24	0	0.4	21.6	0	2	-	0.4	26	0	10	0.2	0	0.6	25.8	0	0	1.2	0	1.4	14.6

25	0	4	0.2	0.4	0.2	2.2	0	21.6	0	2.8	28.4	0	0.2	28.4	9.8	0	0	0	0	0
26	0	7	0	0	0	0	0	0	0.2	0.2	27.4	7.8	0	41.2	14	0	0.2	0	5.6	0.2
27	0.2	0.2	0	0.2	0	0	0	0	0	0	14.2	0.4	0	14.4	10.6	0.8	0	0	0.2	0.4
28	2.6	0.2	0	0	-	0	0	0	0	0	0.8	13.8	0	6.8	21.8	3.2	0	0	0	9.4
29	8	-	0	0	0	0	0	0	0	0	0.2	0.2	0	-	49.6	7	0	0	0	0
30	18.6	-	0	0	0	2.8	0	0	3.4	0	0	0	0	-	18.4	11.8	0	0	0	0.8
31	1.6	-	0	-	0	-	0	0		0	-	0	0	-	0.6		3	0	0	0
Highest Daily	**18.6**	**34.6**	**109.2**	**3**	**28**	**10.8**	**6.6**	**26**	**9.6**	**14.6**	**41**	**43.4**	**57.8**	**41.2**	**145.6**	**32.0**	**13.0**	**2.0**	**121.8**	**14.6**
Monthly Total	**67.0**	**99.8**	**371.8**	**5.0**	**69.0**	**41.8**	**17.6**	**49.8**	**18.2**	**82.4**	**145.0**	**96.6**	**170.0**	**194.4**	**561.4**	**118.4**	**52.0**	**4.2**	**280.0**	**32.8**

10 Water Quality Results

10.1 Total Dissolved Solids (TDS)

Total dissolved solids (TDS) are the measure of all inorganic and organic substances in water. The most common chemical constituents are phosphates, nitrates, sodium, calcium, and chloride which can be found in runoff which has contacted soil material and waste.

QUARRY TDS

While total dissolved solids don't have a recommended trigger value for freshwater ecosystems, they do have a normal range of 3,000-35,000 mg/L was for brackish water (table 4.4.2 of the ANZECC (2000) guidelines). TDS have a direct impact on hardness, conductivity and the nutrient concentrations and can impact the toxicity of metals in surface water.

Concentrations in the water sampled at QUARRY ranged from 2120 mg/L to 3790 mg/L. This can be expected due to the nature of Site operations, with large soil stockpiles of materials being stockpiled and processed on Site, which often require wetting down.

CREEK TDS

TDS results for CREEK were ranged from 530 to 930 mg/L. TDS results for CREEK were significantly less than QUARRY.

UPSTREAM TDS

TDS results for UPSTREAM were between 463 mg/L to 472 mg/L. TDS results for UPSTREAM were significantly less than QUARRY and CREEK.

DOWNSTREAM TDS

TDS results for DOWNSTREAM ranged from 398 mg/L to 624 mg/L.

10.2 Total Hardness

Hardness is defined as the concentration of all metallic cations, except those of the alkali metals, present in the water. Generally, hardness is a measure of the concentration of calcium and magnesium ions in water. The constituents that contribute to hardness (i.e., calcium and magnesium ions) are not toxic.

While total hardness doesn't have a recommended trigger value, it does have a recommended range from 20 to 100 mg/L. Hardness is understood to have an impact on the toxicity of metals in certain water bodies.

QUARRY Hardness

The hardness levels recorded in samples taken from QUARRY were consistently high, ranging from 97 mg/L to 635 mg/L.

CREEK Hardness

Hardness in CREEK ranged from 95 mg/L to 413 mg/L.

UPSTREAM Hardness

Hardness in CREEK ranged from 78 mg/L to 303 mg/L.

DOWNSTREAM Hardness

Hardness in CREEK ranged from 49 mg/L to 174 mg/L.

10.3 Alkalinity

Alkalinity measures the total amount of bases in water. It is considered a capacity factor that represents the acid neutralising capacity of an aqueous system. High levels of alkalinity allow buffering against sudden changes in pH. They are able to do this by absorbing hydrogen ions when the water is acidic or by releasing them, when the water becomes basic.

While there is no trigger value or DGV for alkalinity, table 4.4.2 of the ANZECC (2000) guidelines recommends an Alkalinity of > 20 mg/L.

Water samples from both QUARRY and CREEK have been consistently well buffered with alkalinity well above 20 mg/L with values ranging from 321 mg/L to 363 mg/L and 33 mg/L respectively. The UPSTREAM and DOWNSTREAM alkalinity were 38 mg/L and 16 mg/L respectively.

10.4 Turbidity

Turbidity has a range of 6-50 NTU which is indicative of slightly disturbed ecosystems in south-east Australian lowland rivers. Turbidity in lowland rivers can be extremely variable. The higher range is often found in rivers draining slightly disturbed catchments and in many rivers at high flows.

QUARRY Turbidity

Turbidity results for QUARRY were consistently under the range for slightly disturbed ecosystem in south-east Australian lowland rivers during Site sampling. Results ranged from 1.3 NTU to 6.5 NTU. Positive correlation was seen between Turbidity and rainfall.

CREEK Turbidity

Turbidity results for CREEK were consistently high and visible during Site sampling. Results ranged from 308 NTU to 1300 NTU, with an average of 804 NTU. There was positive correlation with rainfall as the sample taken during light rainfall produced a higher result.

UPSTREAM Turbidity

Turbidity results ranged from 12.6 NTU to 125 NTU, with an average of 69.03 NTU.

DOWNSTREAM Turbidity

Downstream turbidity results ranged from 6.4 NTU to 67.9 NTU, with an average of 22.65 NTU. One out of five samples exceeded the recommended trigger value for NSW low land river.

10.5 Conductivity

QUARRY Conductivity

The conductivity recorded in QUARRY ranged from 3170 $uScm^{-1}$ to 5970 $uScm^{-1}$. The recommended default trigger values for conductivity in lowland rivers are within a range of 125-2200 $uScm^{-1}$. While these Conductivity results exceed the chronic trigger thresholds for ANZECC (2000) lower river ranges, these elevated levels of conductivity have been reported in the lower parts of the South Creek Catchment with approximately 25% of the area potentially salt affected as such are not considered significant exceedances. The primary causes of the salinity are the increased waterable recharges due to reduced vegetation water use by land clearing, over irrigation of golf courses, sport fields, parks, gardens, crops and improved pastures, and leakage from farm dams, water supply and stormwater services.

CREEK Conductivity

Comparatively, conductivity results for CREEK were significantly lower, with the average conductivity being 641.5 $uScm^{-1}$.

UPSTREAM Conductivity

Conductivity upstream of Oaky Creek ranged from 851 $uScm^{-1}$to 2272 $uScm^{-1}$.

DOWNSTREAM Conductivity

Conductivity downstream of Oaky Creek ranged from 773 $uScm^{-1}$ to 1118 $uScm^{-1}$.

10.6 pH

QUARRY pH

The chronic trigger value for pH is 6.5 to 8.5 for slightly to moderately disturbed lowland river. QUARRY recorded exceedances in five of the seven samples for pH. These exceedances were as follows: 8.6, 8.65, 8.66, 8.69. It is noted that given the alkalinity of the water present, there is a significant buffer capacity in the waters if they were to overflow/runoff, which would potentially work gradually to control the pH levels from exceedances of this range.

CREEK pH

The pH for CREEK was within the recommended range with results of 6.99 and 7.53.

UPSTREAM pH

The pH for UPSTREAM was within the recommended range with results of 6.57 and 7.85.

DOWNSTREAM pH

The pH for DOWNSTREAM was also within the recommended range with results of 6.87 and 7.83.

10.7 BOD 5 day

The presence of sufficient concentration of dissolved oxygen is key to maintaining aquatic life and water quality. The decay of organic matter in water is measured as biochemical oxygen demand. The BOD 5-day test measures the oxygen depletion rate used by bacteria over a standard length of time (5 days).

The recommended trigger values in freshwater production for aquaculture protection suggests a BOD of <15 mg/L. Typical values in pristine streams are below 1 mg/L while moderately degraded waterbodies are seen to have values between 2 to 8 mg/L.

QUARRY BOD 5 Day

All results for QUARRY returned results below the 15 mg/L threshold, with results ranging <2 mg/L for both samples.

CREEK BOD 5 Day

All results for CREEK returned results below the 15 mg/L threshold, with results ranging from <2 – 2 mg/L.

10.8 Nutrients – Nitrogen

Nitrogen is an essential nutrient for plant and animal growth, however an excess in nitrogen concentration in waters can cause excess excessive growth of aquatic plants, reduction in oxygen levels in the water and toxic conditions for ammonia and nitrates.

Nitrate (NO_3), Nitrite (NO_2) and ammonia (NH_3 and NH_4) are the most common forms of available nitrogen for plant grown.

Total Kjeldahl Nitrogen (TKN) consists of ammonia and organic forms of nitrogen. Oxidised nitrogen also referred to as NOx consists of nitrate (NO_3) and nitrite (NO_2). The addition of both NO_x and TKN makes up Total Nitrogen (TN).

QUARRY Nitrogen

All samples returned concentrations which exceeded the chronic trigger value of 0.5 mg/L with exceedances of 1.8 mg/L, 2.2 mg/L, 3.3 mg/L, 5mg/L and 7.9 mg/L. It is noted that ammonia levels for the samples were below the chronic trigger value of 0.02 mg/L except for one sample (0.06 mg/L).

These elevated results can be expected given the nature of Site operations and the material received on Site. The Site consists of vegetative bunds and pasture lands, both of which have high potential for breakdown and release of nutrients such as phosphorus and nitrogen.

CREEK Nitrogen

Samples for CREEK all returned concentrations of TN above the chronic trigger value of 0.5 ug/L with exceedances of 2 mg/L and 1.9 mg/L.

UPSTREAM Nitrogen

The concentrations of total nitrogen exceeded in three of the five samples. It ranged from 0.4 mg/L to 11.8 mg/L.

DOWNSTREAM Nitrogen

The concentrations of total nitrogen exceeded in one of the five samples. It ranged from 0.2 mg/L to 1.3 mg/L.

10.9 Nutrients – Phosphorus & Phosphate

Phosphorus is an essential nutrient for sustaining aquatic ecosystems. Similarly, to nitrogen, excess of this nutrient can lead to excessive growth of aquatic plants and depletion of available oxygen in the water body. Phosphorus occurs in dissolved forms and particulate forms. Total Phosphorus measures both the both the dissolved and particulate forms of phosphorus, while Phosphate or Reactive Phosphorus measures the bioavailable component of phosphorus.

QUARRY Phosphorus & Phosphate

The reactive phosphorus (phosphate) returned concentrations which were below the chronic trigger value of 0.02mg/L. The concentration of total phosphorus exceeded the chronic trigger value of 0.05 mg/L in two of the seven samples with values of 0.13 mg/L and 0.36 mg/L.

CREEK Phosphorus and Phosphate

Both total phosphorus and reactive phosphorus (phosphate) returned concentrations which were below the chronic trigger value of 0.05 mg/L and 0.02mg/L respectively.

UPSTREAM Phosphorus and Phosphate

The reactive phosphorus (phosphate) returned concentrations which were below the chronic trigger value of 0.02mg/L. The concentration of total phosphorus exceeded the chronic trigger value of 0.05 mg/L in one of the four samples with value of 0.58 mg/L.

DOWNSTREAM Phosphorus and Phosphate

The reactive phosphorus (phosphate) returned concentrations which were below the chronic trigger value of 0.02mg/L. The concentration of total phosphorus exceeded the chronic trigger value of 0.05 mg/L in one of the five samples with value of 0.11 mg/L.

10.10 Hydrocarbons and Oil and Grease

Oil and Grease was found to be below the detectable limit of 5 mg/L.

QUARRY Hydrocarbons

QUARRY recorded all samples below the detectable limit. No detects for Oil and Grease during sampling.

CREEK Hydrocarbons

CREEK recorded all non-detects. No detects for Oil and Grease during sampling.

10.11 Metals

Metals in water can be present in either dissolved (soluble) or particulate (insoluble) state. Dissolved metals are the soluble metals in the medium, while the total metals are the dissolved metal concentration + particulate(insoluble) metal concentration. It is important to know both concentrations when evaluating water quality, as elevated concentrations of dissolved metals often pose a more difficult treatment challenge/ management.

As such, Samples were analysed for both total and dissolved metals. It is understood that the water medium has a high level of conductivity and dissolved solids, likely due to the content and large quantity of waste materials located and

processed on Site. It is understood that revised/corrected trigger values to account for water hardness and pH for freshwaters are applicable and they have been included as a more appropriate reference point in the summary tables.

A total of 15 metals were analysed, these included Aluminium, Arsenic, Cadmium, Chromium, Hexavalent Chromium, Selenium, Barium, Boron, Cobalt, Copper, Iron, Lead, Nickel, Zinc and Mercury. Not all these metals have respective DGVs. As such they were compared against ANZG freshwater DGVs.

QUARRY Dissolved Metal Results:

Aluminium concentration for dissolved metal was below concentration for the 95% & 90% species protection for fresh water in six of the seven samples. It exceeded the chronic trigger value in one sample with a value of 80 mg/L.

Selenium concentration for dissolved metals was slightly higher than the recommended trigger value for 99% species protection for fresh water with an exceedance value of 10 ug/L. DGVs for 99% species protection level is recommended for slightly to moderately disturbed systems due to the potential for bioaccumulation.

Arsenic concentration for dissolved metal was extremely below concentration for the 95% & 90% species protection for fresh water.

Chromium concentration was below the detectable limits.

Cobalt was below the detectable limits.

Cadmium concentration for dissolved metal recorded below the 95% & 90% species protection for fresh water.

Copper exceeded on five of the seven samples taken. Copper exceedances ranged from 1.67 ug/L to 8 ug/L above the 1.4 ug/L and 1.8 ug/L for 95% and 90% species protection in fresh waters. The Site-specific revised trigger value was calculated dependent on the hardness of the water by using ANZECC 2000 guidelines table 3.4.3. The concentrations of copper were below the revised trigger value.

Nickel concentration for dissolved metal was extremely below concentration for the 95% & 90% species protection for fresh water.

Lead concentration for dissolved metal was below concentration for the 95% & 90% species protection for fresh water.

Mercury concentration was below the detectable limit.

Zinc was significantly elevated compared to other metals in three out of seven samples. The recorded results of zinc ranged from <5 ug/L to 19 ug/L. The Site-specific revised trigger value was calculated dependent on the hardness of the water by using ANZECC 2000 guidelines table 3.4.3. The concentrations of zinc were below the revised trigger value.

CREEK Dissolved Metal Results

Aluminium concentration for dissolved metal was below concentration for the 95% & 90% species protection for fresh water.

Selenium concentration for dissolved metals was slightly higher than the recommended trigger value for 99% species protection for fresh water with an exceedance value of 10 ug/L. DGVs for 99% species protection level is recommended for slightly to moderately disturbed systems due to the potential for bioaccumulation.

Arsenic concentration for dissolved metal was well below concentration for the 95% & 90% species protection for fresh water.

Chromium concentration was below the detectable limits.

Cobalt was below the detectable limits.

Cadmium concentration for dissolved metal recorded below the 95% & 90% species protection for fresh water.

Copper exceeded on one oof the two samples taken. Copper exceeded with a value of 2 ug/L, above the 1.4 ug/L and 1.8 ug/L for 95% and 90% species protection in fresh waters.

Nickel concentration for dissolved metal was extremely below concentration for the 95% & 90% species protection for fresh water.

Lead concentration for dissolved metal was below concentration for the 95% & 90% species protection for fresh water.

Mercury concentration was below the detectable limit.

Zinc was significantly elevated compared to other metals in one out of two samples. The recorded results of zinc ranged from <5 ug/L to 21 ug/L.

UPSTREAM Dissolved Metal Results

Aluminium concentration for dissolved metal was below concentration for the 95% & 90% species protection for fresh water.

Arsenic concentration for dissolved metal was extremely below concentration for the 95% & 90% species protection for fresh water.

Chromium concentration was below the detectable limits.

Cobalt was below the detectable limits.

Manganese concentration for dissolved metal recorded below the 95% species protection for fresh water.

Cadmium concentration for dissolved metal recorded below the 95% & 90% species protection for fresh water.

Copper exceeded on three of the four samples taken. Copper exceedances ranged from 2 ug/L to 14 ug/L above the 1.4 ug/L and 1.8 ug/L for 95% and 90% species protection in fresh waters.

Nickel concentration for dissolved metal was extremely below concentration for the 95% & 90% species protection for fresh water.

Lead concentration for dissolved metal was below concentration for the 95% & 90% species protection for fresh water.

Boron concentration for dissolved metal was below concentration for the 95% & 90% species protection for fresh water.

Zinc was significantly elevated compared to other metals in two out of four samples. The recorded results of zinc ranged from <12 ug/L to 26 ug/L.

DOWNSTREAM Dissolved Metal Results

Aluminium concentration for dissolved metal was below concentration for the 95% & 90% species protection for fresh water.

Arsenic concentration for dissolved metal was extremely below concentration for the 95% & 90% species protection for fresh water.

Chromium concentration was below the detectable limits.

Cobalt was below the detectable limits.

Manganese concentration for dissolved metal recorded below the 95% species protection for fresh water.

Cadmium concentration for dissolved metal recorded below the 95% & 90% species protection for fresh water.

Copper exceeded on one of the five samples taken with a value of 3 ug/L which is above the 1.4 ug/L and 1.8 ug/L chronic trigger values for 95% and 90% species protection in fresh waters.

Nickel concentration for dissolved metal was extremely below concentration for the 95% & 90% species protection for fresh water.

Lead concentration for dissolved metal was below concentration for the 95% & 90% species protection for fresh water.

Boron concentration for dissolved metal was below concentration for the 95% & 90% species protection for fresh water.

Zinc concentration for dissolved metal was below concentration for the 95% & 90% species protection for fresh water.

11 Characterise the quality of the predicted discharge under typical and waste case scenario

Uncontrolled discharges from the quarry pit are impossible considering the depth of the clay/shale extraction workings/water level beneath the natural surface level, meaning that only controlled discharges can occur, when water quality and other factors are considered suitable. Rather than attempting to determine what would constitute a typical and worst-case scenario, and characterising the quality of predicted discharges accordingly, we propose to prescribe limits within which the water would be considered suitable for discharge. When analysis of the water is identified as exceeding or otherwise outside of these limits, no discharge will be permitted to occur, and as such, no 'worst case' scenario is anticipated. As such, at 'worst', the quality of a controlled discharge that occurs will be consistent with the limits proposed.

Notwithstanding the above, we believe it is appropriate to understand the expected quality of water within the pit proposed for discharge through a characterisation study. The sampling plan for the characterisation has been discussed in *Section 10*. The results from samples collected on 23 June 2022 were comparable, with no significant differences in water quality between surface sample and sample collected at depth. As no significant differences were observed between samples collected at surface and depth, within the quarry pit, we consider that the water within the pit is generally consistent throughout. The temperature of the quarry water in both depths taken during sampling using a probe on the field were within a difference of approximately 2^{o}C. This suggests that there is no significant thermocline. As such, a sample collected at any location can be considered representative of water within the pit. It is therefore appropriate to obtain pre- and during- discharge samples from a single location, as detailed in Statement of Environment Effects (SEE).

Results obtained from the water samples showed that the total hardness was consistently high over the sampling regime. It is noted that in some cases, these high levels of dissolved solids allow for the water body to have the capacity to complex certain metals and reduce their overall toxicity. Salinity (Electrical Conductivity) in the quarry pit ranged from 3170 uScm^{-1} to 5970 uScm^{-1} with an average of 4476.57 uS/cm. While these Conductivity results exceed the chronic trigger thresholds for ANZECC (2000) lower river ranges, these elevated levels of conductivity can be seen in the middle and lower levels of the South Creek. It is noted that the salinity in the area is considerably higher due to cleared agricultural land. This is typical for inland watercourses in NSW that have catchments dominated by agricultural land uses. Among the analysed metals, three metals exceeded throughout the sampling regime. Copper had elevated concentrations which ranged from 1.67 ug/L to 8 ug/L and were above the concentration of 1.4 ug/L and 1.8 ug/L for 95% and 90% species protection in fresh waters. A revised Site-specific trigger value dependent on the hardness of the quarry water was generated by using the table 3.4.3 of ANZECC 2000 guidelines for Cadmium, Chromium, Copper, Nickel, Lead and Zinc. Concentrations of these metals in all the quarry water samples were below the revised trigger value. Selenium exceeded on all occasions for 99% species protection level as it is recommended for slightly to moderately disturbed systems due to the potential for bioaccumulation while zinc experienced two exceedances. These metals concentrations are considered to be characteristic of a quarry of this nature. Hexavalent Chromium concentration was below the LOR limit in the CREEK. It is known that the toxicity of hexavalent chromium in water decreases with the increase in hardness, salinity, and alkalinity. Alkalinity level was consistently well buffered with alkalinity well above 20 mg/L with values ranging from 321 mg/L to 363 mg/L. This would provide considerable buffering for water stored on Site. The turbidity levels were consistently low with result ranging from 1.3 NTU to 6.5 NTU. The BOD 5-day results were below the 15 mg/L threshold, with results ranging from 2 mg/L to 2mg/L. The available nutrient concentrations were high, as expected. For nitrogen, all samples returned concentrations which exceeded the chronic trigger value. It is noted that ammonia levels were below the chronic trigger value except one sample. The Site consists of vegetative bunds and pasture lands, both of which have high potential for breakdown and release of nutrients such as phosphorus and nitrogen. It is noted that the water in the pit can be considered phosphorus limited, with reactive phosphorus being below the recommended chronic trigger values, meaning although nutrient levels are high, there is a low possibility of eutrophication or excess toxic conditions. TRH and Oil and Grease were below the detectable limits. Result obtained by EMM Consulting showed elevated level of Electrical Conductivity (EC), ammonia, total Nitrogen, total Kjeldahl nitrogen, Nickel, and turbidity in the quarry pit.

11.1 Characterisation of upstream and downstream quality of receiving water

A surface water sample was obtained by EMM Consulting Pty Ltd on 14 October 2020, 12 February 2021, and 31 August 2022 upstream and downstream of Oaky Creek. An additional two downstream samples and one upstream sample of Oaky Creek were collected by 4Pillars Environmental on 13 January 2023. Results from water quality upstream of Oaky Creek showed elevated amount of total nitrogen in three of the four samples, slightly elevated EC in one sample, elevated ammonia and nitric oxides concentration and dissolved heavy metals like copper and zinc.

Downstream water quality result showed that the pH was slightly lower than the water collected at the pit with a value between 6.87 and 7.83. Turbidity fell within the range for default trigger values presented in Table 3.3.3 of the ANZECC (2000) guidelines for lowland rivers of 6-50 NTUs (average result 22.65 NTUs) except one sample. Electrical conductivity was also within the default trigger values at an average of 962.6 µS/cm. All the analysed metals concentration was under the chronic trigger values of ANZG (2018) except copper in one sample. Total nitrogen and total phosphorus showed exceedances in one of the samples each with value of 1.3 mg/L and 0.11 mg/L respectively. The reactive phosphorus was within the range for default trigger values except for one sample. The results have been presented in Appendix 7, Appendix 8, and Appendix 9. Overall, the water quality of upstream, downstream of Oaky Creek and adjacent to the eastern side of the Site reveals elevated levels of dissolved metals, nutrients such as nitrogen, phosphorus, and ammonia.

12 Anthropogenic pollutants

The proposed discharge of water will be directly from the quarry void at the lowest point in the main shale/clay pit. The quarry has been inactive for more than 3 years and the accumulated water in the quarry pit is because of the prolonged extreme weather conditions. Potential anthropogenic pollutants would be associated with quarry equipment, in particular potential 'small' oil spills originating from leaks (seals) and possible (but improbable) hydraulic line failures. It is noted that almost all refuelling, and all maintenance of mobile plant is carried out outside of the shale/clay extraction area/s. The potential for direct contamination of retained water in the sump by hydrocarbon products is considered low.

Based on the shale/clay extraction activities, the following areas of potential environmental concern are listed below in *Table 9.*

Table 9: Potential anthropogenic Contaminants of Concern.

Potential Contaminants of Concern		
Potential Contaminants	**Quarry Activities**	**Dispersion Mechanism & Areas of Environmental Concern (AEC)**
Oils and Grease	Earthmoving machinery including excavators and haul trucks, and light support vehicles	Potential oil, fuel leaks and spillage

13 Assessment of the Potential Impact of Discharges on the Environmental values of the Receiving Waters

13.1 Background Conditions of the Receiving Surface Water Environment

The Site is located within the Oaky Creek catchment. Oaky Creek is an ephemeral watercourse which forms the eastern boundary of Site and has a total contributing catchment area of approximately 361 ha. The creek rises approximately 2km to the south of the Site and flows generally in a northerly direction. The creek continues downstream of the Site for approximately 0.9km before joining Cosgroves Creek. Oaky Creek falls within the Hawkesbury- Nepean Catchment, which is managed under the Greater Sydney Local Land Service Transition Catchment Action Plan (NSW Catchment Management Authority 2014) and is interpreted to be within the Upper South Creek Management Zone.

Downstream of Elizabeth Drive, Oaky Creek continues for further half a kilometre before discharging into Cosgroves Creek. Cosgroves Creek then continues for another seven kilometres before joining South Creek. In the reach between Oaky Creek and Cosgroves Creek, it passes through rural lots, The Twin Creeks Golf and Country Club and beneath an above-ground Sydney Water Corporation water mains pipeline. The catchments are largely rural and without residential development downstream of the Site, with the exception of the Twin Creeks residential estate located towards Cosgroves Creek's confluence with South Creek.

Oaky Creek is considered to be 'moderately disturbed', a consequence of historical and current agricultural and grazing activities including the current development of Western Sydney Airport. The creek is also classified as 'lowland river' as

the elevation of the Site is less than 150m. Signs of high salinity outbreaks have been reported in the lower parts of the South Creek Catchment with approximately 25% of the area potentially salt affected. The primary causes of the salinity are the increased water table recharges due to reduced vegetation water use by land clearing, over irrigation of golf courses, sport fields, parks, gardens, crops and improved pastures, and leakage from farm dams, water supply and stormwater services. The drastic change in land-use from native vegetation, to agriculture, to urbanisation in the catchment has brought about significant hydrologic changes in terms of water quantity and quality. Water quality in South Creek and its tributaries is already severely degraded by the discharges of high nutrient effluents from both point sources (mainly Sewage Treatment Plants effluents) and diffuse sources (agriculture and stormwater runoff).

13.2 Assessment of Potential Impacts

Sampling and testing of quarry water from the void and receiving water (Oaky Creek) provides a baseline assessment of water quality and enables a comparison against the water quality guidelines for the environmental values. Analytical results for the discharge and receiving waters are summarised in Appendix 2, Appendix 3, Appendix 4, Appendix 5, Appendix 6, Appendix 7, Appendix 8, and Appendix 9.

In summary:

- Similar, low concentrations of ammonia were detected in both waters.
- The BOD concentrations were similar with results of either equal or lower detectable limits.
- The hardness of the water was 'extremely hard' in both quarry and receiving water. Total hardness results were consistently high, ranging from 97 mg/L to 635 mg/L over the sampling regime for quarry water. It is noted that in some cases, these high levels of dissolved solids allow for the water body to have the capacity to complex certain metals and reduce their overall toxicity.
- TRH and Oil and grease were below detectable limit for both waters.
- Reactive phosphorus was recorded low in both the quarry and receiving waters. The detection of total nitrogen and total phosphorus likely reflects past agricultural activities and pasture lands (e.g., fertilizer application). Ammonia levels were higher in receiving water than quarry water.
- Out of 15 metals, three dissolved metals (Copper, Zinc and Selenium) resulted exceedances in quarry pit and receiving water.
- pH and EC values were comparatively different. Both waters are highly alkaline with moderate to high salinity. It is noted that the quarry water was more saline. The high amount of aluminium found within the creek water is thought be the reason for low pH in creek water. This may be a fingerprint of Alum flocculant use higher in the catchment, or the use of agricultural soil additives containing Al.

In summary, the results of the water sampling in the quarry, upstream and downstream of Oaky Creek reveal that the quarry water contains slightly higher pH and electrical conductivity as compared to the creek.

13.3 Downstream Impacts

The flow regimes of Oaky Creek and downstream watercourses have been extensively modified by land clearing, agriculture, extractive activities, and urban and industrial development in the catchment, including the current Western Sydney Airport development. The catchment is largely rural and without residential development downstream of Oaky creek with the exception of the Twin Creeks residential estate towards Cosgrove's Creek's confluence with South Creek. The land use downstream of the Site consists of forest, horticultural, grazing (both naturalised and modified pastures).

The discharge of quarry water may result in increasing downstream flow durations and/or increased hydraulic shear stress can exacerbate erosion of the bed and banks of watercourses channels downstream of the creek. The downstream impact in regard to sedimentation and erosion will be assessed further as a part of the discharge trial through a baseline photo monitoring system. Monitoring conducted downstream will involve:

- Establishing photo point monitoring downstream of the watercourse (depending on the accessibility of the watercourse);
- At the end of each campaign, lab analysis of water quality comparative samples will be taken from the pit and downstream to measure pH, TDS, and conductivity;
- Quarterly water quality comparative samples upstream and downstream to identify water quality impacts associated with the dam overflow; and

- Real time automated monitoring device will be installed upstream and downstream of the watercourse to measure pH, conductivity, and TDS.

It should be noted that the area has experienced some extremely heavy rain events in recent times, from which surface water flows in the creek are expected to have been high. It is assumed that if the waterway was able to remain unaffected or withstand damage from these events, then the discharge of water during a discharge campaign should not cause any detrimental impact.

14 Flow Characteristics of Oaky Creek

The Strahler stream order of mapped watercourses shows that Oaky Creek is a 3rd order watercourse which is a tributary of Cosgroves Creek. The creek is characterized by a meandering shallow channel surrounded by dense vegetation, debris and scoured pools.

Technical assessment documents prepared for the Western Sydney Airport EIS[3] (2016) state that the estimated flow rate in Oaky Creek will be as presented in *Table 10*.

Table 10: Flow rates in Oaky Creek, as per the Western Sydney Airport EIS.

Rainfall event	Existing (m^3/s)	Stage 1 (Construction) (m^3/s)	Long term (post construction) (m3/s)
1 Year ARI 24 hours (77 mm)	7.4	3.1	3.0
100-Year ARI (24 hours) (240 mm)	34.3	12.8	12.5

The data presented in the Western Sydney Airport EIS are the most detailed flow rate estimates available for Oaky Creek. The reduction in flow rates after commencement of airport works is due to the large storages on the airport Site, which provide buffering capacity to pulses in water flow. We note that flow rate in watercourses is a function of rainfall, but also many other factors that are difficult to model in a simple manner. However, we believe that it is possible to estimate conservative flow rates for Oaky Creek that could be used to support decision-making.

The relationship between rainfall in a catchment and flow rate in waterways is not linear. It tends to increase at a faster rate with increasing rainfall, due to a decreasing capacity for land to absorb water as rainfall events progress over time. This is sometimes referred to as the 'rainfall excess' and in runoff curve number models[4] is dependent on several factors, in particular, the representative Curve Number for the catchment being investigated. If we assume that currently, due to initial abstraction (absorption capacity of the land) that rainfall less than 5 mm does not result in direct runoff.

14.1 Flood Impacts

As per the Western Sydney Airport EIS Report, the Site's disturbance area (area surrounding quarry pit) lies above the flooding limit of Oaky Creek for all events up to and including the Probable Maximum Flood (PMF) event. Therefore, there is no potential for adverse impacts of flood. But during the Stage 1 development of the Western Sydney Airport, Water Management Dam is predicted to be personally inundated by flows from the Oaky Creek during heavy rainfall conditions with an estimate depth of Oaky Creek to be around 0.4metre to 0.6metre for a 100-year ARI event and 0.6 metre to 0.8 metre for the PMF event.

The pit has capacity to absorb rainfall during flooding events and discharge would, therefore, not contribute to catchment loads during flood events.

15 Assessment of options for treatment and discharge

It is factual to state that (due to natural processes) levels of some analytes (i.e., conductivity, nutrients, some dissolved metals) are higher in the pit water than in receiving waters and also above recommended default trigger values. It is also

[3] GHD's Technical Report within the Western Sydney Airport EIS *'Surface Water Quality Assessment'* (August 2016) states that modelled flow rates in Oaky creek during Stage 1 and 2 of Airport development (Construction) and Long-Term Operation.

[4] *United States Department of Agriculture (1986). Urban hydrology for small watersheds (PDF). Technical Release 55 (TR-55) (Second ed.). Natural Resources Conservation Service, Conservation Engineering Division.*

a fact that discharge of water is an essential piece of the water balance for the proper functioning of the Site. Discharge is necessary.

Therefore, treatment or other approaches are necessary to achieve a level of water quality that is suitable to discharge.

As part of this assessment, 4Pillars has assessed various options to achieve the desired outcome of an allowable, controlled discharge with minimal to no adverse impact on receiving waters.

15.1 Discharge during flow

Oaky Creek is an ephemeral watercourse which is characterized by a meandering shallow channel surrounded by dense vegetation, debris and scoured pools. It is anticipated that the ephemeral water route would support reasonable flow during high rainfall events The two potential concerns in quarry water are pH and electrical conductivity. The alkalinity of the quarry water presents significant buffer capacity in the waters if they were to overflow/runoff, which would potentially work gradually to control the pH levels from exceedances. Under a rainfall scenario of 15 mm/day, the estimated flow rate of Oaky Creek is 6.1 ML/day.

Table 11: Table showing rainfall (mm/day), estimated flow rate of Oaky Creek on wet weather and diluted concentration of conductivity under different rainfall scenarios. Result highlighted in green shows rainfall required to commence discharge.

MM	Runoff ratio	Runoff (m3/s)	m3 per day	ML per day (Oaky Creek) (V2)	Concentration x Vol for Quarry (C1xV1)	Concentration x Vol for Creek (C2xV2)	Total Volume (V1+V2)	Diluted concentration EC [(C1V1+C2V2)/(V1+V2)]
0.3	0.5	0.0	3.5	0.0	11818.14857	3.21	2.6	4471.9
0.6	0.5	0.0	14.2	0.0	11818.14857	13.11	2.7	4457.6
1.2	0.5	0.0	57.9	0.1	11818.14857	53.52	2.7	4400.3
2.4	0.5	0.0	236.4	0.2	11818.14857	218.45	2.9	4184.6
4.8	0.5	0.0	965.0	1.0	11818.14857	891.64	3.6	3525.6
7.0	0.5	0.0	1437.7	1.4	11818.14857	1328.36	4.1	3224.0
8.7	0.5	0.0	1772.5	1.8	11818.14857	1637.70	2.8	4870.9
9.6	0.5	0.0	3938.9	3.9	11818.14857	3639.34	6.6	2349.6
10.0	0.5	0.0	4096.4	4.1	11818.14857	3784.91	6.7	2316.2
11.1	0.5	0.1	4529.7	4.5	11818.14857	4185.24	7.2	2232.1
12.5	0.5	0.1	5120.6	5.1	11818.14857	4731.14	7.8	2132.5
15.0	0.5	0.1	6144.7	6.1	11818.14857	5677.36	8.8	1991.6
19.3	0.5	0.2	16077.1	16.1	11818.14857	14854.43	18.7	1425.0
38.5	0.5	0.8	65620.8	65.6	11818.14857	60630.34	68.3	1061.3
77.0	1.0	3.1	267840.0	267.8	11818.14857	247470.77	270.5	958.6
Average Quarry EC uS/cm (C1)					Average Creek EC uS/cm (C2)		Discharge Campaign (V1) (ML/day)	
4476.57					923.95		2.64	

In term of managing conductivity, a dilution concentration of conductivity under several rainfall scenario has been shown in *Table 11*. It is also known that the conductivity decreases with the increase in the concentration of the total volume. The average conductivity of the quarry creek is 4446.7 uS/cm while creek has an average conductivity level of 923.95 uS/cm. When a rainfall of 15 mm/day occurs, the discharge of 2.64 ML/day from the Site under a discharge campaign will create enough buffer for the conductivity to be below the recommended ANZECC 2000 water guidelines trigger values for lowland rivers in slightly to moderately disturbed ecosystems.

15.2 Basic treatment and discharge during flow

Luddenham Operations Pty Ltd explored various options for the treatment of the quarry water to lower the electrical conductivity, dissolved metals, and nutrients such as nitrogen, ammonia, and phosphorus. One of the basic options for the treatment is through the application of diatomix. This treatment is predominantly for nutrients, with a potential co-benefit of a slight reduction in the conductivity and heavy metals (approx. 10-15%). Diatomix is a liquid feed that enhances the growth of good algae – these are called diatoms. Diamotix contains nano sized gels of silica, packed full of

micronutrients required by diatoms. Because problematic algae don't get a micro-nutrient boost, they can't grow as quickly. This is one of the ways diatoms out-compete other algae and weeds and hence dominate and improve the water condition and appearance. The diatomix treatment will also reduce the heavy metal concentration and naturally oxygenate the water which will promote the activity of other micro-biological species, potentially consuming other contaminants, and improve general water health and treatability. The success of diatomix treatment will be assessed through the ongoing characterisation sampling procedure associated with the discharge campaign. Diatomix is not intended as a treatment for conductivity of the water, with only minor potential co-benefits expected.

15.2.1 Diatomix Treatment Process

The diatomix will be sourced from an appropriate supplier and will be dosed to the quarry water using an automatic dosing system at least 3 times per week on alternate days, to a total of 9 litres per week. The process to be followed has been discussed with the supplier as suitable and is as per the following: the automated doser will be solar powdered, and a dosing tube will be optimally positioned in the accumulated quarry water so that the mixing of diatomix occurs. The automated doser will suck the quarry water, mix the diatomix and pump out through the outlet point and will be timed for alternate days. The supplier has confirmed that for water sources with depths between 10-15 m, destratification is not necessary to ensure sufficient action of the diatomix once introduced, and that by dosing at the edges the diatoms that are present will be enhanced to reduce the nutrient load.

This process will be continued at the rate of 9 L diatomix per week for one month, at which point the dosing rate may be varied, depending on the nutrient level in the water. The quarry water will be dosed for at least 3 weeks prior to the first discharge campaign to ensure that the nutrient level has been significantly reduced before discharging.

15.3 Complex treatment and discharge

A complex treatment plan was also explored for the management of conductivity, called Reverse Osmosis. Through this system, the quarry water is predicted to lower the conductivity to 1100 uS/cm. This system produces high conductivity salt brine as a by-product which needs to be disposed through a local trade waste discharge. The estimated purchase cost is around $8M with an additional cost of $96K for operational and maintenance. Luddenham also explored renting the plant which has an estimated cost of more than $145K per month. The cost estimation documentation has been prepared by Victory Engineering provided in Appendix 15.

15.4 Dry weather discharge

The Oaky Creek watercourse is ephemeral in nature and doesn't have a permanent flow, although ponding along the watercourse was observed during the site visit. It is anticipated that the ephemeral water route would support reasonable flow during high rainfall events. Oaky Creek continues downstream approximately 0.9 km before joining Cosgroves Creek. Downstream of the confluence with Oaky Creek, Cosgroves Creek flows for approximately 7km before its confluence with South Creek, which ultimately contributes to the Hawkesbury River and Broken Bay.

A float method was used to estimate the standing level of water along Oaky Creek catchment on dry weather scenario, which was performed on 13 January 2023. The width of the channel was taken at two different intervals while depth of the channel was measured at 1/4, 1/3, half and ¾ width of the channel. The average width and depth of the channel was 6.75metre and 0.9metre respectively. This was performed to calculate the attenuation capacity of the creek under no or little rainfall scenarios. The average cross-sectional area of the creek is approximately 6.1 m^2 while the total length of Oaky Creek from the proposed discharge point to South Creek (downstream) is approximately 7km, thus the standing volume of water estimated to be present in Oaky Creek watercourse is 42,7000 m^3 (42.7 ML) on a dry weather scenario with no rainfall. Dry weather discharge has been considered, with a potential process detailed below, however is not proposed at present.

During dry weather with little to no rainfall, quarry water will be discharged on a maximum of 20ML discharge campaign till the next rainfall of 15 mm/day is achieved. Table 12 shows that the Oaky Creek watercourse's standing water level has enough attenuation to dilute conductivity of 20ML of water below the recommended guidelines. The water to be discharged will be pre-treated with diatomix and maximum reutilisation for dust suppression and irrigation will take place. Once the 20ML of water is discharged during dry condition, the discharge campaign will be placed on hold till next round of 15 mm/day of rainfall occurs.

As per the EPA feedback received on 7 March 2023 and 13 April 2023, the dry weather discharge proposal will be assessed at a later stage as part of the discharge trial. The data from wet weather discharge will be correlated to validate the proposed modelling and a new application will be made to the EPA. **The above information has been retained within this assessment, for future reference, but no dry weather discharge is proposed at present**.

Table 12: Table showing rainfall (mm/day), estimated flow rate of Oaky Creek during rainfall, standing water level on dry weather and diluted concentration of conductivity under different rainfall scenarios. Result highlighted in green shows dilution concentration of discharged water on dry weather scenario.

Rainfall MM/day	Runoff ratio	Runoff (m^3/s)	m^3 per day	ML/day	Standing level of Water in Oaky Creek in Dry Weather in ML/day	Total level of Water in Oaky Creek (rainfall + standing) in Dry Weather in ML/day (V2)	Concentration x Vol for Quarry (C1xV1)	Concentration x Vol for Creek (C2xV2)	Total Volume (V1+V2)	Diluted concentration EC [(C1V1+C2V2)/(V1+V2)]
0	0	0	0	0	42	42	11818.1448	38,805.90	44.64	1134.05
0.3	0.5	0	3.5	0	42	42	11818.1448	38,805.90	44.64	1134.05
0.6	0.5	0	14.2	0	42	42	11818.1448	38,805.90	44.64	1134.05
1.2	0.5	0	57.9	0.1	42	42.1	11818.1448	38,898.30	44.74	1133.58
2.4	0.5	0	236.4	0.2	42	42.2	11818.1448	38,990.69	44.84	1133.11
4.8	0.5	0	965	1	42	43	11818.1448	39,729.85	45.64	1129.45
7	0.5	0	1437.7	1.4	42	43.4	11818.1448	40,099.43	46.04	1127.66
8.7	0.5	0	1772.5	1.8	42	43.8	11818.1448	40,469.01	46.44	1125.91
9.6	0.5	0	3938.9	3.9	42	45.9	11818.1448	42,409.31	48.54	1117.17
19.3	0.5	0.2	16077.1	16.1	42	58.1	11818.1448	53,681.50	60.74	1078.36
38.5	0.5	0.8	65620.8	65.6	42	107.6	11818.1448	99,417.02	110.24	1009.03
77	1	3.1	267840	267.8	42	309.8	11818.1448	286,239.71	312.44	953.97

Average Quarry EC uS/cm (C1)	Average Creek EC uS/cm (C2)	Discharge Campaign (V1) (ML/day)
4476.57	923.95	2.64

After analysing the various options and considering the technical feasibility, time frame, relative cost, and effectiveness of the options (as shown in Table 13), we recommend implementing the second option. The cost documentation prepared by Victory Engineering for different treatment options is attached in Appendix 15.

Table 13: Table showing all the proposed options along with their feasibility rating, time frame, relative cost, and effectiveness. Recommended option highlighted in green.

Option	Description	Feasibility Rating	Time Frame	Relative Cost ex GST	Effectiveness
1	No treatment, discharge during flow and natural attenuation	High	Immediate (after suitable rainfall event)	$10-$20k	Effective in reducing concentration of TDS/Conductivity and therefore avoiding risk of chronic exposure risk in the local ecosystem.
2	Basic treatment of quarry water through diatomix and discharge during moderate to heavy flow	Moderate	2-3 weeks	$80K-$100K	Effective in reducing nutrients concentration, reduction to dissolved metals and conductivity by 10% to 15%.
3	Complex treatment of quarry water through Reverse Osmosis	Very Low	6-8 months +	$8M- $9M	Effective in reducing conductivity and dissolved metals by 50%-60%.

16 Sampling and Analysis under Proposed Discharge Regime

Water quality would be assessed prior to any intended discharge from the Site, with results of sampling reviewed prior to commencement. This ensures that the quality of water intended for each discharge campaign is known and considered suitable, with discharge not undertaken when results show the water quality is not appropriate. The sampling and analysis are proposed as a two-stage process, consisting of a pre-discharge "characterisation" sample to be laboratory analysed, followed by a during-discharge "validation" sample to be analysed in the field. Samples are proposed to be collected from the same location as Sample ID: S1, dependent on access conditions and the location of water, as this is expected to vary dependent on the volume of water in the void. The quarry water will be pumped to Oaky Creek so that the water to be discharged from the dam is the same quality that has been previously assessed via the characterisation sample. The detailed sampling and proposed discharge regime have been explained in Statement of Environmental Effects (SEE) submitted along with EPL variation.

17 Proposed discharge details

17.1 Discharge campaigns

A **Discharge Campaign** is defined as a period of time when **Continuous** discharge occurs. A Discharge Campaign may end due to a break in pumping (see definition of 'Continuous' below), or due to a validation sample non-compliance. Continuous discharge is defined as ongoing discharge of water, with up to 24 hours between active pumping on weekdays (to allow for overnight breaks, and repair of any pump faults, refuelling etc.) and up to a 72-hour break over weekends.

During the trial period, discharge will only occur during the quarry's operating hours as specified in the EPL which is 7am to 6pm Mon-Friday and 7am to 1pm on Saturday and will, therefore, not occur overnight or weekend hours when the quarry is closed.

17.2 EPL Points

Two EPL points will be created from this application. The first point will be the sample point in the void, from which the characterisation and validation samples will be collected, as shown in Figure 5, along with current coordinates ("Sample S1: - 33.874338, 150.720133"). We anticipate that as the water level in the void decreases, the sampling location may

vary. However, samples (both characterisation and validation) will always be collected from within the void at the nearest safely accessible point to the pump inlet, to ensure that the water intended for discharge is assessed appropriately. Coordinates of the currently proposed sampling point are included in Figure 5. The second location will be the discharge point at which discharged water exits the pipe which will convey it from the pit, as shown in Figure 5, along with its coordinates ("Discharge Point (D1): -33.872766, 150.720192"). The new discharge point has been proposed by considering the EPA's comment in the 5 April 2023 letter with regard to the concerns of characterisation sample not being representative of water exiting the Site if the characterised water was first pumped to an intermediary dam.

17.3 Predicted quantity of discharge

It is predicted that the maximum volume of water which may be discharged in any one period will not exceed 10,000 m^3 (10ML) unless the downstream conductivity exceeds 2100 uS/cm or a non-compliant validation sample is collected. It should be noted that this volume represents the upper limit of an anticipated single discharge event and that in the majority of events, discharge volumes will be significantly less than this amount. Predicated on a maximum discharge flow of 4,000 L/min, the total continuous time required to discharge water from the pit within the operating hours specified in the EPL will range from two days (5,000m^3) to four days (10,000m^3). The discharge campaign will be operated only during the quarry's operating hours as specified in the EPL 21562 which is Monday to Friday 7am to 6pm and Saturday 7am to 1pm. In the event that water is discharged over multiple consecutive days, validation samples will be collected each day that discharge occurs.

17.4 Mechanism of water discharge

Water will be pumped up from the quarry void to natural ground surface level, using a discharge pump. At surface level, a junction valve in the pipeline will direct water either for reuse, or for discharge, as required. The output for the discharge pipe will be directly to Oaky Creek in the north-east of the Site, slightly downstream of the Water Management Dam. The discharge line will be of heavy-duty pipeline all the way to point D1. The discharge pipeline will be run adjacent to the existing water management dam near the boundary. The pipeline will be isolated from water in the water management dam, to ensure the water exiting the Site at point D1 is representative of the water in the quarry pit, as sampled at S1. A flow meter will be installed on the pipework branch that conveys water to D1. This flow meter will be used to measure the volume of water discharged. This meter may be a manual read meter or may be telemetered.

The discharge campaign will be operated only during the quarry's operating hours as specified in the EPL 21562 which is Monday to Friday 7am to 6pm and Saturday 7am to 1pm. The estimated output of the discharge pump is 4000 L per minute. This equates to 240 kL per hour. We expect that on average, a discharge 'campaign' of 10 ML would take 3-4 days of continuous pumping.

17.5 Stabilisation of the discharge channel

The physical condition of the discharge point will be assessed through the implementation of regular photo point monitoring. This monitoring will determine whether any erosion or other negative effects are being caused by the discharge. If inspections suggest that excessive erosion has been caused by the discharge of water from the Site between the Site boundary and the Oaky Creek, alternative methods for discharge or the installation of mitigating structures will be investigated. These may include a reduction of discharge rate, or the addition of rock chutes or matting.

17.6 Discharge campaigns

17.6.1 Wet weather discharge

During wet weather, each discharge campaign will occur for either till the downstream conductivity level exceeds 2100 uS/cm or when a non-compliant validation sample is collected, whichever is reached first. Prior to the commencement of further discharge in the following discharge campaign, a new characterisation sample will be required, to characterise the water quality of the upcoming campaign and confirm it is appropriate for discharge. Electrical conductivity, pH and turbidity of the upcoming discharge will be measured using a probe. The discharge points will be inspected at the start and end date of each campaign. This will ensure that the quality of water intended for discharge will be regularly assessed during each discharge campaign.

When a rainfall event of a minimum of 15 mm/day occurs, the discharge campaign will be started after taking a characterisation and validation sample. A continuous automated real time monitoring device will be placed upstream and downstream of Oaky Creek to determine daily conductivity, pH and TDS levels using a trigger alert system. Additional information about the monitoring devices have been included in the SEE (Revision 5.0).The placement of the monitoring device is shown in Figure 3 (same as the upstream and downstream monitoring locations conducted by 4Pillars Environmental) but can be varied depending on the accessibility of the watercourse. As per the EPA comment received

on 7 March 2023, the upper limit of the conductivity trigger level has been revised from 2200 uS/cm to 2100 uS/cm. During discharge, if the conductivity level exceeds the trigger value of 2100 uS/cm, the discharge will be placed on hold until a minimum of 15 mm/day rainfall event occurs, and another discharge campaign can be commenced. A weather station will be installed at the Site to allow for accurate measurement of experienced weather. The cycle of wet weather discharge will continue even after rainfall has ceased, assuming the downstream monitoring results are compliant with the 2100 uS/cm trigger value.

As discussed with EPA on 21 February 2023 regarding the wet weather discharge scenario, the wet weather discharge will continue throughout even after the discharge campaign of 10ML is achieved unless the downstream conductivity value exceeds 2100 uS/cm. The flowchart (Figure 1) below illustrates our proposal and the process of discharge campaign.

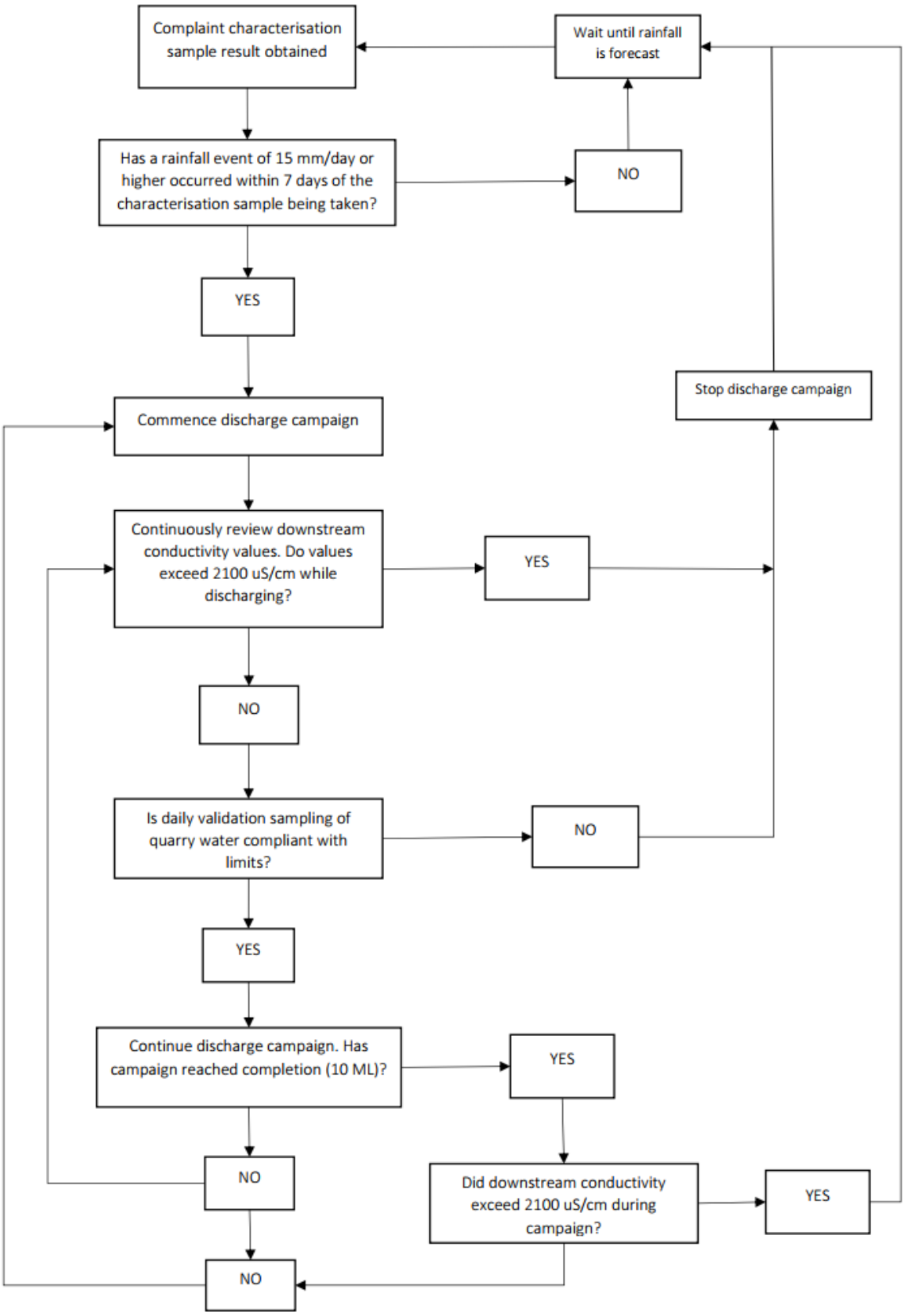


Figure 1: Flowchart showing wet weather discharge.

17.7 Record keeping

Records of all discharge campaigns will be kept, detailing the dates and times when the campaign occurred, the quantity of water discharged (to be recorded with an in-line water meter), the number of samples taken, and the analytical results of each sample. These records will be available for inspection by EPA officers on request.

17.8 Upstream and Downstream inspections

The details about upstream and downstream inspections are outlined in the updated SEE submitted along with the updated Discharge Characterisation Report. If downstream inspections suggest that excessive erosion has been caused by the discharge of water from the Site between the Site boundary and the Oaky Creek, alternative methods for discharge or the installation of mitigating structures will be investigated. These may include a reduction of discharge rate, the addition of rock chutes or matting, or the construction of a pipeline to transport water directly from the Site to the Oaky Creek.

It should be noted that the area has experienced some extremely heavy rain events in recent times, from which surface water flows in the creek are expected to have been high. It is assumed that if the waterway was able to remain unaffected or withstand damage from these events, then the discharge of water during a discharge campaign should not cause any detrimental impact.

18 Conclusions

The Discharge Characterisation and Water Pollution Impact Assessment in the Above Sections has identified that the quarry water and creek has relatively similar water quality. In the event of a runoff/discharge event, the treated water will contain relatively low concentration of nutrients and dissolved metals. Further, the dilution of the high electrical conductivity of quarry water with the Oaky creek's flow rate along with diatomix treatment and continuous automated monitoring would cause a minimal impact to the waterway. Thus, it appears to be a reasonable level of residual impact associated with allowing the quarry to discharge for the sake of operational outcomes.

Appendices

Appendix 1. Site Layout

Appendix 2. Quarry Water Analytes Tabulated Results

Appendix 3. Average Quarry Water Dissolved Analytes Tabulated Results

Appendix 4. Creek Water Sampling Tabulated Results

Appendix 5. Average Creek Dissolved Analytes Tabulated Results

Appendix 6. Quarry Pit Summary Analytes Tabulated Results

Appendix 7. Upstream Inspection Analytes Tabulated Results

Appendix 8. Downstream Inspection Analytes Tabulated Results

Appendix 9. Average Analytes for Quarry Pit, Creek, Upstream and Downstream Tabulated Results

Appendix 10. Development Consent (Modification 5)

Appendix 11. Laboratory Reports

Appendix 12. Laboratory Chain-of-Custody Documentation

Appendix 13. Water Review Report by EMM Consulting

Appendix 14: Surface Water Assessment by EMM Consulting

Appendix 15. Treatment Options Cost Documentation by Victory Engineering

Appendix 1 - Site Layout

Locality plan

Drawn by:	MS	**Report reference:** 20220601_DCWPIA	**Key:**	Refer to legend
Date:	20/07/2022	**Image source:** QGIS with NearMap Overlay		

Figure 2: Locality plan.

Site Layout with Sampling Locations Conducted by 4Pillars

Drawn by:	MS	**Report reference:** 20220601_DCWPIA	**Key:**	Refer to legend
Date:	20/01/2023	**Image source:** QGIS with NearMap Overlay		

Figure 3: Site Layout with Water Sampling Locations conducted by 4Pillars Environmental Consulting.

Site Layout with Sampling Locations Conducted by EMM Consulting

Drawn by:	MS	**Report reference:** 20220601_DCWPIA	**Key:**	Refer to legend
Date:	21/10/2022	**Image source:** QGIS with NearMap Overlay		

Figure 4: Site Layout with Water Sampling Locations conducted by EMM Consulting.

Quarry View with Marked Locations

Drawn by:	MS	**Report reference:** 20220601_DCWPIA	**Key:**	Refer to legend
Date:	17/04/2023	**Image source:** QGIS with NearMap Overlay		

Figure 5: Site layout and proposed locations of sampling (S1) (new EPL point 9), outlet, and discharge (D1) (new EPL point 10).

Appendix 2 – Quarry Water Sampling Tabulated Results

Table 14: Quarry Water Sampling Results conducted by 4Pillars Environmental Consulting.

Results recorded in red indicate concentrations in exceedance of the 95% species protection limit and dark yellow indicates concentrations in exceedance of the 99% species protection to account for the bioaccumulating nature of the toxicant.

Sample ID	Date Collected	Description	Aluminium pH>6.5 (total)	Arsenic As(V) (total)	Cadmium (total)	Chromium (III) (total)	Cobalt (total)	Copper (total)	Iron (total)	Lead (total)	Nickel (total)	Selenium (total)	Zinc (total)	Mercury (total)	Alkalinity	pH	Conductivity	Turbidity	TDS	Hardness	COD	BOD	Calcium	Magnesium	Sodium	Potassium	Cyanide	Benzene	Toluene	Ethylbenzene	Total Xylene	BTEX (SUM)	TRH (C10-C40)	Oil & Grease	Faecal Coliforms	Nitrogen	Phosphate	Phosphorus	NOx (NO2 + NO3)	Ammonia	Chloride	OC	OP
ANZG Marine (95% species protection)			-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ANZG Marine (90% species protection)			-	-	-	-	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ANZG Fresh (99% species protection)			-	-	-	-	-	-	-	-	-	5	-	0.06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<100	-	-	-	-	-	-	-	-	-	-
ANZG Fresh (95% species protection)			55	13	0.2	-	-	1.4	-	3.4	11	11	8	0.6	-	-	-	-	-	-	-	-	-	-	-	-	7	950	180	80	-	-	-	-	-	-	-	-	-	-	-	-	-
ANZG Fresh (90% species protection)			80	42	0.4	-	-	1.8	-	5.6	13	18	15	1.9	-	-	-	-	-	-	-	-	-	-	-	-	11	1300	230	110	-	-	-	-	-	-	-	-	-	-	-	-	-
Trigger Values for SE Australia for Slightly to Moderately Disturbed Ecosystems – Lowland River			-	-	-	-	-	-	-	-	-	-	-	-	-	6.5-8.5	125-2200	6 -50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5	0.02	0.05	0.04	0.02	-	-	-
Revised Trigger Value for Selected Metals in Freshwaters dependent on its Hardness			-	-	1.84	25.54	-	11.68	-	80.87	91.73	-	66.71	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Units			ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	pH Units	uS/cm	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	CFU/100mL	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L
QUARRY	23/06/2022	S1	40	1	<0.1	<1	<1	15	110	13	5	20	86	<0.1	336	8.6	4190	2.1	2300	469	23	<2	20	98	703	13	<4	<1	<2	<2	<2	<1	<100	<5	~4	1.8	<0.01	0.02	1.25	<0.01	943	<0.5	<0.5
		D1	30	1	<0.1	6	<1	2	60	4	6	20	22	<0.1	341	8.66	4190	1.3	2270	480	12	<2	20	98	702	13	<4	<1	<2	<2	<2	<1	<100	<5	~8	1.8	<0.01	<0.01	1.27	<0.01	944	<0.5	<0.5
	22/07/2022		190	1	<0.1	<1	<1	1	80	<1	1	10	5	<0.1	321	8.6	3840	6.5	2120	409	11	<2	23	93	648	14	<4	<1	<2	<2	<2	<1	<100	<5	12	2.2	<0.01	0.02	1.58	<0.01	946	<0.5	<0.5
	16/08/2022		30	1	<0.1	<1	<1	1	50	<1	3	10	6	<0.1	326	8.69	3170	2.5	2130	97	<10	<2	22	86	602	13	<4	<1	<2	<2	<2	<1	<100	<5	2	2.2	<0.01	0.01	1.59	0.02	1030	<0.5	<0.5
Average			72.5	1	<0.1	6	<1	4.75	75	8.5	3.75	15	29.75	<0.1	331	8.63	3847.5	3.1	2205	363.75	15.33	<2	21.25	93.75	663.75	13.25	<4	<1	<2	<2	<2	<1	<100	<5	7	2	<0.01	0.017	1.42	0.02	965.75	<0.5	<0.5

Appendix 3 -Average Quarry Water Dissolved Analytes Tabulated Results.

Table 15: Quarry water dissolved metals concentration results conducted by 4Pillars Environmental Consulting.

Results recorded in red indicate concentrations in exceedance of the 95% species protection limit and dark yellow indicates concentrations in exceedance of the 99% species protection to account for the bioaccumulating nature of the toxicant.

Sample ID	Date Collected	Description	Sample type	Aluminium pH>6.5 (dissolved)	Arsenic As(V) (dissolved)	Cadmium (dissolved)	Chromium Cr (III) (dissolved)	Cobalt (dissolved)	Copper (dissolved)	Iron (dissolved)	Lead (dissolved)	Nickel (dissolved)	Selenium (dissolved)	Zinc (dissolved)	Mercury (dissolved)
ANZG Marine (95% species protection)				-	-	-	-	1	-	-	-	-	-	-	-
ANZG Marine (90% species protection)				-	-	-	-	14	-	-	-	-	-	-	-
ANZG Fresh (99% species protection)				-	-	-	-	-	-	-	-	-	5	-	0.06
ANZG Fresh (95% species protection)				55	13	0.2	-	-	1.4	-	3.4	11	11	8	0.6
ANZG Fresh (90% species protection)				80	42	0.4	-	-	1.8	-	5.6	13	18	15	1.9
Trigger Values for SE Australia for Slightly to Moderately Disturbed Ecosystems – Lowland River				-	-	-	-	-	-	-	-	-	-	-	-
Revised Trigger Value for Selected Metals in Freshwaters dependent on its Hardness				-	-	1.84	25.54	-	11.68	-	80.87	91.73	-	66.71	-
Units				ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L		ug/L	ug/L	ug/L
QUARRY	23/06/2022	S1	Water	10	1	<0.1	<1	<1	2	<50	2	1	10	19	<0.1
		D1		20	1	<0.1	<1	<1	1	<50	2	2	10	16	<0.1
	22/07/2022	July		<10	2	<0.1	<1	<1	<1	<50	<1	<1	10	<5	<0.1
	16/08/2022	August		20	<1	<0.1	<1	<1	2	90	<1	2	<10	<5	<0.1
Average				16.67	1.33	<0.1	<1	<1	1.67	90	2	1.67	10	17.5	<0.1

Appendix 4 – Creek Water Sampling Tabulated Results

Table 16: Creek water sampling results conducted by 4Pillars Environmental Consulting adjacent to the eastern side of the Site.

Results recorded in red indicate concentrations in exceedance of the 95% species protection limit and dark yellow indicates concentrations in exceedance of the 99% species protection to account for the bioaccumulating nature of the toxicant.

Sample ID	Date Collected	Sample Type	Aluminium pH>6.5 (total)	Arsenic As(V) (total)	Barium (total)	Cadmium (total)	Chromium (III) (total)	Cobalt (total)	Copper (total)	Iron (total)	Lead (total)	Nickel (total)	Selenium (total)	Boron (total)	Zinc (total)	Hexavalent Chromium (total)	Mercury (total)	Alkalinity	pH	Conductivity	Turbidity	TDS	Hardness	COD	BOD	Calcium	Magnesium	Sodium	Potassium	Cyanide	Benzene	Toluene	Ethylbenzene	Total Xylene	BTEX (SUM)	TRH (C10-C40)	Oil & Grease	Faecal Coliforms	Nitrogen	Phosphate	Phosphorus	Total Kjeldahl Nitrogen	NOx (NO2 + NO3)	Ammonia	Chloride	OC	OP	Carbamate
		ANZG Marine (95% species protection)	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<100	-	-	-	-	-	-	-	-	-	-	-	-
		ANZG Marine (90% species protection)	-	-	-	-	-	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		ANZG Fresh (99% species protection)	-	-	-	-	-	-	-	-	-	-	5	-	-	-	0.06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<100		-	-	-	-	-	-	-	-	-	-	-	-
		ANZG Fresh (95% species protection)	55	13	-	0.2	-	-	1.4	-	3.4	11	11	370	8	1	0.6	-	-	-	-	-	-	-	-	-	-	-	-	7	950	180	80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		ANZG Fresh (90% species protection)	80	42	-	0.4	-	-	1.8	-	5.6	13	18	-	15	6	1.9	-	-	-	-	-	-	-	-	-	-	-	-	11	1300	230	110	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
		Trigger Values for SE Australia for Slightly to Moderately Disturbed Ecosystems – Lowland River	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.5-8.5	125-2200	6- 50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.5	0.02	0.05	-	0.04	0.02	-	-	-	-
		Units	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L		ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	pH Units	uS/cm	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	CFU/100mL	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	ug/L
CREEK	22/07/2022	Water	26500	6	197	<0.1	25	16	39	28900	22	18	<10	50	70	<10	<0.1	33	6.99	627	1300	930	95	23	2	16	18	68	8	<4	<1	<2	<2	<2	<1	<100	<5	460	<2	<0.01	<0.2	<2	0.68	0.26	126	<0.5	<0.5	<0.2
	16/08/2022		6550	2	100	<0.1	6	3	11	69500	19	7	<10	<50	20	<10	<0.1	33	7.53	656	308	530	413	<10	<2	15	16	76	5	<4	<1	<2	<2	<2	<1	<100	<5	24	1.9	<0.01	0.14	1	0.91	0.05	149	<0.5	<0.5	<0.2
Average			16525	4	148.5	<0.1	15.5	9.5	25	49200	13.5	12.5	<10	50	45	<10	<0.1	33	7.26	641.5	804	730	254	23	2	15.5	17	72	6.5	<4	<1	<2	<2	<2	<1	<100	<5	242	1.9	<0.01	0.14	1	0.795	0.155	137.5	<0.5	<0.5	<0.2

Appendix 5 - Average Creek Water Dissolved Analytes Tabulated Results.

Table 17: Creek water dissolved metals concentration results conducted by 4Pillars adjacent to the eastern side of the Site.

Results recorded in red indicate concentrations in exceedance of the 95% species protection limit and dark yellow indicates concentrations in exceedance of the 99% species protection to account for the bioaccumulating nature of the toxicant.

Sample ID	Date collected	Sample Type	Aluminium pH>6.5 (dissolved)	Arsenic As (V) (dissolved)	Barium (dissolved)	Cadmium (dissolved)	Chromium (III) (dissolved)	Cobalt (dissolved)	Copper (dissolved)	Iron (dissolved)	Lead (dissolved)	Nickel (dissolved)	Selenium (dissolved)	Boron (dissolved)	Zinc (dissolved)	Mercury (dissolved)
ANZG Marine (95% species protection)			-	-	-	-	-	1	-	-	-	-	-	-	-	-
ANZG Marine (90% species protection)			-	-	-	-	-	14	-	-	-	-	-	-	-	-
ANZG Fresh (99% species protection)			-	-	-	-	-	-	-	-	-	-	5	-	-	0.06
ANZG Fresh (95% species protection)			55	13	-	0.2	-	-	1.4	-	3.4	11	11	370	8	0.6
ANZG Fresh (90% species protection)			80	42	-	0.4	-	-	1.8	-	5.6	13	18	-	15	1.9
Trigger Values for SE Australia for Slightly to Moderately Disturbed Ecosystems – Lowland River			-	-	-	-	-	-	-	-	-	-	-	-	-	-
Units			ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
CREEK	22/07/2022	Water	40	<1	50	<0.1	<1	<1	2	100	<1	1	<10	50	21	<0.1
	16/08/2022		<10	<1	85	<0.1	<1	<1	<1	<50	<1	<1	10	<50	<5	<0.1
Average			40	<1	67.5	<0.1	<1	<1	2	100	<1	1	10	50	21	<0.1

Appendix 6 - Quarry Pit Summary Analytes Tabulated Results

Table 18: Summary of the quarry pit results conducted by 4Pillars and EMM Consulting.

Results recorded in red indicate concentrations in exceedance of the 95% species protection limit and dark yellow indicates concentrations in exceedance of the 99% species protection to account for the bioaccumulating nature of the toxicant.

Sample ID	Date Collected	Sample Type	Aluminium pH>6.5 (dissolved)	Arsenic As (V) (dissolved)	Manganese (dissolved)	Cadmium (dissolved)	Chromium Cr (III) (dissolved)	Copper (dissolved)	Iron (dissolved)	Lead (dissolved)	Nickel (dissolved)	Selenium (dissolved)	Boron (dissolved)	Zinc (dissolved)	pH	Conductivity	Turbidity	TSS	TDS	Hardness	Dissolved Oxygen	Nitrogen	Phosphate	Phosphorus	Total Kjeldahl Nitrogen	NOx (NO2 + NO3)	Ammonia
ANZG Marine (95% species protection)			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ANZG Marine (90% species protection)			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ANZG Fresh (99% species protection)			-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ANZG Fresh (95% species protection)			55	13	1900	0.2	-	1.4	-	3.4	11	11	370	8	-	-	-	-	-	-	-	-	-	-	-	-	-
ANZG Fresh (90% species protection)			80	42	-	0.4	-	1.8	-	5.6	13	18		15	-	-	-	-	-	-	-	-	-	-	-	-	-
Trigger Values for SE Australia for Slightly to Moderately Disturbed Ecosystems – Lowland River			-	-	-	-	-	-	-	-	-	-	-	-	6.5-8.5	125-2200	6 - 50	-	-	-	-	0.5	0.02	0.05	-	0.04	0.02
Revised Trigger Value for Selected Metals in Freshwaters dependent on its Hardness			-	-	-	2.21	30.17	13.88	-	104.67	109.03	-	-	79.29	-	-	-	-	-	-	-	-	-	-	-	-	-
Units			ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L			ug/L	ug/L	pH Unit	uS/cm	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
QUARRY	14/10/2020	Water	<10	1	2	<0.1	<1	2	<50	<1	3	-	<50	<5	8.65	5970	3.1	13	3290	604	10	7.9	<0.01	<0.01	1.2	6.51	0.01
	12/02/2021		<10	1	<1	<0.1	<1	<1	<50	<1	<1	-	<50	<5	-	5990	2.3	8	3720	635	10.5	5	<0.01	0.13	1.2	3.76	<0.01
	31/08/2022		80	<1	15	<0.1	<1	8	130	<1	3	-	<50	9	8.01	3986	-	11	-	426	9.47	3.3	<0.01	0.36	2.3	0.99	0.06
QUARRY (S1)	23/06/2022		10	1	-	<0.1	<1	2	<50	2	1	10	-	19	8.6	4190	2.1	-	2300	469	-	1.8	<0.01	0.02	-	1.25	<0.01
QUARRY (D1)	23/06/2022		20	1	-	<0.1	<1	1	<50	2	2	10	-	16	8.66	4190	1.3	-	2270	480	-	1.8	<0.01	<0.01	-	1.27	<0.01
QUARRY	22/07/2022		<10	2	-	<0.1	<1	<1	<50	<1	<1	10	<50	<5	8.6	3840	6.5	-	2120	409	-	2.2	<0.01	0.02	0.6	1.58	<0.01
	16/08/2022		20	<1	-	<0.1	<1	2	90	<1	2	<10	<50	<5	8.69	3170	2.5	-	2130	97	-	2.2	<0.01	0.01	0.6	1.59	0.02
Average			32.50	1.20	8.50	<0.1	<1	3	110	2	2.2	10	<50	14.67	8.69	4476.57	2.97	10.67	2638.33	445.71	9.99	3.46	<0.01	0.11	1.18	2.42	0.03

Appendix 7 - Upstream Inspection Analytes Tabulated Results

Table 19: Upstream of Oaky Creek sampling results conducted by EMM Consulting.

Results recorded in red indicate concentrations in exceedance of the 95% species protection limit.

Sample ID	Date Collected	Sample Type	Aluminium pH>6.5 (dissolved)	Arsenic As (V) (dissolved)	Manganese (dissolved)	Cadmium (dissolved)	Chromium Cr (III) (dissolved)	Copper (dissolved)	Iron (dissolved)	Lead (dissolved)	Nickel (dissolved)	Boron (dissolved)	Zinc (dissolved)	pH	Conductivity	Turbidity	TSS	TDS	Hardness	Dissolved Oxygen	Nitrogen	Phosphate	Phosphorus	Total Kjeldahl Nitrogen	NOx (NO2 + NO3)	Ammonia
ANZG Marine (95% species protection)			-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-
ANZG Marine (90% species protection)			-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-
ANZG Fresh (99% species protection)			-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-
ANZG Fresh (95% species protection)			55	13	1900	0.2	-	1.4	-	3.4	11	370	8		-	-	-	-	-	-	-	-	-	-	-	-
ANZG Fresh (90% species protection)			80	42	-	0.4	-	1.8	-	5.6	13		15		-	-	-	-	-	-	-	-	-	-	-	-
Trigger Values for SE Australia for Slightly to Moderately Disturbed Ecosystems – Lowland River			-	-	-	-	-	-	-	-	-	-	-	6.5-8.5	125-2200	6 to 50	-	-	-	-	0.5	0.02	0.05	-	0.04	0.02
Units			ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L		ug/L	ug/L	pH Unit	uS/cm	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
UPSTREAM	14/10/2020	Water	<10	<1	27	<0.1	<1	1	<50	<1	<1	<50	26	7.85	851	12.6	<5	463	148	9.2	0.4	<0.01	0.01	0.4	<0.01	0.03
	12/02/2021		40	<1	59	<0.1	<1	14	<50	<1	4	<50	12	-	929	42.5	22	472	78	8.8	0.6	<0.01	0.04	0.2	0.42	0.01
	31/08/2022		30	<1	1790	<0.1	<1	2	80	<1	2	<50	<5	6.57	2272	-	252	-	303	9.93	11.8	<0.01	0.05	2.8	8.95	0.15
	13/01/2023		<10	<1	-	<0.1	<1	2	<50	<1	1	<50	<5	7.84	619	152	-	432	102	-	1.5	<0.01	0.58	1.5	0.04	0.04
Average			35	<1	625.33	<0.1	<1	4.75	80	<1	2.33	<50	19	7.42	1167.75	69.03	137	455.67	157.75	9.31	3.58	<0.01	0.17	1.23	3.14	0.06

Appendix 8 - Downstream Inspection Analytes Tabulated Results

Table 20: Downstream of Oaky Creek sampling results conducted by EMM Consulting.

Results recorded in red indicate concentrations in exceedance of the 95% species protection limit.

Sample ID	Date Collected	Sample Type	Aluminium pH>6.5 (dissolved)	Arsenic As(V) (dissolved)	Manganese (dissolved)	Cadmium (dissolved)	Chromium Cr (III) (dissolved)	Copper (dissolved)	Iron (dissolved)	Lead (dissolved)	Nickel (dissolved)	Boron (dissolved)	Zinc (dissolved)	pH	Conductivity	Turbidity	TSS	TDS	Hardness	Dissolved Oxygen	Nitrogen	Phosphate	Phosphorus	Total Kjeldahl Nitrogen	NOx (NO2 + NO3)	Ammonia
ANZG Marine (95% species protection)			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ANZG Marine (90% species protection)			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ANZG Fresh (99% species protection)			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ANZG Fresh (95% species protection)			55	13	1900	0.2	-	1.4	-	3.4	11	370	8	-	-	-	-	-	-	-	-	-	-	-	-	-
ANZG Fresh (90% species protection)			80	42	-	0.4	-	1.8	-	5.6	13	-	15	-	-	-	-	-	-	-	-	-	-	-	-	-
Trigger Values for SE Australia for Slightly to Moderately Disturbed Ecosystems – Lowland River			-	-	-	-	-	-	-	-	-	-	-	6.5-8.5	125-2200	6 to 50	-	-	-	-	0.5	0.02	0.05	-	0.04	0.02
Units			ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L		ug/L	ug/L	pH Unit	uS/cm	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
DOWNSTREAM	14/10/2020	Water	20	<1	26	<0.1	<1	<1	<50	<1	<1	<50	<5	7.82	782	6.4	16	398	119	9.6	0.2	<0.01	0.01	0.2	0.04	<0.01
	12/02/2021		20	<1	38	<0.1	<1	<1	<50	<1	<1	<50	<5	-	773	67.9	40	412	49	8	0.4	<0.01	0.04	0.2	0.22	0.1
	31/08/2022		<10	<1	330	<0.1	<1	3	<50	<1	1	<50	5	6.87	1118	-	47	-	154	7.47	1.3	<0.01	0.11	1	0.29	0.02
	13/01/2023		<10	<1	-	<0.1	<1	<1	<50	<1	<1	<50	<5	7.77	1070	8.3	-	619	172	-	0.5	<0.01	0.04	0.5	0.02	0.02
	13/01/2023		<10	<1	-	<0.1	<1	<1	<50	<1	<1	<50	<5	7.83	1070	8	-	624	174	-	0.8	<0.01	0.05	0.8	0.02	0.02
Average			20	<1	131.33	<0.1	<1	3	<50	<1	1	<50	5	7.57	962.6	22.65	34.33	513.25	133.6	8.36	0.64	<0.01	0.05	0.54	0.118	0.04

Appendix 9 - Average Analytes for Quarry Pit, Creek, Upstream and Downstream Tabulated Results

Table 21: Average analytes results tabulated from the sampling regime October 2020 to August 2022.

Results recorded in red indicate concentrations in exceedance of the 95% species protection limit and dark yellow indicates concentrations in exceedance of the 99% species protection to account for the bioaccumulating nature of the toxicant.

Sample ID	Sample Type	Aluminium pH>6.5 (dissolved)	Arsenic As (V) (dissolved)	Manganese (dissolved)	Cadmium (dissolved)	Chromium Cr (V) (dissolved)	Copper (dissolved)	Iron (dissolved)	Lead (dissolved)	Nickel (dissolved)	Selenium (dissolved)	Boron (dissolved)	Zinc (dissolved)	pH	Conductivity	Turbidity	TSS	TDS	Hardness	Dissolved Oxygen	Nitrogen	Phosphate	Phosphorus	Total Kjeldahl Nitrogen	NOx (NO2 + NO3)	Ammonia
ANZG Marine (95% species protection)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ANZG Marine (90% species protection)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ANZG Fresh (99% species protection)		-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ANZG Fresh (95% species protection)		55	13	1900	0.2	1	1.4	-	3.4	11	11	370	8	-	-	-	-	-	-	-	-	-	-	-	-	-
ANZG Fresh (90% species protection)		80	42	-	0.4	6	1.8	-	5.6	13	18		15	-	-	-	-	-	-	-	-	-	-	-	-	-
ANZECC Fresh (95% species protection)		-	-	-	-	-	-	-	-	-	-	-	-	6.5-8.5	125-2200	6 to 50	-	-	-	-	0.5	0.02	0.05	-	0.04	0.02
Units		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L			ug/L	ug/L	pH Unit	uS/cm	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Average QUARRY	Water	32.5	1.2	8.5	<0.1	<1	3	110	2	2.2	10	<50	14.67	8.69	4476.57	2.97	10.67	2638.33	445.71	9.99	3.46	<0.01	0.11	1.18	2.42	0.03
Average CREEK		40	<1	-	<0.1	<1	2	100	<1	1	10	50	21	7.26	641.5	804	-	730	254	-	1.9	<0.01	0.14	1	0.795	0.155
Average UPSTREAM		35	<1	625.33	<0.1	<1	4.75	80	<1	2.33	-	<50	19	7.42	1167.75	69.03	137	455.67	157.75	9.31	3.58	<0.01	0.17	1.23	3.14	0.06
Average DOWNSTREAM		20	<1	131.33	<0.1	<1	3	<50	<1	1	-	<50	5	7.57	962.6	22.65	34.33	513.25	133.6	8.36	0.64	<0.01	0.05	0.54	0.12	0.04

Appendix 10 - Development Consent (Modification 5)

Development Consent

Section 80 of the *Environmental Planning & Assessment Act 1979*

I, the Minister for Infrastructure, Planning and Natural Resources, approve the Development Application referred to in Schedule 1, subject to the conditions in Schedules 2 to 5.

These conditions are required to:
(i) prevent, minimise, and/or offset adverse environmental impacts;
(ii) set standards and performance measures for acceptable environmental performance;
(iii) require regular monitoring and reporting; and
(iv) provide for the on-going environmental management of the development.

Craig Knowles, MP
Minister for Infrastructure, Planning and Natural Resources

Sydney, 2004 File No. P91/02045

SCHEDULE 1

Development Application:	DA No. 315-7-2003.
Applicant:	CFT No 13 Pty Ltd.
Consent Authority:	The Minister for Infrastructure, Planning and Natural Resources.
Land:	Lot 3, DP 623799.
Proposed Development:	The development and operation of a clay/shale quarry on Lot 3, DP 623799.
State Significant Development	The proposal is classified as State significant development under section 76A(7) of the *Environmental Planning and Assessment Act 1979* because it is a class of development listed in the schedule of the Minister's declaration of 3 August 1999.
Integrated Development	The proposal is classified as integrated development under section 91 of the *Environmental Planning and Assessment Act 1979,* because it requires approvals under the: • *Protection of the Environment Operations Act 1997;* • *Rivers and Foreshores Improvement Act 1948;* • *Water Act 1912; and* • *Roads Act 1993.*
Designated Development	The proposal is classified as designated development under section 77A of the *Environmental Planning and Assessment Act 1979,* because it would disturb a total surface area of more than 2 hectares of land by clearing or excavating, and consequently meets the criteria in Schedule 3 of the *Environmental Planning and Assessment Regulation 2000.*

BCA Classification:	Class 10b	Bunded fuel storage Plant nursery Weighbridge Bridge Conveyor and hoppers

Note:

1) *To find out when this consent becomes effective, see Section 83 of the Environmental Planning and Assessment Act 1979 (EP&A Act);*
2) *To find out when this consent is liable to lapse, see Section 95 of the EP&A Act; and*
3) *To find out about appeal rights, see Section 97 of the EP&A Act.*

Red Type represents the 4 January 2006 Modification (MOD 1)
Blue Type represents the 28 January 2010 Modification (MOD 2)
Green Type represents the April 2015 Modification (MOD 3)
Purple type represents the May 2021 Modification (MOD 5)

SCHEDULE 2
DEFINITIONS

Annual Review	Annual Review, as required under condition 5 of Schedule 6
Applicant	CFT No 13 Pty Ltd, or any other person who seeks to carry out development approved under this consent
BCA	Building Code of Australia
Calendar year	A period of 12 months from 1 January to 31 December
Conditions of this consent	Conditions contained in Schedules 2 to 6
Construction	All physical works to enable quarrying operations to be carried out, including demolition and removal of buildings or works, and erection of buildings and other infrastructure permitted by this consent
Council	Liverpool City Council
DA	Development Application
Day	Day is defined as the period from 7 am to 6 pm on Monday to Saturday, and 8 am to 6 pm on Sundays and Public Holidays
Decommission	The deconstruction or demolition and removal of works installed as part of the development
Demolition	The deconstruction and removal of buildings, sheds and other structures on the site
Department	Department of Planning, Industry and Environment
Development	The development described in the documents listed in condition 2 of Schedule 3
Development layout plan	The plan in Appendix 1
DITRDC	Commonwealth Department of Infrastructure, Transport, Regional Development and Communities
DPIE Water	Water Group within the Department
Dust	Any solid material that may become suspended in air or deposited
EIS	Environmental Impact Statement
Environment	Includes all aspects of the surroundings of humans, whether affecting any human as an individual or in his or her social groupings
EPA	Environment Protection Authority
EP&A Act	*Environmental Planning and Assessment Act 1979*
EP&A Regulation	*Environmental Planning and Assessment Regulation 2000*
EPL	Environment Protection Licence issued under the *Protection of the Environment Operations Act 1997*
Extraction area	Approved extraction footprint shown in Appendix 1
Feasible	Means what is possible and practical in the circumstances
Incident	A set of circumstances that: • causes, or threatens to cause, material harm to the environment; and/or • breaches or exceeds the limits or performance measures/criteria in this consent
Laden truck	Trucks transporting materials or products to or from the site
Land	As defined in the EP&A Act, except where the term is used in the noise and air quality conditions in Schedules 4, 5 and 6 of this consent, where it is defined as the whole of a lot, or contiguous lots owned by the same landowner, in a current plan registered at the Land Titles Office at the date of this consent.
Material harm	Is harm to the environment that: • involves actual or potential harm to the health or safety of human beings or to the environment that is not trivial; or • results in actual or potential loss or property damage of an amount, or amounts in aggregate, exceeding $10,000, (such loss includes the reasonable costs and expenses that would be incurred in taking all reasonable and practicable measures to prevent, mitigate or make good harm to the environment).
MEG	Regional NSW – Mining, Exploration & Geoscience
Minimise	Implement all reasonable and feasible mitigation measures to reduce the impacts of the development
Minister	Minister for Planning and Public Spaces, or delegate

Mitigation	Activities associated with reducing the impacts of the development
Modification 5	Modification Application DA 315-7-2003 MOD 5
Non-compliance	An occurrence, set of circumstances or development that is a breach of this consent
NPfI	NSW *Noise Policy for Industry*
PCC	Penrith City Council
Planning Secretary	Secretary of the Department, or nominee
Privately-owned land	Land that is not owned by a public agency, a quarrying company or its subsidiary; or where relevant, land that is not covered by a private agreement between the Applicant and the land owner that specifically allows for variances to criteria for environmental performance in this consent
POEO Act	*Protection of the Environment Operations Act 1997*
Public infrastructure	Linear and other infrastructure that provides services to the general public, such as roads, railways, water supply, drainage, sewerage, gas supply, electricity, telephone, telecommunications, etc.
Quarrying operations	The extraction, processing, stockpiling and transportation of extractive materials carried out on the site and the associated removal of vegetation, topsoil and overburden, and other land disturbance associated with the development
Quarry products	Extractive material which is extracted from and transported from the site
Reasonable	Reasonable relates to the application of judgement in arriving at a decision, taking into account: mitigation benefits, cost of mitigation versus benefits provided, community views and the nature and extent of potential improvements
Rehabilitation	The restoration of land disturbed by the development to a good condition, to ensure it is safe, stable and non-polluting
Residence	Existing or approved dwelling at the date of determination of Modification 5
RFS	NSW Rural Fire Service
Riparian zone	A 40 metre-wide strip of land adjacent to a local watercourse, measured horizontally from the top of the bank of the watercourse
Site	The development land shown in Figure 1 of Appendix 1, with land Lot and DP number identified in Schedule 1
SEE	Statement of Environmental Effects
TfNSW	Transport for NSW
Vacant land	The whole of a lot in a current plan registered at the Land Titles office that does not have a dwelling situated on the lot and is permitted to have a dwelling on that lot at the date of this consent
Waste	Has the same meaning as the definition of the term in the Dictionary to the POEO Act
WSA	The operator of the Western Sydney Airport

SCHEDULE 3
ADMINISTRATIVE CONDITIONS

Obligation to Minimise Harm to the Environment

1. In addition to meeting the specific performance measures and criteria established under this consent, the Applicant must implement all reasonable and feasible measures to prevent, and if prevention is not reasonable and feasible, minimise, any material harm to the environment that may result from the construction and operation of the development, and any rehabilitation required under this consent.

Terms of Consent

2. The Applicant must carry out the development:

   (a) in compliance with these conditions of consent;
   (b) in accordance with all written directions of the Planning Secretary;
   (c) generally in accordance with EIS titled *Proposed Clay/Shale Extraction Operation – Lot 3 – 275 Adams Road Luddenham*, dated May 2003, and prepared by Douglas Nicolaisen & Associates Pty Ltd;
   (d) generally in accordance with correspondence from Douglas Nicolaisen & Associates Pty Ltd to the Department dated 16 March 2004 relating to operating hours, location of environmental bunds and reduction in the proposed extraction area;
   (e) generally in accordance with information accompanying modification application DA 315-7-2003-MOD 1 for the relocation of the access bridge across Oaky Creek, lodged 16 November 2005, and prepared by Stuart J Castle Pty Ltd;
   (f) generally in accordance with Modification Application DA 315-7-2003 MOD 2 and the accompanying SEE titled "*Section 96(1A) Modification Application, 275 Adams Road Luddenham"* produced by Planning Direction Pty Ltd and dated 3 November 2009 and "*Acoustic Report – Clay/Shale Quarry at 275 Adams Road Luddenham*" produced by Golders Associates Ltd and dated 15 December 2009;
   (g) generally in accordance with Modification Application DA 315-7-2003 MOD 3 and the accompanying Environmental Assessment titled *Environmental Assessment Report for Epic Mining Pty Ltd: 275 Adams Road, Luddenham, NSW*, prepared by Benbow Environmental Pty Ltd and dated November 2014 relating to temporary stockpiling, extraction sequencing and other activities; and
   (h) generally in accordance with Modification Application DA 315-7-2003 MOD 5 and the accompanying Modification Report titled *Luddenham Quarry Modification Report DA 315-7-2003 MOD 5 Prepared for Coombs Property Group & KLF Holdings*, prepared by EMM Consulting and dated August 2020; Submissions Report dated December 2020 and RFI Responses dated March 2021; as amended by the revised project description prepared by EMM Consulting and dated 16 April 2021.

   ***Note**: The general layout of the development, including quarrying extraction area and development sequence, is shown in Appendix 1.*

3. The conditions of this consent and directions of the Planning Secretary prevail to the extent of any inconsistency, ambiguity or conflict between them and the document/s listed in condition 2. In the event of an inconsistency, ambiguity or conflict between any of the document/s listed in condition 2, the most recent document prevails to the extent of the inconsistency, ambiguity or conflict.

4. Consistent with the requirements in this consent, the Planning Secretary may make written directions to the Applicant in relation to:
   (a) the content of any strategy, study, system, plan, program, review, audit, notification, report or correspondence submitted under or otherwise made in relation to this consent, including those that are required to be, and have been, approved by the Planning Secretary; and
   (b) the implementation of any actions or measures contained in any such document referred to in condition 4(a).

4A. *Deleted.*

Limits on Approval

5. The Applicant may undertake quarrying operations on the site until 31 December 2024.

   Note: Under this consent, the Applicant is required to rehabilitate the site and perform additional undertakings to the satisfaction of the Planning Secretary. Consequently, this consent will continue to apply in all other respects other than the right to conduct quarrying operations until the site has been properly rehabilitated.

Limits on Production

6. The hours of operation for the development are limited to between 7 am and 6 pm Monday to Friday. The Applicant must ensure that no haulage vehicles enter or leave the site between 6 pm and 7 am Monday to Friday, and on public holidays. Maintenance activities may be conducted between 7 am and 1 pm on Saturday. No other work is to be undertaken on Saturday, Sunday and public holidays.

7. The production of quarry products from the quarry must not exceed 300,000 tonnes in any calendar year.

8. The Applicant must provide annual production data to the MEG, in the manner required, on the standard form supplied for that purpose. These data are also to be included in the Annual Review.

Quarry Product Transport

8A. A maximum of 300,000 tonnes of quarry products may be transported from the site in any calendar year.

8B. A maximum of 50 laden trucks may be dispatched from the site on any calendar day.

***Note**: Dispatch of laden trucks is also controlled by the operating hours specified in condition 6.*

Protection of Public Infrastructure

9. The Applicant must:
   (a) repair, or pay the full costs associated with repairing, any public infrastructure that is damaged by the development; and
   (b) relocate, or pay the full costs associated with relocating, any public infrastructure that needs to be relocated as a result of the development.

Structural Adequacy

10. The Applicant must ensure that all new buildings and structures, and any alterations or additions to existing buildings and structures, are constructed in accordance with the relevant requirements of the BCA.

Notes:
(a) Under Part 6 of the EP&A Act, the Applicant is required to obtain construction and occupation certificates for the proposed building works.
(b) Part 8 of the EP&A Regulation sets out the requirements for the certification of development.

Demolition

11. The Applicant must ensure that any demolition work is carried out in accordance with *AS 2601-2001: The Demolition of Structures*, or its latest version.

Operation of Plant and Equipment

12. The Applicant must ensure that all plant and equipment at the site, or used in connection with the development, are:
   (a) maintained in a proper and efficient condition; and
   (b) operated in a proper and efficient manner.

Compliance

13. Prior to commencement of development on Lot 3 DP 629799, the Applicant must commission an independent person(s) or organisation(s), approved by the Planning Secretary, to certify in writing to the satisfaction of the Planning Secretary, that the Applicant has complied with all relevant conditions of this consent applicable prior to that event.

Applicability of Guidelines

14. References in the conditions of this consent to any guideline, protocol, Australian Standard or policy are to such guidelines, protocols, standards or policies in the form they are in as at the date of this consent.

However, consistent with the conditions of this consent and without altering any limits or criteria in this consent, the Planning Secretary may, when issuing directions under this consent in respect of ongoing monitoring and management obligations, require compliance with an updated or revised version of such a guideline, protocol, standard or policy, or a replacement of them.

Evidence of Consultation

15. Where conditions of this consent require consultation with an identified party, the Applicant must:
   (a) consult with the relevant party prior to submitting the subject document; and
   (b) provide details of the consultation undertaken including:
      (i) the outcome of that consultation, matters resolved and unresolved; and
      (ii) details of any disagreement remaining between the party consulted and the Applicant and how the Applicant has addressed the matters not resolved.

Staging, Combining and Updating Strategies, Plans or Programs

16. With the approval of the Planning Secretary, the Applicant may:
   (a) prepare and submit any strategy, plan or program required by this consent on a staged basis (if a clear description is provided as to the specific stage and scope of the development to which the strategy, plan or program applies, the relationship of the stage to any future stages and the trigger for updating the strategy, plan or program);
   (b) combine any strategy, plan or program required by this consent (if a clear relationship is demonstrated between the strategies, plans or programs that are proposed to be combined); and
   (c) update any strategy, plan or program required by this consent (to ensure the strategies, plans and programs required under this consent are updated on a regular basis and incorporate additional measures or amendments to improve the environmental performance of the development).

Application of Existing Strategies, Plans or Programs

17. The Applicant must continue to apply all existing management strategies, plans or monitoring programs required and approved under this consent prior to the approval of any modification of this consent, until the approval of a similar plan, strategy or program required as a result of the modification.

SCHEDULE 4
ENVIRONMENTAL PERFORMANCE

AIR QUALITY

Air Quality Criteria

1. The Applicant must ensure that the particulate matter emissions generated by the development do not exceed the criteria listed in Tables 1, 2, and 3 at any privately-owned land.

Table 1: Long-term air quality criteria for particulate matter

Pollutant	Averaging period	Criterion
Total suspended particulate (TSP) matter	Annual	90 µg/m^3
Particulate matter <10 µm (PM_{10})	Annual	[a, c] 25 µg/m^3
Particulate matter <2.5 µm ($PM_{2.5}$)	Annual	[a, c] 8 µg/m^3

Table 2: Short-term air quality criteria for particulate matter

Pollutant	Averaging period	Criterion
Particulate matter <10 µm (PM_{10})	24 hour	[b] 50 µg/m^3
Particulate matter <2.5 µm ($PM_{2.5}$)	24 hour	[b] 25 µg/m^3

Table 3: Long-term air quality criteria for deposited dust

Pollutant	Averaging period	Maximum increase in deposited dust level	Maximum total deposited dust level
[d] Deposited dust	Annual	[b] 2 g/m^2/month	[a] 4 g/m^2/month

Notes:

[a] *Total impact (i.e. incremental increase in concentrations due to the development plus background concentrations due to all other sources).*
[b] *Incremental impact (i.e. incremental increase in concentrations due to the development on its own).*
[c] *Excludes extraordinary events such as bushfires, prescribed burning, dust storms, fire incidents or any other activity agreed by the Planning Secretary.*
[d] *Deposited dust is to be assessed as insoluble solids as defined by Standards Australia, AS/NZS 3580.10.1:2003: Methods for Sampling and Analysis of Ambient Air - Determination of Particulate Matter - Deposited Matter - Gravimetric Method.*

2. The air quality criteria in Tables 1, 2, and 3 do not apply if the Applicant has an agreement with the owner/s of the relevant residence or infrastructure to exceed the air quality criteria, and the Applicant has advised the Department in writing of the terms of this agreement.

Air Quality Operating Conditions

3. The Applicant must:
   (a) take all reasonable steps to:
      (i) minimise odour, fume and particulate matter (including PM_{10} and $PM_{2.5}$) emissions of the development, paying particular attention to minimising wheel-generated haul road emissions;
      (ii) improve energy efficiency and reduce greenhouse gas emissions of the development;
      (iii) minimise any visible off-site air pollution generated by the development; and
      (iv) minimise the extent of potential dust generating surfaces exposed on the site at any given point in time;
   (b) ensure that all 'non-road' mobile diesel equipment used in undertaking the development includes reasonable and feasible diesel emissions reduction technology;
   (c) operate an air quality management system to guide the day to day planning of quarrying operations;
   (d) minimise the air quality impacts of the development during adverse meteorological conditions and extraordinary events (see Note c to Tables 1 to 3);
   (e) carry out regular air quality monitoring to determine whether the development is complying with the relevant conditions in this consent; and

(f) regularly assess meteorological and air quality monitoring data and relocate, modify or stop operations on the site to ensure compliance with the relevant conditions of this consent.

Air Quality Management Plan

4. Prior to recommencing quarrying operations under Modification 5, the Applicant must prepare an Air Quality Management Plan for the development to the satisfaction of the Planning Secretary. This plan must:
   (a) be prepared by a suitably qualified and experienced person/s;
   (b) be prepared in consultation with the EPA;
   (c) describe the measures to be implemented to ensure:
      (i) compliance with the air quality criteria and operating conditions in this consent;
      (ii) best practice management is being employed; and
      (iii) air quality impacts of the development are minimised during adverse meteorological conditions and extraordinary events;
   (d) describe the air quality management system; and
   (e) include an air quality monitoring program, prepared in accordance with the *Approved Methods for Sampling and Analysis of Air Pollutants in New South Wales* (DEC, 2007), that:
      (i) is capable of evaluating the performance of the development against the air quality criteria;
      (ii) adequately supports the air quality management system; and
      (iii) includes a protocol for identifying any air quality-related exceedance, incident or non-compliance and for notifying the Department and relevant stakeholders of these events.

5. *Deleted*

6. *Deleted*

7. *Deleted*

8. *Deleted*

Soil and Land Management

9. The Applicant must immediately utilise or stockpile, for use in the rehabilitation of the site, any topsoil removed during the development. Topsoil must not be mixed with other overburden products. The topsoil stockpile(s) must be protected from erosion. The topsoil stockpile(s) must be sown with appropriate vegetation to stabilise the soil if they are to be stored for longer than 6 weeks. The topsoil stockpile(s) must have a maximum height of 1.5 metres.

10. The Applicant must minimise the removal of trees and other vegetation from the development site, and restrict any clearance to the areas occupied by quarrying activities, noise attenuation bund, access roads and ancillary facilities.

11. The Applicant must regularly consult with adjoining property owners to ensure property management issues including maintenance of common fences, weed control measures, and bushfire management are coordinated. Details of this consultation are to be reported in the Annual Review.

NOISE

Operational Noise Criteria

12. Except for the carrying out of construction works, the Applicant must ensure that the noise generated by the development does not exceed the criteria in Table 5 at any residence[a] on privately-owned land.

Table 5: Operational noise criteria dB(A) $L_{Aeq(15\ min)}$

Residences	Day Criteria
R3	53
R6	52
R4	46
R5	45
R2	43
R1, R7, R8	41

[a] *The Residences referred to in Table 5 are shown in Appendix 2.*

Noise generated by the development must be monitored and measured in accordance with the relevant procedures and modifications (including certain meteorological conditions) of the NPfI.

The noise criterion in Table 5 do not apply if the Applicant has an agreement with the owner/s of the relevant residence or land to exceed the noise criteria, and the Applicant has advised the Department in writing of the terms of this agreement.

Additional Mitigation Upon Request

12A. Upon receiving a written request from the owner of any land listed in Table 5A, the Applicant must implement additional noise mitigation measures at the residence in consultation with the landowner.

These measures must be reasonable and feasible, consistent with the measures outlined in the *Voluntary Land Acquisition and Mitigation Policy for State Significant Mining, Petroleum and Extractive Industry Developments* (2018), proportionate to the level of predicted impacts and directed towards reducing the noise impacts from the development.

Table 5A: Land subject to additional mitigation upon request

Mitigation basis	Land
Noise	R3 – 285 Adams Road, Luddenham
Noise	R6 – 225 Adams Road, Luddenham

12B. If within 3 months of receiving this request from the landowner, the Applicant and the landowner cannot agree on the measures to be implemented, or there is dispute about the implementation of these measures, then either party may refer the matter to the Planning Secretary for resolution.

Noise Operating Conditions

13. The Applicant must:
    (a) take all reasonable steps to minimise noise from construction, traffic and operational activities, including low frequency noise and other audible characteristics, associated with the development;
    (b) implement reasonable and feasible noise attenuation measures on all plant and equipment that will operate in noise sensitive areas;
    (c) operate a noise management system to guide the day to day planning of quarrying operations;
    (d) take all reasonable steps to minimise the noise impacts of the development during noise-enhancing meteorological conditions when the noise criteria in this consent do not apply (see NPfI);
    (e) carry out regular noise monitoring to determine whether the development is complying with the relevant conditions of this consent; and
    (f) regularly assess the noise monitoring data and modify or stop operations on the site to ensure compliance with the relevant conditions of this consent.

Noise Management Plan

14. Prior to recommencing quarrying operations under Modification 5, the Applicant must prepare a Noise Management Plan for the development to the satisfaction of the Planning Secretary. This plan must:
    (a) be prepared by a suitably qualified and experienced person/s;
    (b) be prepared in consultation with the EPA;
    (c) describe the measures to be implemented to ensure:
        (i) compliance with the noise criteria and operating conditions in this consent;
        (ii) best practice management is being employed;
        (iii) noise impacts of the development are minimised during noise-enhancing meteorological conditions when the noise criteria in this consent do not apply (see NPfI);
    (d) describe the noise management system in detail; and
    (e) include a monitoring program that:
        (i) is capable of evaluating the performance of the development;
        (ii) monitors noise at the nearest and/or most affected residences;
        (iii) adequately supports the noise management system;
        (iv) includes a protocol for distinguishing noise emissions of the development from any neighbouring developments; and
        (v) includes a protocol for identifying any noise-related exceedance, incident or non-compliance and for notifying the Department and relevant stakeholders of any such event.

15. *Deleted*.

Construction of the Noise Attenuation Bund

Note: The noise attenuation bund also functions as visual screen of the operations associated with the extraction of the clay/shale resource.

16. The Applicant must minimise noise levels during the construction of the noise attenuation bund by the implementation of best available techniques economically achievable.

17. The Applicant must complete the construction of the noise attenuation bund in the minimum time, not to exceed 6 weeks from the commencement of its construction, unless otherwise approved by the Planning Secretary.

18. The Applicant must prepare a noise assessment of the construction of the noise attenuation bund within 3 weeks of the commencement of construction of the bund. The assessment must be carried out by a suitably qualified and experienced acoustical consultant, approved by the Planning Secretary, and submitted to the EPA and the Department.

19. The Applicant must not remove the northern noise bund unless the Applicant has demonstrated that a suitable alternative has been approved and that the alternative will achieve compliance with the consent noise criteria in this consent, to the satisfaction of the Planning Secretary.

METEOROLOGICAL MONITORING

20. Prior to recommencing quarrying operations under Modification 5, the Applicant must ensure that there is a suitable meteorological station operating in close proximity to the site that:
    (a) complies with the requirements in the *Approved Methods for Sampling and Analysis of Air Pollutants in New South Wales* (DEC, 2007); and
    (b) is capable of measuring meteorological conditions in accordance with the NPfI,

    unless a suitable alternative is approved by the Planning Secretary following consultation with the EPA.

BLASTING

21. Blasting is not permitted on the site.

SURFACE & GROUND WATER

Note: *Under the Water Act 1912 and/or the Water Management Act 2000, the Applicant is required to obtain all necessary water licences for the development.*

Water Supply

21A. The Applicant must ensure that it has sufficient water for all stages of the development, and if necessary, adjust the scale of the development to match its available water supply.

21B. The Applicant must report on water extracted from the site each year (direct and indirect) in the Annual Review, including water taken under any water licence.

Pollution of Waters

22. Except as may be expressly provided by an EPL, the Applicant must comply with section 120 of the *Protection of the Environment Operations Act 1997* during the carrying out of the development.

23. The Applicant must not discharge any water from the development to Oaky Creek, except as otherwise approved under an EPL, and following approval of a Discharge Characterisation and Water Pollution Impact Assessment in accordance with condition 25 below.

Soil and Water Management Plan

24. Prior to recommencing quarrying operations under Modification 5, the Applicant must prepare a Soil and Water Management Plan for the development to the satisfaction of the Planning Secretary. This plan must:
    (a) be prepared by suitably qualified and experienced person/s;
    (b) be prepared in consultation with EPA and DPIE Water; and
    (c) include a:
        (i) **Site Water Balance** that includes details of:
            a. predicted annual inflows to and outflows from the site;
            b. sources and security of water supply for the life of the development (including authorised entitlements and licences);
            c. water storage capacity;
            d. water use and management on the site, including any water transfers or sharing with neighbouring land users;
            e. licensed discharges points and limits; and
            f. reporting procedures, including the annual preparation of an updated site water balance;
        (ii) **Erosion and Sediment Control Plan** that:
            a. is consistent with the requirements of Managing Urban Stormwater: Soils and Construction – Volume 1: Blue Book (Landcom, 2004) and Volume 2E: Mines and Quarries (DECC, 2008);
            b. identifies activities that could cause soil erosion, generate sediment or affect flooding;
            c. describes measures to minimise soil erosion and the potential for the transport of sediment to downstream waters, and manage flood risk;
            d. describes the location, function, and capacity of erosion and sediment control structures and flood management structures; and
            e. describes what measures would be implemented to maintain (and if necessary decommission) the structures over time;

(iii) **Surface Water Management Plan**, that includes:
   a. detailed baseline data on surface water flows and quality in water bodies within the site and in Oaky Creek;
   b. surface water impact assessment criteria, including trigger levels for investigating any potentially adverse impacts, and surface water management performance measures;
   c. a detailed description of the surface water management system on the site, including the:
      - clean water diversion system;
      - erosion and sediment controls;
      - dirty water management system;
      - water storages; and
      - measures to minimise the need for surface water discharges to Oaky Creek;
   d. a program to monitor and evaluate:
      - any approved surface water discharges;
      - the effectiveness of the water management system;
      - impacts on water supply for other water users; and
      - surface water flows and quality in watercourses and/or waterbodies that could potentially be impacted by the development; and
   e. a protocol for identifying and investigating any exceedances of the surface water impact assessment criteria and for notifying the Department and relevant stakeholders of these events; and

(iv) **Groundwater Management Plan** that includes:
   a. detailed baseline data on groundwater levels and quality across the site;
   b. a program to monitor and report on:
      - groundwater levels and quality across the site and identify any unauthorised groundwater interference; and
      - impacts of the development on alluvium and associated surface water sources and groundwater dependent ecosystems;
   c. a protocol for identifying and investigating any exceedances of the groundwater performance criteria and for notifying the Department and relevant stakeholders of these events; and
   d. a protocol to obtain appropriate water licence(s) to cover the volume of any unforeseen groundwater inflows into the extraction areas.

Discharge Characterisation and Water Pollution Impact Assessment

25. Prior to any discharges from the quarry water management system to Oaky Creek, the Applicant must prepare a Discharge Characterisation and Water Pollution Impact Assessment for the development to the satisfaction of the Planning Secretary. This plan must:
   (a) be prepared by suitably qualified and experienced person/s;
   (b) be prepared in consultation with EPA and DPIE Water; and
   (c) include:
      (i) measures to avoid the need for discharges as far as reasonable and feasible;
      (ii) analysis of the frequency and volume of discharges during a range of weather conditions;
      (iii) characterisation of the expected quality of proposed discharges;
      (iv) assessment of the impacts of discharges to receiving waters; and
      (v) measures to minimise pollution and potential impacts on receiving waters;

Irrigation Management Plan

26. Prior to the use of water from the quarry water management system for irrigation purposes, the Applicant must prepare an Irrigation Management Plan for the development to the satisfaction of the Planning Secretary. This plan must:
   (a) identify the specific areas of land to be irrigated;
   (b) include baseline data on soil and water quality in the irrigation areas;
   (c) determine sustainable water application rates and management requirements;
   (d) describe measures to prevent any tailwater drainage from entering Oaky Creek;
   (e) describe measures to ensure that soils subject to irrigation are not adversely affected by the concentration of salts; and
   (f) include a monitoring program for the irrigation management system.

27. *Deleted.*

28. *Deleted.*

29. *Deleted.*

WASTE MANAGEMENT

30. The Applicant must:
   (a) not cause, permit or allow any waste generated outside the site to be received at the site for storage, treatment, processing, reprocessing or disposal, or any waste generated at the site to be

disposed of at the site, except as expressly permitted by an EPL and/or a separate development consent;

(b) manage onsite sewage to the satisfaction of Council;

(c) minimise the waste generated by the development;

(d) ensure that the waste generated by the development is appropriately stored, handled, and disposed of; and

(e) report on waste minimisation and management in the Annual Review.

31. *Deleted.*

ABORIGINAL HERITAGE

32. The Applicant must:

(a) protect from disturbance, by fencing, the Aboriginal site and relics (the site) located close to Oaky Creek shown in Figure 2 of Technical Document 8 of the EIS (*"Assessment and Management Recommendations for the Aboriginal Archaeological Site at 275 Adams Road Luddenham"* prepared by Umwelt (Australia) Pty Limited and dated September 2001) (ie. AIHMS site #45-5-2280);

(b) implement measures to protect the extant Aboriginal sites from direct and indirect damage, including in relation to erosion and sedimentation;

(c) provide training in the cultural values of Aboriginal sites to all permanent staff;

(d) prepare and implement an unexpected finds protocol to manage the discovery of any previously unidentified Aboriginal objects or human remains on the site; and

(e) allow reasonable access to the site by representatives of the Gandangara Local Aboriginal Land Council to allow educational and cultural activities and monitoring of the condition of the extant Aboriginal sites.

REHABILITATION & BIODIVERSITY

33. Prior to the carrying out of any development on the site, the Applicant must prepare a Site Rehabilitation Plan in accordance with the rehabilitation guidelines in the document titled "*Sydney Regional Environmental Plan No. 9 – Extractive Industry (No. 2) – Planning Report",* to the satisfaction of the Planning Secretary. The Site Rehabilitation Plan must include a Biodiversity Management Plan.

34. The Biodiversity Management Plan must include:

(a) revegetation of the riparian zone of Oaky Creek;

(b) protection, establishment and maintenance of the riparian zone;

(c) protection of remnant native vegetation;

(d) restoration of any areas within the riparian zone disturbed by the development;

(e) a program to vegetate the noise attenuation bund;

(f) a protocol for monitoring and relocating native fauna encountered during the recommissioning and dewatering of the quarry and storages;

(g) a protocol for pre-clearance surveys for vegetation clearing activities;

(h) salvage of resources during vegetation clearing activities for use in rehabilitation activities; and

(i) measures for minimising the attraction of wildlife, in consultation with DITRDC and WSA.

35. *Deleted.*

36. Prior to 5 years of the estimated completion of extractive activities at the site, the Applicant must submit a Final Land Use Plan to the Department identifying the final land use of the site and method of treatment for the final void.

36A. Prior to recommencing quarrying operations approved under Modification 5, or other timeframe agreed by the Planning Secretary, the Applicant must review and update the Site Rehabilitation Plan, Biodiversity Management Plan, and Final Land Use Plan in consultation with EPA, DITRDC and WSA, and to the satisfaction of the Planning Secretary. The updated plans must:

(a) be consistent with any related approvals that provide for filling the final void, while also providing contingency rehabilitation activities in the event that such approvals are not obtained; and

(b) include measures to minimise the short, medium and long term risks to the construction and operation of the Western Sydney Airport and other surrounding land users.

Rehabilitation Bond

37. Prior to commencement of operations on Lot 3, DP 623799, the Applicant must provide a Rehabilitation Bond in the sum of $166,750 in the form of an insurance bond or bank guarantee acceptable to the Planning Secretary from any bank licensed pursuant to the *Banking Act 1959 (Cth)*. The Rehabilitation Bond must be made in favour of the Minister administering the *Environmental Planning & Assessment Act 1979* to ensure completion of the rehabilitation and landscaping works at the site. The sum of the Rehabilitation Bond is calculated based on $2.50 per square metre for a maximum exposed area of 6.67 hectares (ha).

The Department may review the adequacy of Rehabilitation Bond to provide for the completion of rehabilitation and landscaping works on the site at intervals of not less than three years. The Applicant must ensure that the Rehabilitation Bond is in accordance with the sum determined by the review.

Notes:

(a) The Planning Secretary may at any time, and without notice to the Applicant, demand all or part of the monies available under the Rehabilitation Bond if, in the Planning Secretary's opinion, the Applicant has failed to make satisfactory progress on the rehabilitation and landscaping of the site.

(b) The Secretary may apply the monies to ensure that the actions specified in the documents listed in condition 2 of Schedule 3 and/or any approved Site Rehabilitation Plan are achieved.

(c) The Rehabilitation Bond will be released when the Applicant submits documentation prepared by a qualified rehabilitation consultant certifying that the final rehabilitation has been completed in accordance with the conditions of this consent and/or any approved Site Rehabilitation Plan, to the satisfaction of the Planning Secretary.

VISUAL AMENITY

38. The Applicant must:
    (a) take all reasonable and feasible steps to minimise the visual and offsite lighting impacts of the development, including impacts on the Western Sydney Airport;
    (b) take all reasonable steps to shield views of quarrying operations and associated equipment from users of public roads and privately-owned residences;
    (c) ensure no fixed outdoor lights shine directly above the horizontal or above the building line or any illuminated structure;
    (d) ensure that all external lighting associated with the development complies with relevant Australian Standards including *Australian Standard AS4282 (INT) 1997 – Control of Obtrusive Effects of Outdoor Lighting*;
    (e) ensure that the visual appearance of all buildings, structures, facilities or works (including paint colours and specifications) is aimed at blending as far as possible with the surrounding landscape.

39. *Deleted.*

TRAFFIC & TRANSPORT

Access and Heavy Vehicle Limits

40. Unless otherwise agreed by the Planning Secretary, the Applicant must:
    (a) restrict all heavy vehicle access to the site to a maximum truck length of 19 metres;
    (b) restrict all quarry-related traffic to left-in, right-out movements at the intersection of Elizabeth Drive and Adams Road; and
    (c) not use the portion of Adams Road south of the site access road for any quarry-related heavy vehicle traffic.

Road Upgrades

41. Prior to recommencing quarrying operations approved under Modification 5, the Applicant must:
    (a) upgrade (seal) the portion of Adams Road between Elizabeth Drive to approximately 40 metres south of the site access road, and obtain approval to lift the load limit on that section of the road, to the satisfaction of Council;
    (b) prepare and implement a signage and linemarking plan for the Elizabeth Drive/Adams Road intersection to restrict and manage truck access, to the satisfaction of TfNSW; and
    (c) upgrade (seal) the internal site access road between Adams Road and the proposed weighbridge.

Road Transport Protocol

42. Prior to recommencing quarrying operations approved under Modification 5, the Applicant must develop a Road Transport Protocol, in consultation with TfNSW and Council, and to the satisfaction of the Planning Secretary. This protocol must:
    (a) specify the haulage route(s) to be used, the maximum number of road movements and the haulage hours;
    (b) include a Traffic Management Plan which addresses:
        - procedures to ensure that drivers adhere to the designated haulage route(s) as required under this Protocol;
        - measures to achieve a low-frequency, regular trucking schedule rather than a high-frequency, campaign trucking schedule;
        - contingency plans where, for example, any designated transport route is disrupted. This must also address procedures for notifying relevant agencies and affected communities by the implementation of any such contingency plan;
        - procedures to ensure that all haulage vehicles associated with the quarry are clearly distinguishable as being related to the development;
        - procedures for monitoring of product transport, including keeping of accurate records of all laden truck movements to and from the site (including time of arrival and dispatch) and publishing a summary of these records in the Annual Review;

- procedures for covering of all loads and ensuring that trucks do not track material onto public roads;
- details for procedures for receiving and addressing complaints from the community concerning traffic issues associated with haulage from the quarry or return of unladen trucks to the quarry; and
- measures to ensure the provisions of the traffic management plan are implemented, for example, education of drivers and any contractual agreements with operators of heavy vehicles which serve the quarry.

(c) include a Code of Conduct for drivers which addresses:

- travelling speeds;
- staggering of truck departures to ensure a regular trucking schedule throughout the day;
- instructions to drivers not to overtake each other on the haulage route(s), as far as practicable, and to maintain appropriate distances between vehicles;
- instructions to drivers to adhere to the designated haulage route(s);
- instructions to drivers to be especially safety conscious and to ensure that traffic regulations are obeyed strictly;
- driver training in the Code to ensure that all drivers are made aware and adhere to the Code; and
- procedures for ensuring compliance with and enforcement of the Code.

DANGEROUS GOODS

43. The Applicant must ensure that:
    (a) all tanks and similar storage facilities (other than for water) are protected by appropriate bunding or other containment, in accordance with the relevant Australian Standards; and
    (b) the storage, handling, and transport of all dangerous goods are undertaken in accordance with the relevant Australian Standards, particularly AS1940 and AS1596, and the Dangerous Goods Code.

BUSHFIRE MANAGEMENT

44. The Applicant must:
    (a) ensure that the development provides:
        (i) asset protection in accordance with the relevant requirements in *the Planning for Bushfire Protection* (RFS, 2019) guideline; and
        (ii) is suitably equipped to respond to any fires on the site; and
    (b) assist the RFS and emergency services to the extent practicable if there is a fire in the vicinity of the site.

SCHEDULE 5
ADDITIONAL PROCEDURES

NOTIFICATION OF LANDOWNERS/TENANTS

1. Within one month of the approval of Modification 5, the Applicant must notify in writing the owners of the residences on the land listed in Table 5A of Schedule 4 that they are entitled to ask the Applicant to install additional mitigation measures at their residence.

2. Prior to entering into any tenancy agreement for any land owned by the Applicant that is predicted to experience exceedances of the recommended air quality criteria, the Applicant must:
   (a) advise the prospective tenants of the potential health and amenity impacts associated with living on the land, and give them a copy of the fact sheet entitled "Mine Dust and You" (NSW Health, 2017); and
   (b) advise the prospective tenants of the rights they would have under this consent,

   to the satisfaction of the Planning Secretary.

NOTIFICATION OF EXCEEDANCES

3. As soon as practicable and no longer than 7 days after obtaining monitoring results showing an exceedance of any noise or air quality criterion in Schedule 4 of this consent, the Applicant must provide the details of the exceedance to any affected landowners and/or tenants.

4. For any exceedance of the air quality criteria in Schedule 4 of this consent, the Applicant must also provide to any affected landowners and/or tenants a copy of the fact sheet entitled "Mine Dust and You" (NSW Health, 2017).

INDEPENDENT REVIEW

5. If a landowner considers the development to be exceeding any relevant noise or air quality criterion in Schedule 4 of this consent, they may ask the Planning Secretary in writing for an independent review of the impacts of the development on their residence or land.

6. If the Planning Secretary is not satisfied that an independent review is warranted, the Planning Secretary will notify the landowner in writing of that decision, and the reasons for that decision, within 21 days of the request for a review.

7. If the Planning Secretary is satisfied that an independent review is warranted, within 3 months, or other timeframe agreed by the Planning Secretary and the landowner, of the Planning Secretary's decision, the Applicant must:
   (a) commission a suitably qualified, experienced and independent person, whose appointment has been approved by the Planning Secretary, to:
      (i) consult with the landowner to determine their concerns;
      (ii) conduct monitoring to determine whether the development is complying with the relevant criterion in Schedule 4 of this consent; and
      (iii) if the development is not complying with the relevant criterion, identify measures that could be implemented to ensure compliance with the relevant criterion;
   (b) provide the Planning Secretary and landowner a copy of the independent review; and
   (c) comply with any written requests made by the Planning Secretary to implement any findings of the review.

SCHEDULE 6
ENVIRONMENTAL MANAGEMENT, MONITORING, AUDITING & REPORTING

ENVIRONMENTAL MANAGEMENT

Environmental Management Strategy

1. The Applicant must prepare an Environmental Management Strategy for the development to the satisfaction of the Planning Secretary. This strategy must:
   (a) provide the strategic framework for environmental management of the development;
   (b) identify the statutory approvals that apply to the development;
   (c) set out the role, responsibility, authority and accountability of all key personnel involved in the environmental management of the development;
   (d) set out the procedures to be implemented to:
      (i) keep the local community and relevant agencies informed about the operation and environmental performance of the development;
      (ii) receive record, handle and respond to complaints;
      (iii) resolve any disputes that may arise during the course of the development;
      (iv) respond to any non-compliance and any incident;
      (v) respond to emergencies; and
   (e) include:
      (i) references to any strategies, plans and programs approved under the conditions of this consent; and
      (ii) a clear plan depicting all the monitoring to be carried out under the conditions of this consent.

2. The Applicant must implement the Environmental Management Strategy as approved by the Planning Secretary.

Adaptive Management

3. The Applicant must assess and manage development-related risks to ensure that there are no exceedances of the criteria and performance measures in this consent. Any exceedance of these criteria or performance measures constitutes a breach of this consent and may be subject to penalty or offence provisions under the EP&A Act or EP&A Regulation.

   Where any exceedance of these criteria or performance measures has occurred, the Applicant must, at the earliest opportunity:
   (a) take all reasonable and feasible steps to ensure that the exceedance ceases and does not recur;
   (b) consider all reasonable and feasible options for remediation (where relevant) and submit a report to the Department describing those options and any preferred remediation measures or other course of action; and
   (c) implement reasonable remediation measures as directed by the Planning Secretary.

Management Plan Requirements

4. Management plans required under this consent must be prepared in accordance with relevant guidelines, and include:
   (a) a summary of relevant background or baseline data;
   (b) details of:
      (i) the relevant statutory requirements (including any relevant approval, licence or lease conditions);
      (ii) any relevant limits or performance measures and criteria; and
      (iii) the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the development or any management measures;
   (c) any relevant commitments or recommendations identified in the document/s listed in condition 2 of Schedule 3;
   (d) a description of the measures to be implemented to comply with the relevant statutory requirements, limits, or performance measures and criteria;
   (e) a program to monitor and report on the:
      (i) impacts and environmental performance of the development; and
      (ii) effectiveness of the management measures set out pursuant to sub-condition (d) above;
   (f) a contingency plan to manage any unpredicted impacts and their consequences and to ensure that ongoing impacts reduce to levels below relevant impact assessment criteria as quickly as possible;
   (g) a program to investigate and implement ways to improve the environmental performance of the development over time;
   (h) a protocol for managing and reporting any:
      (i) incident, non-compliance or exceedance of the impact assessment criteria or performance criteria;
      (ii) complaint; or
      (iii) failure to comply with statutory requirements;
   (i) public sources of information and data to assist stakeholders in understanding environmental impacts of the development; and

(j) a protocol for periodic review of the plan.

Note: *The Planning Secretary may waive some of these requirements if they are unnecessary or unwarranted for particular management plans.*

ANNUAL REVIEW

5. By the end of September 2016 and each year following, or other timing as may be agreed by the Planning Secretary, the Applicant must review the environmental performance of the development to the satisfaction of the Planning Secretary. This review must:
   (a) describe the development (including rehabilitation) that was carried out in the previous calendar year, and the development that is proposed to be carried out over the current calendar year;
   (b) include a comprehensive review of the monitoring results and complaints records of the development over the previous calendar year, which includes a comparison of these results against:
      - the relevant statutory requirements, limits or performance measures/criteria;
      - the monitoring results of previous years; and
      - the relevant predictions in the document/s listed in condition 2 of Schedule 3;
   (c) identify any non-compliance over the last year, and describe what actions were (or are being) taken to ensure compliance;
   (d) identify any trends in the monitoring data over the life of the development;
   (e) identify any discrepancies between the predicted and actual impacts of the development, and analyse the potential cause of any significant discrepancies; and
   (f) describe what measures will be implemented over the current calendar year to improve the environmental performance of the development.

6. Copies of the Annual Review must be made available to Council and any interested person upon request.

INDEPENDENT ENVIRONMENTAL AUDIT

7. Before 31 December 2010, and every 3 years thereafter, unless the Secretary directs otherwise, the Applicant must commission and pay the full cost of an Independent Environmental Audit of the development. This audit must:
   (a) be conducted by a suitably qualified, experienced, and independent team of experts whose appointment has been endorsed by the Planning Secretary;
   (b) include consultation with the relevant agencies;
   (c) assess the environmental performance of the development, and whether it is complying with the relevant requirements in this consent and any relevant EPL (including any assessment, plan or program required under these approvals);
   (d) review the adequacy of any approved strategy, plan or program required under these approvals; and
   (e) recommend measures or actions to improve the environmental performance of the development, and/or any assessment, plan or program required under these approvals;

   Note: This audit team must be led by a suitably qualified auditor and include experts in rehabilitation and any other field specified by the Planning Secretary.

8. Within six weeks of the completion of this audit, or as otherwise agreed by the Planning Secretary, the Applicant must submit a copy of the audit report to the Planning Secretary, together with its response to any recommendations contained in the audit report.

REVISION OF STRATEGIES, PLANS AND PROGRAMS

9. Within three months of:
   (a) the submission of an incident report under condition 12 below;
   (b) the submission of an Annual Review under condition 5 above;
   (c) the submission of an Independent Environmental Audit under condition 7 above; or
   (d) the approval of any modification of the conditions of this consent (unless the conditions require otherwise);

   the suitability of existing strategies, plans and programs required under this consent must be reviewed by the Applicant.

10. If necessary, to either improve the environmental performance of the development, cater for a modification or comply with a direction, the strategies, plans and programs required under this consent must be revised, to the satisfaction of the Planning Secretary and submitted to the Planning Secretary for approval within six weeks of the review.

    Note: This is to ensure that strategies, plans and programs are regularly updated to incorporate any measures recommended to improve the environmental performance of the development.

11. The Applicant must implement all strategies, plans and programs required under this consent as approved by the Planning Secretary.

REPORTING AND AUDITING

Incident Reporting

12. The Applicant must immediately notify the Department and any other relevant agencies after it becomes aware of an incident. The notification must be in writing via the Major Projects Website and identify the development (including the development application number and name) and set out the location and nature of the incident.

Non-Compliance Notification

13. Within seven days of becoming aware of a non-compliance, the Applicant must notify the Department of the non-compliance. The notification must be in writing via the Major Projects Website and identify the development (including the development application number and name), set out the condition of this consent that the development is non-compliant with, the way in which it does not comply and the reasons for the non-compliance (if known) and what actions have been, or will be, undertaken to address the non-compliance.

    ***Note**: A non-compliance which has been notified as an incident does not need to also be notified as a non-compliance.*

Regular Reporting

14. The Applicant must provide regular reporting on the environmental performance of the development on its website, in accordance with the reporting arrangements in any plans or programs approved under the conditions of this consent.

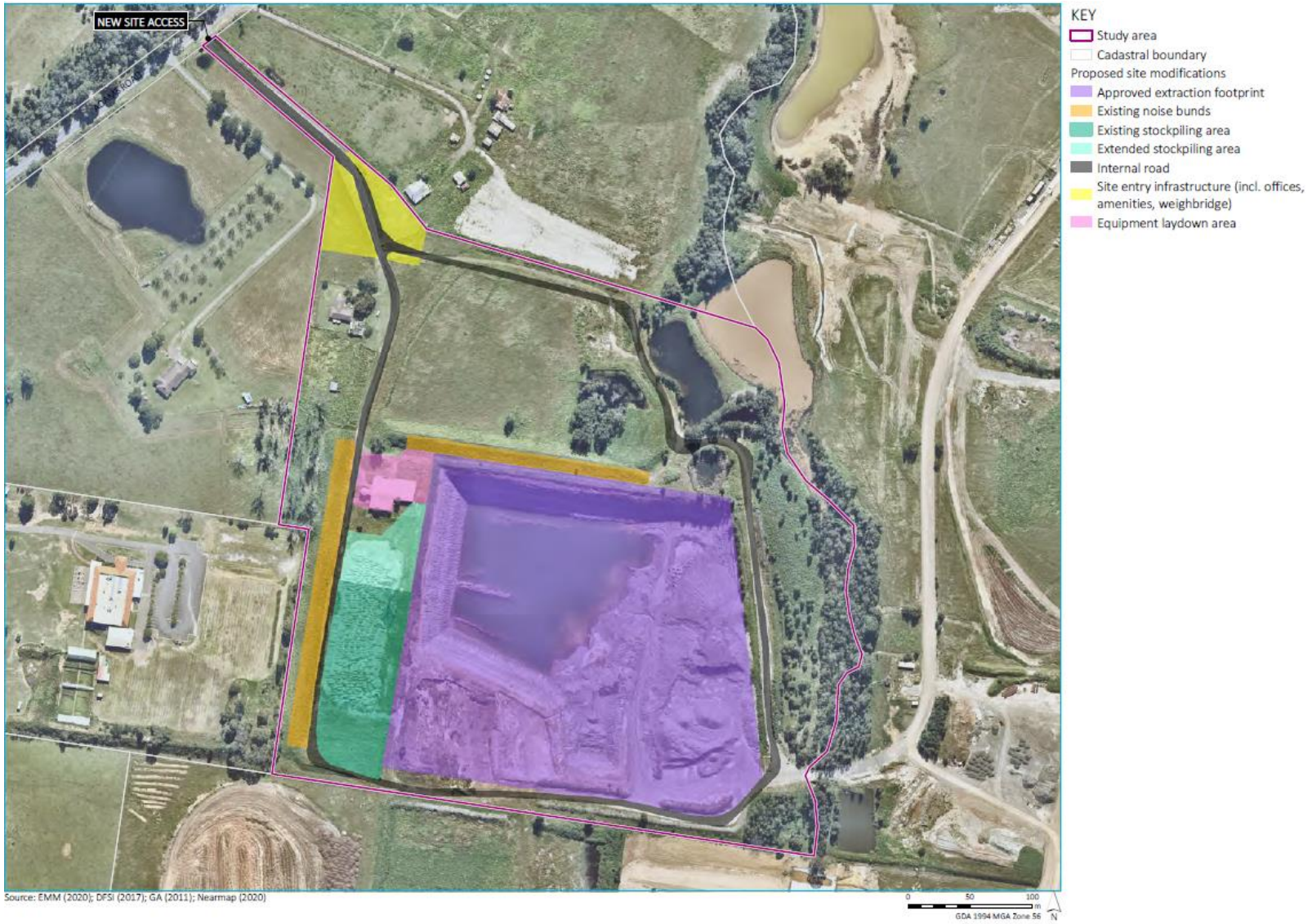
ACCESS TO INFORMATION

15. From 30 September 2016 and for the duration of the development, the Applicant must:
    (a) make copies of the following publicly available on its website:
        - the document/s listed in condition 2 of Schedule 3;
        - current statutory approvals for the development;
        - approved strategies, plans and programs required under the conditions of this consent;
        - a comprehensive summary of the monitoring results of the development, reported in accordance with the specifications in any conditions of this consent, or any approved plans and programs;
        - a complaints register, which is to be updated monthly;
        - the Annual Reviews of the development (for the last 5 years);
        - any Independent Environmental Audit of the development, and the Applicant's response to the recommendations in any audit;
        - any other matter required by the Planning Secretary; and

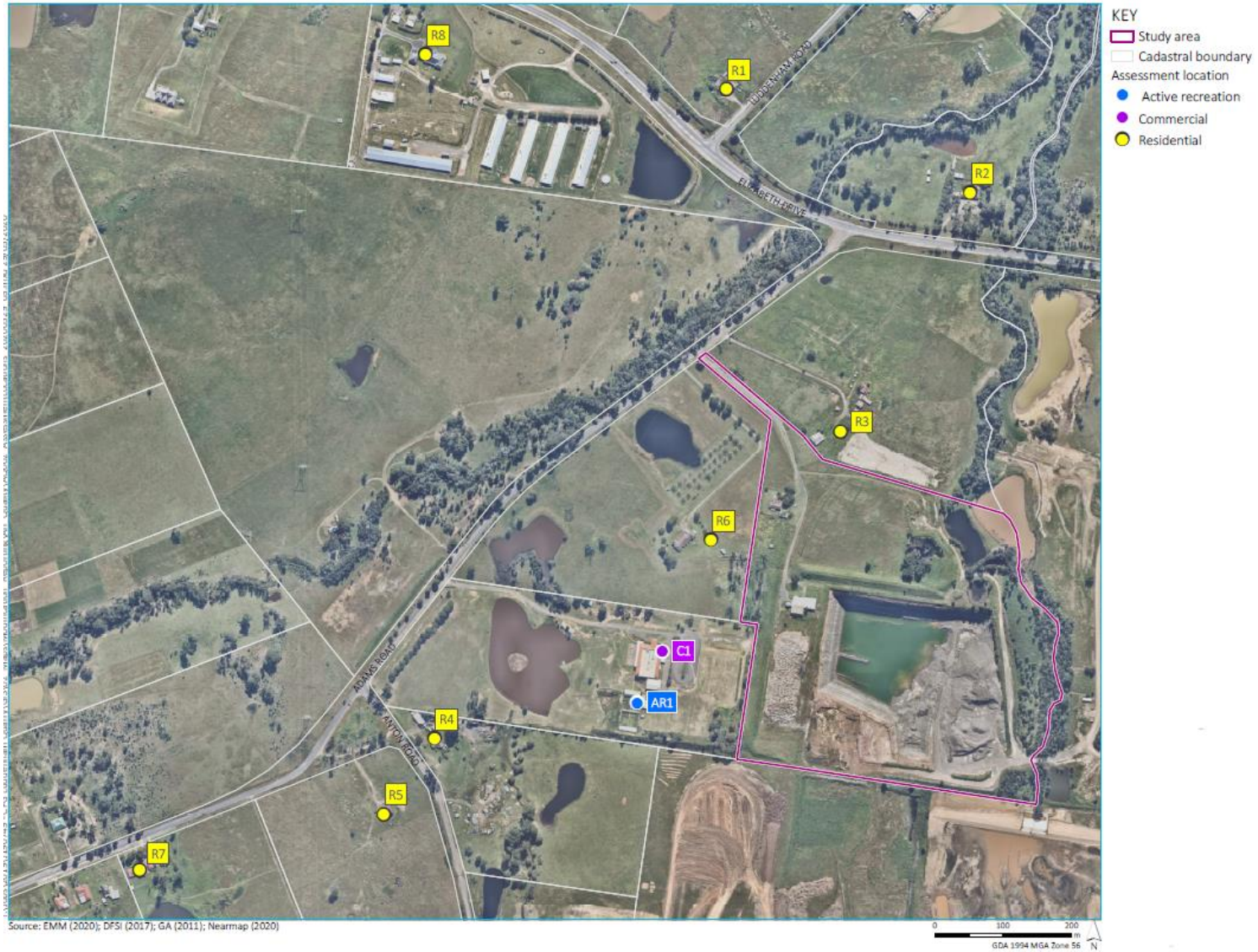
    (b) keep this information up-to-date, to the satisfaction of the Planning Secretary.

APPENDIX 1

DEVELOPMENT LAYOUT PLAN



APPENDIX 2
LOCATION OF RESIDENCES



Appendix 11 - Laboratory Reports

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES2222130**	Page	: 1 of 13
Client	: **4 PILLARS ENVIRONMENTAL CONSULTING**	Laboratory	: Environmental Division Sydney
Contact	: RESULTS	Contact	: Customer Services ES
Address	: Suite 16, 9 George Street NORTH STRATHFIELD 2137	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: 20220601KLF - June Quarry Water	Date Samples Received	: 23-Jun-2022 15:40
Order number	: ----	Date Analysis Commenced	: 23-Jun-2022
C-O-C number	: ----	Issue Date	: 30-Jun-2022 16:23
Sampler	: MS		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 2		
No. of samples analysed	: 2		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW
Edwandy Fadjar	Organic Coordinator	Sydney Organics, Smithfield, NSW
Franco Lentini	LCMS Coordinator	Sydney Organics, Smithfield, NSW
Sarah Griffiths	Microbiologist	Sydney Microbiology, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EP234: Poor matrix spike recovery for particular compounds due to matrix interferences and high matrix spike recovery has been noted for particular compounds due to ion enhancement.
- MF = membrane filtration
- CFU = colony forming unit
- EP068: Where reported, Total Chlordane (sum) is the sum of the reported concentrations of cis-Chlordane and trans-Chlordane at or above the LOR.
- EP080: Where reported, Total Xylenes is the sum of the reported concentrations of m&p-Xylene and o-Xylene at or above the LOR.
- ED093/ EG020: It is recognised that total concentration is less than dissolved for some metal analytes. However, the difference is within experimental variation of the methods.
- Microbiological Comment: In accordance with ALS work instruction QWI-MIC/04, membrane filtration result is reported an approximate (~) when the count of colonies on the filtered membrane is outside the range of 10 - 100cfu.
- MW006 is ALS's internal code and is equivalent to AS4276.7.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	S1	D1	----	----	----
			Sampling date / time	23-Jun-2022 00:00	23-Jun-2022 00:00	----	----	----
Compound	CAS Number	LOR	Unit	ES2222130-001	ES2222130-002	--------	--------	--------
				Result	Result	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**8.60**	**8.66**	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**4190**	**4190**	----	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**2300**	**2270**	----	----	----
EA045: Turbidity								
Turbidity	----	0.1	NTU	**2.1**	**1.3**	----	----	----
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	**469**	**480**	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	**40**	**44**	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**297**	**297**	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**336**	**341**	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**256**	**259**	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**943**	**944**	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**23**	**24**	----	----	----
Magnesium	7439-95-4	1	mg/L	**100**	**102**	----	----	----
Sodium	7440-23-5	1	mg/L	**729**	**735**	----	----	----
Potassium	7440-09-7	1	mg/L	**16**	**16**	----	----	----
ED093T: Total Major Cations								
Calcium	7440-70-2	1	mg/L	**20**	**20**	----	----	----
Magnesium	7439-95-4	1	mg/L	**98**	**98**	----	----	----
Sodium	7440-23-5	1	mg/L	**703**	**702**	----	----	----
Potassium	7440-09-7	1	mg/L	**13**	**13**	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	**0.02**	----	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.001**	**0.001**	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	S1	D1	----	----	----
			Sampling date / time	23-Jun-2022 00:00	23-Jun-2022 00:00	----	----	----
Compound	CAS Number	LOR	Unit	ES2222130-001	ES2222130-002	--------	--------	--------
				Result	Result	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Copper	7440-50-8	0.001	mg/L	**0.002**	**0.001**	----	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	----	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	**0.002**	----	----	----
Lead	7439-92-1	0.001	mg/L	**0.002**	**0.002**	----	----	----
Zinc	7440-66-6	0.005	mg/L	**0.019**	**0.016**	----	----	----
Selenium	7782-49-2	0.01	mg/L	**0.01**	**0.01**	----	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	----	----	----
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.04**	**0.03**	----	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.001**	**0.001**	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	**0.006**	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.015**	**0.002**	----	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.005**	**0.006**	----	----	----
Lead	7439-92-1	0.001	mg/L	**0.013**	**0.004**	----	----	----
Zinc	7440-66-6	0.005	mg/L	**0.086**	**0.022**	----	----	----
Selenium	7782-49-2	0.01	mg/L	**0.02**	**0.02**	----	----	----
Iron	7439-89-6	0.05	mg/L	**0.11**	**0.06**	----	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	----	----	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	----	----	----
EK025SF: Free CN by Segmented Flow Analyser								
Free Cyanide	----	0.004	mg/L	<0.004	<0.004	----	----	----
EK026SF: Total CN by Segmented Flow Analyser								
Total Cyanide	57-12-5	0.004	mg/L	<0.004	<0.004	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	<0.01	<0.01	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	**0.03**	**0.03**	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**1.22**	**1.24**	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	S1	D1	----	----	----
			Sampling date / time	23-Jun-2022 00:00	23-Jun-2022 00:00	----	----	----
Compound	CAS Number	LOR	Unit	ES2222130-001	ES2222130-002	--------	--------	--------
				Result	Result	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser - Continued								
Nitrite + Nitrate as N	----	0.01	mg/L	**1.25**	**1.27**	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.6**	**0.5**	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	**1.8**	**1.8**	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.02**	<0.01	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	<0.01	----	----	----
EN055: Ionic Balance								
ø Total Anions	----	0.01	meq/L	**38.6**	**38.8**	----	----	----
ø Total Cations	----	0.01	meq/L	**41.5**	**42.0**	----	----	----
ø Ionic Balance	----	0.01	%	**3.56**	**3.88**	----	----	----
EP020: Oil and Grease (O&G)								
Oil & Grease	----	5	mg/L	<5	<5	----	----	----
EP026SP: Chemical Oxygen Demand (Spectrophotometric)								
Chemical Oxygen Demand	----	10	mg/L	**23**	**12**	----	----	----
EP030: Biochemical Oxygen Demand (BOD)								
Biochemical Oxygen Demand	----	2	mg/L	<2	<2	----	----	----
EP068A: Organochlorine Pesticides (OC)								
alpha-BHC	319-84-6	0.5	µg/L	<0.5	<0.5	----	----	----
Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<0.5	<0.5	----	----	----
beta-BHC	319-85-7	0.5	µg/L	<0.5	<0.5	----	----	----
gamma-BHC	58-89-9	0.5	µg/L	<0.5	<0.5	----	----	----
delta-BHC	319-86-8	0.5	µg/L	<0.5	<0.5	----	----	----
Heptachlor	76-44-8	0.5	µg/L	<0.5	<0.5	----	----	----
Aldrin	309-00-2	0.5	µg/L	<0.5	<0.5	----	----	----
Heptachlor epoxide	1024-57-3	0.5	µg/L	<0.5	<0.5	----	----	----
trans-Chlordane	5103-74-2	0.5	µg/L	<0.5	<0.5	----	----	----
alpha-Endosulfan	959-98-8	0.5	µg/L	<0.5	<0.5	----	----	----
cis-Chlordane	5103-71-9	0.5	µg/L	<0.5	<0.5	----	----	----
Dichlobenil	1194-65-6	0.1	µg/L	<0.1	<0.1	----	----	----
Dieldrin	60-57-1	0.5	µg/L	<0.5	<0.5	----	----	----
4.4`-DDE	72-55-9	0.5	µg/L	<0.5	<0.5	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	S1	D1	----	----	----
			Sampling date / time	23-Jun-2022 00:00	23-Jun-2022 00:00	----	----	----
Compound	CAS Number	LOR	Unit	ES2222130-001	ES2222130-002	--------	--------	--------
				Result	Result	----	----	----
EP068A: Organochlorine Pesticides (OC) - Continued								
Endrin	72-20-8	0.5	µg/L	<0.5	<0.5	----	----	----
beta-Endosulfan	33213-65-9	0.5	µg/L	<0.5	<0.5	----	----	----
4.4`-DDD	72-54-8	0.5	µg/L	<0.5	<0.5	----	----	----
Endrin aldehyde	7421-93-4	0.5	µg/L	<0.5	<0.5	----	----	----
Endosulfan sulfate	1031-07-8	0.5	µg/L	<0.5	<0.5	----	----	----
4.4`-DDT	50-29-3	2.0	µg/L	<2.0	<2.0	----	----	----
Endrin ketone	53494-70-5	0.5	µg/L	<0.5	<0.5	----	----	----
Methoxychlor	72-43-5	2.0	µg/L	<2.0	<2.0	----	----	----
^ Total Chlordane (sum)	----	0.5	µg/L	<0.5	<0.5	----	----	----
^ Sum of DDD + DDE + DDT	72-54-8/72-55-9/50-2	0.5	µg/L	<0.5	<0.5	----	----	----
^ Sum of Aldrin + Dieldrin	309-00-2/60-57-1	0.5	µg/L	<0.5	<0.5	----	----	----
EP068B: Organophosphorus Pesticides (OP)								
Dichlorvos	62-73-7	0.5	µg/L	<0.5	<0.5	----	----	----
Demeton-S-methyl	919-86-8	0.5	µg/L	<0.5	<0.5	----	----	----
Monocrotophos	6923-22-4	2.0	µg/L	<2.0	<2.0	----	----	----
Dimethoate	60-51-5	0.5	µg/L	<0.5	<0.5	----	----	----
Diazinon	333-41-5	0.5	µg/L	<0.5	<0.5	----	----	----
Chlorpyrifos-methyl	5598-13-0	0.5	µg/L	<0.5	<0.5	----	----	----
Parathion-methyl	298-00-0	2.0	µg/L	<2.0	<2.0	----	----	----
Malathion	121-75-5	0.5	µg/L	<0.5	<0.5	----	----	----
Fenthion	55-38-9	0.5	µg/L	<0.5	<0.5	----	----	----
Chlorpyrifos	2921-88-2	0.5	µg/L	<0.5	<0.5	----	----	----
Parathion	56-38-2	2.0	µg/L	<2.0	<2.0	----	----	----
Pirimphos-ethyl	23505-41-1	0.5	µg/L	<0.5	<0.5	----	----	----
Chlorfenvinphos	470-90-6	0.5	µg/L	<0.5	<0.5	----	----	----
Bromophos-ethyl	4824-78-6	0.5	µg/L	<0.5	<0.5	----	----	----
Fenamiphos	22224-92-6	0.5	µg/L	<0.5	<0.5	----	----	----
Prothiofos	34643-46-4	0.5	µg/L	<0.5	<0.5	----	----	----
Ethion	563-12-2	0.5	µg/L	<0.5	<0.5	----	----	----
Carbophenothion	786-19-6	0.5	µg/L	<0.5	<0.5	----	----	----
Azinphos Methyl	86-50-0	0.5	µg/L	<0.5	<0.5	----	----	----
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	<20	<20	----	----	----
C10 - C14 Fraction	----	50	µg/L	<50	<50	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	S1	D1	----	----	----
				Sampling date / time	23-Jun-2022 00:00	23-Jun-2022 00:00	----	----	----
Compound	CAS Number	LOR	Unit		ES2222130-001	ES2222130-002	--------	--------	--------
					Result	Result	----	----	----
EP080/071: Total Petroleum Hydrocarbons - Continued									
C15 - C28 Fraction	----	100	µg/L		<100	<100	----	----	----
C29 - C36 Fraction	----	50	µg/L		<50	<50	----	----	----
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	<50	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	----	----	----
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	----	----	----
>C10 - C16 Fraction	----	100	µg/L		<100	<100	----	----	----
>C16 - C34 Fraction	----	100	µg/L		<100	<100	----	----	----
>C34 - C40 Fraction	----	100	µg/L		<100	<100	----	----	----
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	<100	----	----	----
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	<100	----	----	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	----	----	----
Toluene	108-88-3	2	µg/L		<2	<2	----	----	----
Ethylbenzene	100-41-4	2	µg/L		<2	<2	----	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	----	----	----
ortho-Xylene	95-47-6	2	µg/L		<2	<2	----	----	----
^ Total Xylenes	----	2	µg/L		<2	<2	----	----	----
^ Sum of BTEX	----	1	µg/L		<1	<1	----	----	----
Naphthalene	91-20-3	5	µg/L		<5	<5	----	----	----
EP234: Multiresidue Pesticides (ESI Positive)									
3-Hydroxy Carbofuran	16655-82-6	0.02	µg/L		<0.02	<0.02	----	----	----
Abamectin	71751-41-2	0.1	µg/L		<0.1	<0.1	----	----	----
Acephate	30560-19-1	0.5	µg/L		<0.5	<0.5	----	----	----
Alachlor	15972-60-8	0.1	µg/L		<0.1	<0.1	----	----	----
Aldicarb	116-06-3	0.05	µg/L		<0.05	<0.05	----	----	----
Ametryn	834-12-8	0.01	µg/L		**0.02**	<0.01	----	----	----
Aminopyralid	150114-71-9	0.1	µg/L		<0.1	<0.1	----	----	----
Amitraz	33089-61-1	100	µg/L		<100	<100	----	----	----
Atrazine	1912-24-9	0.01	µg/L		<0.01	<0.01	----	----	----
Atrazine-desethyl	6190-65-4	0.1	µg/L		<0.1	<0.1	----	----	----
Atrazine-desisopropyl	1007-28-9	0.1	µg/L		<0.1	<0.1	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	S1	D1	----	----	----
				Sampling date / time	23-Jun-2022 00:00	23-Jun-2022 00:00	----	----	----
Compound	CAS Number	LOR	Unit		ES2222130-001	ES2222130-002	--------	--------	--------
					Result	Result	----	----	----
EP234: Multiresidue Pesticides (ESI Positive) - Continued									
Azinphos-ethyl	2642-71-9	0.02	µg/L		<0.02	<0.02	----	----	----
Azinphos-methyl	86-50-0	0.02	µg/L		<0.02	<0.02	----	----	----
Azoxystrobin	131860-33-8	0.1	µg/L		<0.1	<0.1	----	----	----
Bendiocarb	22781-23-3	0.10	µg/L		<0.10	<0.10	----	----	----
Benomyl	17804-35-2	0.01	µg/L		<0.01	<0.01	----	----	----
Bensulfuron methyl	83055-99-6	0.1	µg/L		<0.1	<0.1	----	----	----
Bensulide	741-58-2	0.1	µg/L		<0.1	<0.1	----	----	----
Boscalid	188425-85-6	0.1	µg/L		<0.1	<0.1	----	----	----
Bromacil	314-40-9	0.02	µg/L		<0.02	<0.02	----	----	----
Bromophos-ethyl	4824-78-6	0.10	µg/L		<0.10	<0.10	----	----	----
Butachlor	23184-66-9	0.1	µg/L		<0.1	<0.1	----	----	----
Carbaryl	63-25-2	0.01	µg/L		<0.01	<0.01	----	----	----
Carbendazim (Thiophanate methyl)	10605-21-7	0.1	µg/L		<0.1	<0.1	----	----	----
Carbofenothion	786-19-6	0.02	µg/L		<0.02	<0.02	----	----	----
Carbofuran	1563-66-2	0.01	µg/L		<0.01	<0.01	----	----	----
Carboxin	5234-68-4	0.1	µg/L		<0.1	<0.1	----	----	----
Carfentrazone-ethyl	128639-02-1	0.1	µg/L		<0.1	<0.1	----	----	----
Chlorantraniliprole	500008-45-7	0.1	µg/L		<0.1	<0.1	----	----	----
Chlorfenvinphos	470-90-6	0.02	µg/L		<0.02	<0.02	----	----	----
Chloroxuron	1982-47-4	0.1	µg/L		<0.1	<0.1	----	----	----
Chlorpyrifos	2921-88-2	0.02	µg/L		<0.02	<0.02	----	----	----
Chlorpyrifos-methyl	5598-13-0	0.1	µg/L		<0.2	<0.2	----	----	----
Chlorsulfuron	64902-72-3	0.2	µg/L		<0.2	<0.2	----	----	----
Coumaphos	56-72-4	0.01	µg/L		<0.01	<0.01	----	----	----
Cyanazine	21725-46-2	0.02	µg/L		<0.02	<0.02	----	----	----
Cyproconazole	94361-06-5	0.02	µg/L		<0.02	<0.02	----	----	----
Cyprodinil	121552-61-2	0.01	µg/L		<0.01	<0.01	----	----	----
Cyromazine	66215-27-8	0.05	µg/L		<0.05	<0.05	----	----	----
Demeton-O	298-03-3	0.02	µg/L		<0.02	<0.02	----	----	----
Demeton-O & Demeton-S	298-03-3/126-75-0	0.02	µg/L		<0.02	<0.02	----	----	----
Demeton-S	126-75-0	0.02	µg/L		<0.02	<0.02	----	----	----
Demeton-S-methyl	919-86-8	0.02	µg/L		<0.02	<0.02	----	----	----
Diazinon	333-41-5	0.01	µg/L		<0.01	<0.01	----	----	----
Dichlorvos	62-73-7	0.20	µg/L		<0.20	<0.20	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	S1	D1	----	----	----
			Sampling date / time	23-Jun-2022 00:00	23-Jun-2022 00:00	----	----	----
Compound	CAS Number	LOR	Unit	ES2222130-001	ES2222130-002	--------	--------	--------
				Result	Result	----	----	----
EP234: Multiresidue Pesticides (ESI Positive) - Continued								
Diclofop-methyl	51338-27-3	0.05	µg/L	<0.05	<0.05	----	----	----
Difenoconazole	119446-68-3	0.02	µg/L	<0.02	<0.02	----	----	----
Diflubenzuron	35367-38-5	0.1	µg/L	<0.1	<0.1	----	----	----
Dimethoate	60-51-5	0.02	µg/L	<0.02	<0.02	----	----	----
Diphenamid	957-51-7	0.1	µg/L	<0.1	<0.1	----	----	----
Disulfoton	298-04-4	0.05	µg/L	<0.05	<0.05	----	----	----
Diuron	330-54-1	0.02	µg/L	<0.02	<0.02	----	----	----
EPN	2104-64-5	0.05	µg/L	<0.05	<0.05	----	----	----
EPTC	759-94-4	0.1	µg/L	<0.1	<0.1	----	----	----
Ethion	563-12-2	0.02	µg/L	<0.02	<0.02	----	----	----
Ethoprophos	13194-48-4	0.01	µg/L	<0.01	<0.01	----	----	----
Etridiazole	2593-15-9	0.5	µg/L	<0.5	<0.5	----	----	----
Fenamiphos	22224-92-6	0.01	µg/L	<0.01	<0.01	----	----	----
Fenarimol	60168-88-9	0.02	µg/L	<0.02	<0.02	----	----	----
Fenchlorphos (Ronnel)	299-84-3	10	µg/L	<10	<10	----	----	----
Fenitrothion	122-14-5	2	µg/L	<2	<2	----	----	----
Fenoxycarb	79127-80-3	0.1	µg/L	<0.1	<0.1	----	----	----
Fensulfothion	115-90-2	0.01	µg/L	<0.01	<0.01	----	----	----
Fenthion	55-38-9	0.05	µg/L	<0.05	<0.05	----	----	----
Flamprop methyl	52756-25-9	0.1	µg/L	<0.1	<0.1	----	----	----
Fluometuron	2164-17-2	0.01	µg/L	<0.01	<0.01	----	----	----
Flusilazole	85509-19-9	0.02	µg/L	<0.02	<0.02	----	----	----
Formothion	2540-82-1	20	µg/L	<20	<20	----	----	----
Fosetyl Aluminium	39148-24-8	10	µg/L	<10	<10	----	----	----
Haloxyfop	69806-34-4	0.1	µg/L	<0.1	<0.1	----	----	----
Hexaconazole	79983-71-4	0.02	µg/L	<0.02	<0.02	----	----	----
Hexazinone	51235-04-2	0.02	µg/L	<0.02	<0.02	----	----	----
Imazapyr	94795-74-1	10.0	µg/L	<10.0	<10.0	----	----	----
Indoxacarb	173584-44-6	0.1	µg/L	<0.1	<0.1	----	----	----
Iodosulfuron methyl	144550-36-7	0.1	µg/L	<0.1	<0.1	----	----	----
Irgarol	28159-98-0	0.002	µg/L	<0.002	<0.002	----	----	----
Isoproturon	34123-59-6	0.1	µg/L	<0.1	<0.1	----	----	----
Malathion	121-75-5	0.02	µg/L	<0.02	<0.02	----	----	----
Metalaxyl	57837-19-1	0.1	µg/L	<0.1	<0.1	----	----	----
Metalaxyl-M	70630-17-0	0.1	µg/L	<0.1	<0.1	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	S1	D1	----	----	----
				Sampling date / time	23-Jun-2022 00:00	23-Jun-2022 00:00	----	----	----
Compound	CAS Number	LOR	Unit		ES2222130-001	ES2222130-002	--------	--------	--------
					Result	Result	----	----	----
EP234: Multiresidue Pesticides (ESI Positive) - Continued									
Metaldehyde	108-62-3	10	µg/L		<10	<10	----	----	----
Methidathion	950-37-8	0.1	µg/L		<0.1	<0.1	----	----	----
Methiocarb	2032-65-7	0.01	µg/L		<0.01	<0.01	----	----	----
Methomyl	16752-77-5	0.01	µg/L		<0.01	<0.01	----	----	----
Metolachlor	51218-45-2	0.01	µg/L		**0.02**	**0.02**	----	----	----
Metribuzin	21087-64-9	0.02	µg/L		<0.02	<0.02	----	----	----
Mevinphos	7786-34-7	0.02	µg/L		<0.02	<0.02	----	----	----
Molinate	2212-67-1	0.1	µg/L		<0.1	<0.1	----	----	----
Monocrotophos	6923-22-4	0.02	µg/L		<0.02	<0.02	----	----	----
Myclobutanil	88671-89-0	0.1	µg/L		<0.1	<0.1	----	----	----
Naftalofos	1491-41-4	1.0	µg/L		<1.0	<1.0	----	----	----
Napropamide	15299-99-7	0.1	µg/L		<0.1	<0.1	----	----	----
Nitralin	4726-14-1	0.1	µg/L		<0.1	<0.1	----	----	----
Norflurazon	27314-13-2	0.1	µg/L		<0.1	<0.1	----	----	----
Novaluron	116714-46-6	0.1	µg/L		<0.1	<0.1	----	----	----
Omethoate	1113-02-6	0.01	µg/L		<0.01	<0.01	----	----	----
Oxamyl	23135-22-0	0.01	µg/L		<0.01	<0.01	----	----	----
Oxyfluorfen	42874-03-3	1.0	µg/L		<1.0	<1.0	----	----	----
Paclobutrazole	76738-62-0	0.05	µg/L		<0.05	<0.05	----	----	----
Parathion	56-38-2	0.2	µg/L		<0.2	<0.2	----	----	----
Parathion-methyl	298-00-0	0.5	µg/L		<0.5	<0.5	----	----	----
Pebulate	1114-71-2	0.1	µg/L		<0.1	<0.1	----	----	----
Penconazole	66246-88-6	0.01	µg/L		<0.01	<0.01	----	----	----
Pendimethalin	40487-42-1	0.05	µg/L		<0.05	<0.05	----	----	----
Phorate	298-02-2	0.1	µg/L		<0.1	<0.1	----	----	----
Pirimicarb	23103-98-2	0.1	µg/L		<0.1	<0.1	----	----	----
Pirimiphos-ethyl	23505-41-1	0.01	µg/L		<0.01	<0.01	----	----	----
Pirimiphos-methyl	29232-93-7	0.01	µg/L		<0.01	<0.01	----	----	----
Prochloraz	67747-09-5	0.1	µg/L		<0.1	<0.1	----	----	----
Profenofos	41198-08-7	0.01	µg/L		<0.01	<0.01	----	----	----
Promecarb	2631-37-0	0.1	µg/L		<0.1	<0.1	----	----	----
Prometryn	7287-19-6	0.01	µg/L		<0.01	<0.01	----	----	----
Propachlor	1918-16-7	0.1	µg/L		<0.1	<0.1	----	----	----
Propamocarb	24579-73-5	0.1	µg/L		<0.1	<0.1	----	----	----
Propargite	2312-35-8	0.1	µg/L		<0.1	<0.1	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	S1	D1	----	----	----
				Sampling date / time	23-Jun-2022 00:00	23-Jun-2022 00:00	----	----	----
Compound	CAS Number	LOR	Unit		ES2222130-001	ES2222130-002	--------	--------	--------
					Result	Result	----	----	----
EP234: Multiresidue Pesticides (ESI Positive) - Continued									
Propazine	139-40-2	0.01	µg/L		<0.01	<0.01	----	----	----
Propiconazole	60207-90-1	0.05	µg/L		<0.05	<0.05	----	----	----
Propyzamide	23950-58-5	0.1	µg/L		<0.1	<0.1	----	----	----
Prothiofos	34643-46-4	0.1	µg/L		<0.1	<0.1	----	----	----
Pyraclostrobin	175013-18-0	0.1	µg/L		<0.1	<0.1	----	----	----
Pyrazophos	13457-18-6	0.1	µg/L		<0.1	<0.1	----	----	----
Pyrimethanil	53112-28-0	0.02	µg/L		<0.02	<0.02	----	----	----
Pyriproxyfen	95737-68-1	0.1	µg/L		<0.1	<0.1	----	----	----
Pyroxsulam	422556-08-9	0.1	µg/L		<0.1	<0.1	----	----	----
Quinclorac	84087-01-4	0.1	µg/L		<0.1	<0.1	----	----	----
Rimsulfuron	122931-48-0	0.1	µg/L		<0.1	<0.1	----	----	----
Siduron	1982-49-6	0.1	µg/L		<0.1	<0.1	----	----	----
Simazine	122-34-9	0.02	µg/L		<0.02	<0.02	----	----	----
Spirotetramat	203313-25-1	0.1	µg/L		<0.1	<0.1	----	----	----
Sulfotep	3689-24-5	0.005	µg/L		<0.005	<0.005	----	----	----
Sulprofos	35400-43-2	0.05	µg/L		<0.05	<0.05	----	----	----
Tebuconazole	107534-96-3	0.01	µg/L		<0.01	<0.01	----	----	----
Tebuthiuron	34014-18-1	0.02	µg/L		<0.02	<0.02	----	----	----
Temephos	3383-96-8	0.02	µg/L		<0.02	<0.02	----	----	----
Terbufos	13071-79-9	0.01	µg/L		<0.01	<0.01	----	----	----
Terbuthylazine	5915-41-3	0.01	µg/L		<0.01	<0.01	----	----	----
Terbutryn	886-50-0	0.01	µg/L		<0.01	<0.01	----	----	----
Tetrachlorvinphos	22248-79-9	0.01	µg/L		<0.01	<0.01	----	----	----
Tetraconazole	112281-77-3	0.1	µg/L		<0.1	<0.1	----	----	----
Thiamethoxam	153719-23-4	0.02	µg/L		<0.02	<0.02	----	----	----
Thiobencarb	28249-77-6	0.01	µg/L		<0.01	<0.01	----	----	----
Thiodicarb	59669-26-0	0.01	µg/L		<0.01	<0.01	----	----	----
Thiometon	640-15-3	0.5	µg/L		<0.5	<0.5	----	----	----
Toltrazuril	69004-03-1	0.5	µg/L		<0.5	<0.5	----	----	----
Triadimefon	43121-43-3	0.1	µg/L		<0.1	<0.1	----	----	----
Triadimenol	55219-65-3	0.1	µg/L		<0.1	<0.1	----	----	----
Triazophos	24017-47-8	0.005	µg/L		<0.005	<0.005	----	----	----
Trichlorfon	52-68-6	0.02	µg/L		<0.02	<0.02	----	----	----
Trichloronate	327-98-0	0.5	µg/L		<0.5	<0.5	----	----	----
Trifloxystrobin	141517-21-7	0.1	µg/L		<0.1	<0.1	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	S1	D1	----	----	----
			Sampling date / time	23-Jun-2022 00:00	23-Jun-2022 00:00	----	----	----
Compound	CAS Number	LOR	Unit	ES2222130-001	ES2222130-002	--------	--------	--------
				Result	Result	----	----	----
EP234: Multiresidue Pesticides (ESI Positive) - Continued								
Trifloxysulfuron-sodium	199119-58-9	0.1	µg/L	<0.1	<0.1	----	----	----
Trifluralin	1582-09-8	10.0	µg/L	<10.0	<10.0	----	----	----
Trinexapac Ethyl	95266-40-3	1	µg/L	<1	<1	----	----	----
Vernolate	1929-77-7	0.1	µg/L	<0.1	<0.1	----	----	----
EP234I: Miscellaneous (ESI Positive Mode) Pesticides								
2-Aminobenzimidazole	934-32-7	0.01	µg/L	<0.01	<0.01	----	----	----
Imidacloprid	----	0.01	µg/L	<0.01	<0.01	----	----	----
MW006: Faecal Coliforms & E.coli by MF								
Faecal Coliforms	----	1	CFU/100mL	**~4**	**~8**	----	----	----
EP068S: Organochlorine Pesticide Surrogate								
Dibromo-DDE	21655-73-2	0.5	%	**78.4**	**70.7**	----	----	----
EP068T: Organophosphorus Pesticide Surrogate								
DEF	78-48-8	0.5	%	**83.8**	**81.0**	----	----	----
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	2	%	**106**	**104**	----	----	----
Toluene-D8	2037-26-5	2	%	**96.4**	**99.2**	----	----	----
4-Bromofluorobenzene	460-00-4	2	%	**94.4**	**95.6**	----	----	----

Surrogate Control Limits

Sub-Matrix: **WATER**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP068S: Organochlorine Pesticide Surrogate			
Dibromo-DDE	21655-73-2	67	111
EP068T: Organophosphorus Pesticide Surrogate			
DEF	78-48-8	67	111
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	71	137
Toluene-D8	2037-26-5	79	131
4-Bromofluorobenzene	460-00-4	70	128

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES2226007**	Page	: 1 of 9
Amendment	: **1**		
Client	: **4 PILLARS ENVIRONMENTAL CONSULTING**	Laboratory	: Environmental Division Sydney
Contact	: RESULTS	Contact	: Customer Services ES
Address	: Suite 16, 9 George Street NORTH STRATHFIELD 2137	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: 20220601KLF - July Quarry and Creek Water	Date Samples Received	: 22-Jul-2022 17:00
Order number	: ----	Date Analysis Commenced	: 22-Jul-2022
C-O-C number	: ----	Issue Date	: 15-Aug-2022 11:17
Sampler	: MS		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 2		
No. of samples analysed	: 2		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW
Edwandy Fadjar	Organic Coordinator	Sydney Organics, Smithfield, NSW
Franco Lentini	LCMS Coordinator	Sydney Organics, Smithfield, NSW
Sarah Griffiths	Microbiologist	Sydney Microbiology, Smithfield, NSW
Wisam Marassa	Inorganics Coordinator	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- MF = membrane filtration
- CFU = colony forming unit
- EP068: Where reported, Total Chlordane (sum) is the sum of the reported concentrations of cis-Chlordane and trans-Chlordane at or above the LOR.
- EP080: Where reported, Total Xylenes is the sum of the reported concentrations of m&p-Xylene and o-Xylene at or above the LOR.
- EG020: It is recognised that total concentration is less than dissolved for some metal analytes. However, the difference is within experimental variation of the methods.
- EK061G: LOR raised for TKN due to sample matrix.
- EK067G: LOR raised for TP due to sample matrix.
- TDS by method EA-015 may bias high due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper.
- Microbiological Comment: In accordance with ALS work instruction QWI-MIC/04, membrane filtration result is reported an approximate (~) when the count of colonies on the filtered membrane is outside the range of 10 - 100cfu.
- Amendment (12/08/22): This report has been amended and re-released to allow the reporting of additional analytical data, specifically method Na, Ca, K and Chloride.
- MW006 is ALS's internal code and is equivalent to AS4276.7.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	Quarry	Creek	----	----	----
			Sampling date / time	22-Jul-2022 00:00	22-Jul-2022 00:00	----	----	----
Compound	CAS Number	LOR	Unit	ES2226007-001	ES2226007-002	--------	--------	--------
				Result	Result	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**8.60**	**6.99**	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**3840**	**627**	----	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**2120**	**930**	----	----	----
EA045: Turbidity								
Turbidity	----	0.1	NTU	**6.5**	**1300**	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	**50**	<1	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**271**	**33**	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**321**	**33**	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**946**	**126**	----	----	----
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	**409**	**95**	----	----	----
ED093T: Total Major Cations								
Calcium	7440-70-2	1	mg/L	**23**	**16**	----	----	----
Magnesium	7439-95-4	1	mg/L	**93**	**18**	----	----	----
Sodium	7440-23-5	1	mg/L	**648**	**68**	----	----	----
Potassium	7440-09-7	1	mg/L	**14**	**8**	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	**0.04**	----	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.002**	<0.001	----	----	----
Barium	7440-39-3	0.001	mg/L	**0.080**	**0.050**	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	----	----	----
Copper	7440-50-8	0.001	mg/L	<0.001	**0.002**	----	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	----	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	**0.001**	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	----	----	----
Selenium	7782-49-2	0.01	mg/L	**0.01**	<0.01	----	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	**0.021**	----	----	----
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	Quarry	Creek	----	----	----
			Sampling date / time	22-Jul-2022 00:00	22-Jul-2022 00:00	----	----	----
Compound	CAS Number	LOR	Unit	ES2226007-001	ES2226007-002	--------	--------	--------
				Result	Result	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Iron	7439-89-6	0.05	mg/L	<0.05	**0.10**	----	----	----
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.19**	**26.5**	----	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.001**	**0.006**	----	----	----
Barium	7440-39-3	0.001	mg/L	**0.097**	**0.197**	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	**0.025**	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.001**	**0.039**	----	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	**0.016**	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.001**	**0.018**	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	**0.022**	----	----	----
Selenium	7782-49-2	0.01	mg/L	**0.01**	<0.01	----	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	**0.070**	----	----	----
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	----	----	----
Iron	7439-89-6	0.05	mg/L	**0.08**	**28.9**	----	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	----	----	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	----	----	----
EG050T: Total Hexavalent Chromium								
Hexavalent Chromium	18540-29-9	0.01	mg/L	<0.01	<0.01	----	----	----
EK026SF: Total CN by Segmented Flow Analyser								
Total Cyanide	57-12-5	0.004	mg/L	<0.004	<0.004	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	<0.01	**0.26**	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	**0.04**	**0.03**	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**1.54**	**0.65**	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**1.58**	**0.68**	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.6**	<2.0	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	Quarry	Creek	----	----	----
			Sampling date / time	22-Jul-2022 00:00	22-Jul-2022 00:00	----	----	----
Compound	CAS Number	LOR	Unit	ES2226007-001	ES2226007-002	--------	--------	--------
				Result	Result	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	**2.2**	<2.0	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.02**	<0.20	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	<0.01	----	----	----
EP020: Oil and Grease (O&G)								
Oil & Grease	----	5	mg/L	<5	<5	----	----	----
EP026SP: Chemical Oxygen Demand (Spectrophotometric)								
Chemical Oxygen Demand	----	10	mg/L	**11**	**23**	----	----	----
EP030: Biochemical Oxygen Demand (BOD)								
Biochemical Oxygen Demand	----	2	mg/L	<2	**2**	----	----	----
EP068A: Organochlorine Pesticides (OC)								
alpha-BHC	319-84-6	0.5	µg/L	<0.5	<0.5	----	----	----
Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<0.5	<0.5	----	----	----
beta-BHC	319-85-7	0.5	µg/L	<0.5	<0.5	----	----	----
gamma-BHC	58-89-9	0.5	µg/L	<0.5	<0.5	----	----	----
delta-BHC	319-86-8	0.5	µg/L	<0.5	<0.5	----	----	----
Heptachlor	76-44-8	0.5	µg/L	<0.5	<0.5	----	----	----
Aldrin	309-00-2	0.5	µg/L	<0.5	<0.5	----	----	----
Heptachlor epoxide	1024-57-3	0.5	µg/L	<0.5	<0.5	----	----	----
trans-Chlordane	5103-74-2	0.5	µg/L	<0.5	<0.5	----	----	----
alpha-Endosulfan	959-98-8	0.5	µg/L	<0.5	<0.5	----	----	----
cis-Chlordane	5103-71-9	0.5	µg/L	<0.5	<0.5	----	----	----
Dieldrin	60-57-1	0.5	µg/L	<0.5	<0.5	----	----	----
4.4`-DDE	72-55-9	0.5	µg/L	<0.5	<0.5	----	----	----
Endrin	72-20-8	0.5	µg/L	<0.5	<0.5	----	----	----
beta-Endosulfan	33213-65-9	0.5	µg/L	<0.5	<0.5	----	----	----
4.4`-DDD	72-54-8	0.5	µg/L	<0.5	<0.5	----	----	----
Endrin aldehyde	7421-93-4	0.5	µg/L	<0.5	<0.5	----	----	----
Endosulfan sulfate	1031-07-8	0.5	µg/L	<0.5	<0.5	----	----	----
4.4`-DDT	50-29-3	2.0	µg/L	<2.0	<2.0	----	----	----
Endrin ketone	53494-70-5	0.5	µg/L	<0.5	<0.5	----	----	----
Methoxychlor	72-43-5	2.0	µg/L	<2.0	<2.0	----	----	----
^ Total Chlordane (sum)	----	0.5	µg/L	<0.5	<0.5	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	Quarry	Creek	----	----	----
				Sampling date / time	22-Jul-2022 00:00	22-Jul-2022 00:00	----	----	----
Compound	CAS Number	LOR	Unit		ES2226007-001	ES2226007-002	--------	--------	--------
					Result	Result	----	----	----
EP068A: Organochlorine Pesticides (OC) - Continued									
^ Sum of DDD + DDE + DDT	72-54-8/72-55-9/50-2	0.5	µg/L		<0.5	<0.5	----	----	----
^ Sum of Aldrin + Dieldrin	309-00-2/60-57-1	0.5	µg/L		<0.5	<0.5	----	----	----
EP068B: Organophosphorus Pesticides (OP)									
Dichlorvos	62-73-7	0.5	µg/L		<0.5	<0.5	----	----	----
Demeton-S-methyl	919-86-8	0.5	µg/L		<0.5	<0.5	----	----	----
Monocrotophos	6923-22-4	2.0	µg/L		<2.0	<2.0	----	----	----
Dimethoate	60-51-5	0.5	µg/L		<0.5	<0.5	----	----	----
Diazinon	333-41-5	0.5	µg/L		<0.5	<0.5	----	----	----
Chlorpyrifos-methyl	5598-13-0	0.5	µg/L		<0.5	<0.5	----	----	----
Parathion-methyl	298-00-0	2.0	µg/L		<2.0	<2.0	----	----	----
Malathion	121-75-5	0.5	µg/L		<0.5	<0.5	----	----	----
Fenthion	55-38-9	0.5	µg/L		<0.5	<0.5	----	----	----
Chlorpyrifos	2921-88-2	0.5	µg/L		<0.5	<0.5	----	----	----
Parathion	56-38-2	2.0	µg/L		<2.0	<2.0	----	----	----
Pirimphos-ethyl	23505-41-1	0.5	µg/L		<0.5	<0.5	----	----	----
Chlorfenvinphos	470-90-6	0.5	µg/L		<0.5	<0.5	----	----	----
Bromophos-ethyl	4824-78-6	0.5	µg/L		<0.5	<0.5	----	----	----
Fenamiphos	22224-92-6	0.5	µg/L		<0.5	<0.5	----	----	----
Prothiofos	34643-46-4	0.5	µg/L		<0.5	<0.5	----	----	----
Ethion	563-12-2	0.5	µg/L		<0.5	<0.5	----	----	----
Carbophenothion	786-19-6	0.5	µg/L		<0.5	<0.5	----	----	----
Azinphos Methyl	86-50-0	0.5	µg/L		<0.5	<0.5	----	----	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	----	----	----
C10 - C14 Fraction	----	50	µg/L		<50	<50	----	----	----
C15 - C28 Fraction	----	100	µg/L		<100	<100	----	----	----
C29 - C36 Fraction	----	50	µg/L		<50	<50	----	----	----
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	<50	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	----	----	----
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	----	----	----
>C10 - C16 Fraction	----	100	µg/L		<100	<100	----	----	----
>C16 - C34 Fraction	----	100	µg/L		<100	<100	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	Quarry	Creek	----	----	----
				Sampling date / time	22-Jul-2022 00:00	22-Jul-2022 00:00	----	----	----
Compound	CAS Number	LOR	Unit		ES2226007-001	ES2226007-002	--------	--------	--------
					Result	Result	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
>C34 - C40 Fraction	----	100	µg/L		<100	<100	----	----	----
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	<100	----	----	----
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	<100	----	----	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	----	----	----
Toluene	108-88-3	2	µg/L		<2	<2	----	----	----
Ethylbenzene	100-41-4	2	µg/L		<2	<2	----	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	----	----	----
ortho-Xylene	95-47-6	2	µg/L		<2	<2	----	----	----
^ Total Xylenes	----	2	µg/L		<2	<2	----	----	----
^ Sum of BTEX	----	1	µg/L		<1	<1	----	----	----
Naphthalene	91-20-3	5	µg/L		<5	<5	----	----	----
EP201: Carbamate Pesticides by LCMS									
Oxamyl	23135-22-0	0.2	µg/L		<0.2	<0.2	----	----	----
Methomyl	16752-77-5	0.2	µg/L		<0.2	<0.2	----	----	----
3-Hydroxy Carbofuran	16655-82-6	0.2	µg/L		<0.2	<0.2	----	----	----
Aldicarb	116-06-3	0.2	µg/L		<0.2	<0.2	----	----	----
Bendiocarb	22781-23-3	0.2	µg/L		<0.2	<0.2	----	----	----
Thiodicarb	59669-26-0	0.2	µg/L		<0.2	<0.2	----	----	----
Carbofuran	1563-66-2	0.2	µg/L		<0.2	<0.2	----	----	----
Carbaryl	63-25-2	0.2	µg/L		<0.2	<0.2	----	----	----
Methiocarb	2032-65-7	0.2	µg/L		<0.2	<0.2	----	----	----
MW006: Faecal Coliforms & E.coli by MF									
Faecal Coliforms	----	1	CFU/100mL		**12**	**460**	----	----	----
EP068S: Organochlorine Pesticide Surrogate									
Dibromo-DDE	21655-73-2	0.5	%		**65.1**	**62.1**	----	----	----
EP068T: Organophosphorus Pesticide Surrogate									
DEF	78-48-8	0.5	%		**61.6**	**63.2**	----	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**107**	**109**	----	----	----
Toluene-D8	2037-26-5	2	%		**99.9**	**104**	----	----	----
4-Bromofluorobenzene	460-00-4	2	%		**99.0**	**102**	----	----	----
EP201S: Carbamate Surrogate									

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)				Sample ID	**Quarry**	**Creek**	**----**	**----**	**----**
				Sampling date / time	22-Jul-2022 00:00	22-Jul-2022 00:00	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*		**ES2226007-001**	**ES2226007-002**	**--------**	**--------**	**--------**
					Result	Result	----	----	----
EP201S: Carbamate Surrogate - Continued									
4-Bromo-3.5-dimethylphenyl-N-methylcarbamate	672-99-1	0.2	%		**83.9**	**83.6**	**----**	**----**	**----**

Surrogate Control Limits

Sub-Matrix: **WATER**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP068S: Organochlorine Pesticide Surrogate			
Dibromo-DDE	21655-73-2	67	111
EP068T: Organophosphorus Pesticide Surrogate			
DEF	78-48-8	67	111
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	71	137
Toluene-D8	2037-26-5	79	131
4-Bromofluorobenzene	460-00-4	70	128
EP201S: Carbamate Surrogate			
4-Bromo-3.5-dimethylphenyl-N-methy lcarbamate	672-99-1	65	147

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES2229178**	Page	: 1 of 9
Client	: **4 PILLARS ENVIRONMENTAL CONSULTING**	Laboratory	: Environmental Division Sydney
Contact	: Manikshya Shrestha	Contact	: Customer Services ES
Address	: Suite 16, 9 George Street NORTH STRATHFIELD 2137	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: 20220601KLF - July Quarry and Creek Water	Date Samples Received	: 16-Aug-2022 17:20
Order number	: ----	Date Analysis Commenced	: 17-Aug-2022
C-O-C number	: ----	Issue Date	: 24-Aug-2022 18:33
Sampler	: ----		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 2		
No. of samples analysed	: 2		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW
Edwandy Fadjar	Organic Coordinator	Sydney Organics, Smithfield, NSW
Franco Lentini	LCMS Coordinator	Sydney Organics, Smithfield, NSW
Somlok Chai	Microbiologist	Sydney Microbiology, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- MF = membrane filtration
- CFU = colony forming unit
- EP068: Where reported, Total Chlordane (sum) is the sum of the reported concentrations of cis-Chlordane and trans-Chlordane at or above the LOR.
- EP080: Where reported, Total Xylenes is the sum of the reported concentrations of m&p-Xylene and o-Xylene at or above the LOR.
- EG020: It is recognised that total concentration is less than dissolved for some metal analytes. However, the difference is within experimental variation of the methods.
- TDS by method EA-015 may bias high for sample 2 due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper.
- Microbiological Comment: In accordance with ALS work instruction QWI-MIC/04, membrane filtration result is reported an approximate (~) when the count of colonies on the filtered membrane is outside the range of 10 - 100cfu.
- MW006 is ALS's internal code and is equivalent to AS4276.7.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	QUARRY	CREEK	----	----	----
			Sampling date / time	16-Aug-2022 00:00	16-Aug-2022 00:00	----	----	----
Compound	CAS Number	LOR	Unit	ES2229178-001	ES2229178-002	--------	--------	--------
				Result	Result	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**8.69**	**7.53**	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**3170**	**656**	----	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**2130**	**530**	----	----	----
EA045: Turbidity								
Turbidity	----	0.1	NTU	**2.4**	**308**	----	----	----
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	**97**	**413**	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	**48**	<1	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**278**	**33**	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**326**	**33**	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**1030**	**149**	----	----	----
ED093T: Total Major Cations								
Calcium	7440-70-2	1	mg/L	**22**	**15**	----	----	----
Magnesium	7439-95-4	1	mg/L	**86**	**16**	----	----	----
Sodium	7440-23-5	1	mg/L	**602**	**76**	----	----	----
Potassium	7440-09-7	1	mg/L	**13**	**5**	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.02**	**0.01**	----	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	----	----	----
Barium	7440-39-3	0.001	mg/L	**0.054**	**0.085**	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.002**	<0.001	----	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.002**	<0.001	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	----	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	----	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	**0.01**	----	----	----
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	QUARRY	CREEK	----	----	----
			Sampling date / time	16-Aug-2022 00:00	16-Aug-2022 00:00	----	----	----
Compound	CAS Number	LOR	Unit	ES2229178-001	ES2229178-002	--------	--------	--------
				Result	Result	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Iron	7439-89-6	0.05	mg/L	**0.09**	<0.05	----	----	----
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.03**	**6.55**	----	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.001**	**0.002**	----	----	----
Barium	7440-39-3	0.001	mg/L	**0.096**	**0.100**	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	**0.006**	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.001**	**0.011**	----	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	**0.003**	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.003**	**0.007**	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	**0.005**	----	----	----
Zinc	7440-66-6	0.005	mg/L	**0.006**	**0.020**	----	----	----
Selenium	7782-49-2	0.01	mg/L	**0.01**	<0.01	----	----	----
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	----	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	**6.95**	----	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	----	----	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	----	----	----
EG050T: Total Hexavalent Chromium								
Hexavalent Chromium	18540-29-9	0.01	mg/L	<0.01	<0.01	----	----	----
EK026SF: Total CN by Segmented Flow Analyser								
Total Cyanide	57-12-5	0.004	mg/L	<0.004	<0.004	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.02**	**0.05**	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	**0.04**	<0.01	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**1.55**	**0.91**	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**1.59**	**0.91**	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.6**	**1.0**	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	QUARRY	CREEK	----	----	----
			Sampling date / time	16-Aug-2022 00:00	16-Aug-2022 00:00	----	----	----
Compound	CAS Number	LOR	Unit	ES2229178-001	ES2229178-002	--------	--------	--------
				Result	Result	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	**2.2**	**1.9**	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.01**	**0.14**	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	<0.01	----	----	----
EP020: Oil and Grease (O&G)								
Oil & Grease	----	5	mg/L	<5	<5	----	----	----
EP026SP: Chemical Oxygen Demand (Spectrophotometric)								
Chemical Oxygen Demand	----	10	mg/L	<10	<10	----	----	----
EP030: Biochemical Oxygen Demand (BOD)								
Biochemical Oxygen Demand	----	2	mg/L	<2	<2	----	----	----
EP068A: Organochlorine Pesticides (OC)								
alpha-BHC	319-84-6	0.5	µg/L	<0.5	<0.5	----	----	----
Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<0.5	<0.5	----	----	----
beta-BHC	319-85-7	0.5	µg/L	<0.5	<0.5	----	----	----
gamma-BHC	58-89-9	0.5	µg/L	<0.5	<0.5	----	----	----
delta-BHC	319-86-8	0.5	µg/L	<0.5	<0.5	----	----	----
Heptachlor	76-44-8	0.5	µg/L	<0.5	<0.5	----	----	----
Aldrin	309-00-2	0.5	µg/L	<0.5	<0.5	----	----	----
Heptachlor epoxide	1024-57-3	0.5	µg/L	<0.5	<0.5	----	----	----
trans-Chlordane	5103-74-2	0.5	µg/L	<0.5	<0.5	----	----	----
alpha-Endosulfan	959-98-8	0.5	µg/L	<0.5	<0.5	----	----	----
cis-Chlordane	5103-71-9	0.5	µg/L	<0.5	<0.5	----	----	----
Dieldrin	60-57-1	0.5	µg/L	<0.5	<0.5	----	----	----
4.4`-DDE	72-55-9	0.5	µg/L	<0.5	<0.5	----	----	----
Endrin	72-20-8	0.5	µg/L	<0.5	<0.5	----	----	----
beta-Endosulfan	33213-65-9	0.5	µg/L	<0.5	<0.5	----	----	----
4.4`-DDD	72-54-8	0.5	µg/L	<0.5	<0.5	----	----	----
Endrin aldehyde	7421-93-4	0.5	µg/L	<0.5	<0.5	----	----	----
Endosulfan sulfate	1031-07-8	0.5	µg/L	<0.5	<0.5	----	----	----
4.4`-DDT	50-29-3	2.0	µg/L	<2.0	<2.0	----	----	----
Endrin ketone	53494-70-5	0.5	µg/L	<0.5	<0.5	----	----	----
Methoxychlor	72-43-5	2.0	µg/L	<2.0	<2.0	----	----	----
^ Total Chlordane (sum)	----	0.5	µg/L	<0.5	<0.5	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	QUARRY	CREEK	----	----	----
				Sampling date / time	16-Aug-2022 00:00	16-Aug-2022 00:00	----	----	----
Compound	CAS Number	LOR	Unit		ES2229178-001	ES2229178-002	--------	--------	--------
					Result	Result	----	----	----
EP068A: Organochlorine Pesticides (OC) - Continued									
^ Sum of DDD + DDE + DDT	72-54-8/72-55-9/50-2	0.5	µg/L		<0.5	<0.5	----	----	----
^ Sum of Aldrin + Dieldrin	309-00-2/60-57-1	0.5	µg/L		<0.5	<0.5	----	----	----
EP068B: Organophosphorus Pesticides (OP)									
Dichlorvos	62-73-7	0.5	µg/L		<0.5	<0.5	----	----	----
Demeton-S-methyl	919-86-8	0.5	µg/L		<0.5	<0.5	----	----	----
Monocrotophos	6923-22-4	2.0	µg/L		<2.0	<2.0	----	----	----
Dimethoate	60-51-5	0.5	µg/L		<0.5	<0.5	----	----	----
Diazinon	333-41-5	0.5	µg/L		<0.5	<0.5	----	----	----
Chlorpyrifos-methyl	5598-13-0	0.5	µg/L		<0.5	<0.5	----	----	----
Parathion-methyl	298-00-0	2.0	µg/L		<2.0	<2.0	----	----	----
Malathion	121-75-5	0.5	µg/L		<0.5	<0.5	----	----	----
Fenthion	55-38-9	0.5	µg/L		<0.5	<0.5	----	----	----
Chlorpyrifos	2921-88-2	0.5	µg/L		<0.5	<0.5	----	----	----
Parathion	56-38-2	2.0	µg/L		<2.0	<2.0	----	----	----
Pirimphos-ethyl	23505-41-1	0.5	µg/L		<0.5	<0.5	----	----	----
Chlorfenvinphos	470-90-6	0.5	µg/L		<0.5	<0.5	----	----	----
Bromophos-ethyl	4824-78-6	0.5	µg/L		<0.5	<0.5	----	----	----
Fenamiphos	22224-92-6	0.5	µg/L		<0.5	<0.5	----	----	----
Prothiofos	34643-46-4	0.5	µg/L		<0.5	<0.5	----	----	----
Ethion	563-12-2	0.5	µg/L		<0.5	<0.5	----	----	----
Carbophenothion	786-19-6	0.5	µg/L		<0.5	<0.5	----	----	----
Azinphos Methyl	86-50-0	0.5	µg/L		<0.5	<0.5	----	----	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	----	----	----
C10 - C14 Fraction	----	50	µg/L		<50	<50	----	----	----
C15 - C28 Fraction	----	100	µg/L		<100	<100	----	----	----
C29 - C36 Fraction	----	50	µg/L		<50	<50	----	----	----
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	<50	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	----	----	----
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	----	----	----
>C10 - C16 Fraction	----	100	µg/L		<100	<100	----	----	----
>C16 - C34 Fraction	----	100	µg/L		<100	<100	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	QUARRY	CREEK	----	----	----
				Sampling date / time	16-Aug-2022 00:00	16-Aug-2022 00:00	----	----	----
Compound	CAS Number	LOR	Unit		ES2229178-001	ES2229178-002	--------	--------	--------
					Result	Result	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
>C34 - C40 Fraction	----	100	µg/L		<100	<100	----	----	----
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L		<100	<100	----	----	----
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L		<100	<100	----	----	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	----	----	----
Toluene	108-88-3	2	µg/L		<2	<2	----	----	----
Ethylbenzene	100-41-4	2	µg/L		<2	<2	----	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	----	----	----
ortho-Xylene	95-47-6	2	µg/L		<2	<2	----	----	----
^ **Total Xylenes**	----	2	µg/L		<2	<2	----	----	----
^ **Sum of BTEX**	----	1	µg/L		<1	<1	----	----	----
Naphthalene	91-20-3	5	µg/L		<5	<5	----	----	----
EP201: Carbamate Pesticides by LCMS									
Oxamyl	23135-22-0	0.2	µg/L		<0.2	<0.2	----	----	----
Methomyl	16752-77-5	0.2	µg/L		<0.2	<0.2	----	----	----
3-Hydroxy Carbofuran	16655-82-6	0.2	µg/L		<0.2	<0.2	----	----	----
Aldicarb	116-06-3	0.2	µg/L		<0.2	<0.2	----	----	----
Bendiocarb	22781-23-3	0.2	µg/L		<0.2	<0.2	----	----	----
Thiodicarb	59669-26-0	0.2	µg/L		<0.2	<0.2	----	----	----
Carbofuran	1563-66-2	0.2	µg/L		<0.2	<0.2	----	----	----
Carbaryl	63-25-2	0.2	µg/L		<0.2	<0.2	----	----	----
Methiocarb	2032-65-7	0.2	µg/L		<0.2	<0.2	----	----	----
MW006: Faecal Coliforms & E.coli by MF									
Faecal Coliforms	----	1	CFU/100mL		**~2**	**24**	----	----	----
EP068S: Organochlorine Pesticide Surrogate									
Dibromo-DDE	21655-73-2	0.5	%		**64.2**	**60.6**	----	----	----
EP068T: Organophosphorus Pesticide Surrogate									
DEF	78-48-8	0.5	%		**65.8**	**66.1**	----	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**85.1**	**85.0**	----	----	----
Toluene-D8	2037-26-5	2	%		**85.2**	**92.9**	----	----	----
4-Bromofluorobenzene	460-00-4	2	%		**92.5**	**106**	----	----	----
EP201S: Carbamate Surrogate									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	QUARRY	CREEK	----	----	----
				Sampling date / time	16-Aug-2022 00:00	16-Aug-2022 00:00	----	----	----
Compound	CAS Number	LOR	Unit		ES2229178-001	ES2229178-002	--------	--------	--------
					Result	Result	----	----	----
EP201S: Carbamate Surrogate - Continued									
4-Bromo-3.5-dimethylphenyl-N-methylcarbamate	672-99-1	0.2	%		**90.6**	**98.8**	**----**	**----**	**----**

Surrogate Control Limits

Sub-Matrix: **WATER**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP068S: Organochlorine Pesticide Surrogate			
Dibromo-DDE	21655-73-2	67	111
EP068T: Organophosphorus Pesticide Surrogate			
DEF	78-48-8	67	111
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	71	137
Toluene-D8	2037-26-5	79	131
4-Bromofluorobenzene	460-00-4	70	128
EP201S: Carbamate Surrogate			
4-Bromo-3.5-dimethylphenyl-N-methy lcarbamate	672-99-1	65	147

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES2301099**	Page	: 1 of 9
Client	: **4 PILLARS ENVIRONMENTAL CONSULTING**	Laboratory	: Environmental Division Sydney
Contact	: Manikshya Shrestha	Contact	: Customer Services ES
Address	: Suite 16, 9 George Street NORTH STRATHFIELD 2137	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: ----	Telephone	: +61-2-8784 8555
Project	: 20220601KLF UPSTREAM AND DOWNSTREAM OAKY CREEK	Date Samples Received	: 13-Jan-2023 12:50
Order number	: Category 3	Date Analysis Commenced	: 13-Jan-2023
C-O-C number	: ----	Issue Date	: 23-Jan-2023 11:41
Sampler	: Manikshya Shrestha		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 3		
No. of samples analysed	: 3		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Dian Dao	Senior Chemist - Inorganics	Sydney Inorganics, Smithfield, NSW
Edwandy Fadjar	Organic Coordinator	Sydney Organics, Smithfield, NSW
Franco Lentini	LCMS Coordinator	Sydney Organics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW
Somlok Chai	Microbiologist	Sydney Microbiology, Smithfield, NSW
Wisam Marassa	Inorganics Coordinator	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contract for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- MF = membrane filtration
- CFU = colony forming unit
- EP068: Where reported, Total Chlordane (sum) is the sum of the reported concentrations of cis-Chlordane and trans-Chlordane at or above the LOR.
- EP080: Where reported, Total Xylenes is the sum of the reported concentrations of m&p-Xylene and o-Xylene at or above the LOR.
- MW006 is ALS's internal code and is equivalent to AS4276.5.
- EG020: It is recognised that total concentration is less than dissolved for some metal analytes. However, the difference is within experimental variation of the methods.
- Microbiological Comment: In accordance with ALS work instruction QWI-MIC/04, membrane filtration result is reported an approximate (~) when the count of colonies on the filtered membrane is outside the range of 10 - 100cfu.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	UPSTREAM	DWS1	DWS2	----	----
			Sampling date / time	13-Jan-2023 00:00	13-Jan-2023 00:00	13-Jan-2023 00:00	----	----
Compound	CAS Number	LOR	Unit	ES2301099-001	ES2301099-002	ES2301099-003	--------	--------
				Result	Result	Result	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.84**	**7.77**	**7.83**	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**619**	**1070**	**1070**	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**432**	**619**	**624**	----	----
EA045: Turbidity								
Turbidity	----	0.1	NTU	**152**	**8.3**	**8.0**	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**97**	**96**	**98**	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**97**	**96**	**98**	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**116**	**260**	**254**	----	----
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	**102**	**172**	**174**	----	----
ED093T: Total Major Cations								
Calcium	7440-70-2	1	mg/L	**20**	**30**	**30**	----	----
Magnesium	7439-95-4	1	mg/L	**20**	**30**	**30**	----	----
Sodium	7440-23-5	1	mg/L	**82**	**140**	**141**	----	----
Potassium	7440-09-7	1	mg/L	**6**	**6**	**6**	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Barium	7440-39-3	0.001	mg/L	**0.084**	**0.100**	**0.100**	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Copper	7440-50-8	0.001	mg/L	**0.002**	<0.001	<0.001	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Nickel	7440-02-0	0.001	mg/L	**0.001**	<0.001	<0.001	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	<0.005	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	<0.05	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	UPSTREAM	DWS1	DWS2	----	----
			Sampling date / time	13-Jan-2023 00:00	13-Jan-2023 00:00	13-Jan-2023 00:00	----	----
Compound	CAS Number	LOR	Unit	ES2301099-001	ES2301099-002	ES2301099-003	--------	--------
				Result	Result	Result	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	----	----
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**4.15**	**0.25**	**0.25**	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.002**	<0.001	<0.001	----	----
Barium	7440-39-3	0.001	mg/L	**0.116**	**0.098**	**0.098**	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
Chromium	7440-47-3	0.001	mg/L	**0.004**	<0.001	<0.001	----	----
Copper	7440-50-8	0.001	mg/L	**0.007**	**0.001**	<0.001	----	----
Cobalt	7440-48-4	0.001	mg/L	**0.002**	<0.001	<0.001	----	----
Nickel	7440-02-0	0.001	mg/L	**0.003**	<0.001	<0.001	----	----
Lead	7439-92-1	0.001	mg/L	**0.002**	<0.001	<0.001	----	----
Zinc	7440-66-6	0.005	mg/L	**0.009**	<0.005	<0.005	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	<0.05	----	----
Iron	7439-89-6	0.05	mg/L	**3.83**	**0.26**	**0.26**	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
EG050T: Total Hexavalent Chromium								
Hexavalent Chromium	18540-29-9	0.01	mg/L	<0.01	<0.01	<0.01	----	----
EK025SF: Free CN by Segmented Flow Analyser								
Free Cyanide	----	0.004	mg/L	<0.004	<0.004	<0.004	----	----
EK026SF: Total CN by Segmented Flow Analyser								
Total Cyanide	57-12-5	0.004	mg/L	<0.004	<0.004	<0.004	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.04**	**0.02**	**0.02**	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.04**	**0.02**	**0.02**	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.04**	**0.02**	**0.02**	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	UPSTREAM	DWS1	DWS2	----	----
			Sampling date / time	13-Jan-2023 00:00	13-Jan-2023 00:00	13-Jan-2023 00:00	----	----
Compound	CAS Number	LOR	Unit	ES2301099-001	ES2301099-002	ES2301099-003	--------	--------
				Result	Result	Result	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**1.5**	**0.5**	**0.8**	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	**1.5**	**0.5**	**0.8**	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.58**	**0.04**	**0.05**	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
EP020: Oil and Grease (O&G)								
Oil & Grease	----	5	mg/L	<5	<5	<5	----	----
EP026SP: Chemical Oxygen Demand (Spectrophotometric)								
Chemical Oxygen Demand	----	10	mg/L	**45**	**15**	**15**	----	----
EP030: Biochemical Oxygen Demand (BOD)								
Biochemical Oxygen Demand	----	2	mg/L	**2**	<2	**3**	----	----
EP068A: Organochlorine Pesticides (OC)								
alpha-BHC	319-84-6	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<0.5	<0.5	<0.5	----	----
beta-BHC	319-85-7	0.5	µg/L	<0.5	<0.5	<0.5	----	----
gamma-BHC	58-89-9	0.5	µg/L	<0.5	<0.5	<0.5	----	----
delta-BHC	319-86-8	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Heptachlor	76-44-8	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Aldrin	309-00-2	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Heptachlor epoxide	1024-57-3	0.5	µg/L	<0.5	<0.5	<0.5	----	----
trans-Chlordane	5103-74-2	0.5	µg/L	<0.5	<0.5	<0.5	----	----
alpha-Endosulfan	959-98-8	0.5	µg/L	<0.5	<0.5	<0.5	----	----
cis-Chlordane	5103-71-9	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Dieldrin	60-57-1	0.5	µg/L	<0.5	<0.5	<0.5	----	----
4.4`-DDE	72-55-9	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Endrin	72-20-8	0.5	µg/L	<0.5	<0.5	<0.5	----	----
beta-Endosulfan	33213-65-9	0.5	µg/L	<0.5	<0.5	<0.5	----	----
4.4`-DDD	72-54-8	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Endrin aldehyde	7421-93-4	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Endosulfan sulfate	1031-07-8	0.5	µg/L	<0.5	<0.5	<0.5	----	----
4.4`-DDT	50-29-3	2.0	µg/L	<2.0	<2.0	<2.0	----	----
Endrin ketone	53494-70-5	0.5	µg/L	<0.5	<0.5	<0.5	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	UPSTREAM	DWS1	DWS2	----	----
			Sampling date / time	13-Jan-2023 00:00	13-Jan-2023 00:00	13-Jan-2023 00:00	----	----
Compound	CAS Number	LOR	Unit	ES2301099-001	ES2301099-002	ES2301099-003	--------	--------
				Result	Result	Result	----	----
EP068A: Organochlorine Pesticides (OC) - Continued								
Methoxychlor	72-43-5	2.0	µg/L	<2.0	<2.0	<2.0	----	----
^ Total Chlordane (sum)	----	0.5	µg/L	<0.5	<0.5	<0.5	----	----
^ Sum of DDD + DDE + DDT	72-54-8/72-55-9/50-2	0.5	µg/L	<0.5	<0.5	<0.5	----	----
^ Sum of Aldrin + Dieldrin	309-00-2/60-57-1	0.5	µg/L	<0.5	<0.5	<0.5	----	----
EP068B: Organophosphorus Pesticides (OP)								
Dichlorvos	62-73-7	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Demeton-S-methyl	919-86-8	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Monocrotophos	6923-22-4	2.0	µg/L	<2.0	<2.0	<2.0	----	----
Dimethoate	60-51-5	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Diazinon	333-41-5	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Chlorpyrifos-methyl	5598-13-0	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Parathion-methyl	298-00-0	2.0	µg/L	<2.0	<2.0	<2.0	----	----
Malathion	121-75-5	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Fenthion	55-38-9	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Chlorpyrifos	2921-88-2	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Parathion	56-38-2	2.0	µg/L	<2.0	<2.0	<2.0	----	----
Pirimphos-ethyl	23505-41-1	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Chlorfenvinphos	470-90-6	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Bromophos-ethyl	4824-78-6	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Fenamiphos	22224-92-6	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Prothiofos	34643-46-4	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Ethion	563-12-2	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Carbophenothion	786-19-6	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Azinphos Methyl	86-50-0	0.5	µg/L	<0.5	<0.5	<0.5	----	----
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	<20	<20	<20	----	----
C10 - C14 Fraction	----	50	µg/L	<50	<50	<50	----	----
C15 - C28 Fraction	----	100	µg/L	<100	<100	<100	----	----
C29 - C36 Fraction	----	50	µg/L	<50	<50	<50	----	----
^ C10 - C36 Fraction (sum)	----	50	µg/L	<50	<50	<50	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	<20	----	----
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L	<20	<20	<20	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	UPSTREAM	DWS1	DWS2	----	----
				Sampling date / time	13-Jan-2023 00:00	13-Jan-2023 00:00	13-Jan-2023 00:00	----	----
Compound	CAS Number	LOR	Unit		ES2301099-001	ES2301099-002	ES2301099-003	--------	--------
					Result	Result	Result	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	----	----
>C16 - C34 Fraction	----	100	µg/L		<100	<100	<100	----	----
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	----	----
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	<100	<100	----	----
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	<100	<100	----	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	----	----
Toluene	108-88-3	2	µg/L		<2	<2	<2	----	----
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	----	----
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	----	----
^ Total Xylenes	----	2	µg/L		<2	<2	<2	----	----
^ Sum of BTEX	----	1	µg/L		<1	<1	<1	----	----
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	----	----
EP201: Carbamate Pesticides by LCMS									
Oxamyl	23135-22-0	0.2	µg/L		<0.2	<0.2	<0.2	----	----
Methomyl	16752-77-5	0.2	µg/L		<0.2	<0.2	<0.2	----	----
3-Hydroxy Carbofuran	16655-82-6	0.2	µg/L		<0.2	<0.2	<0.2	----	----
Aldicarb	116-06-3	0.2	µg/L		<0.2	<0.2	<0.2	----	----
Bendiocarb	22781-23-3	0.2	µg/L		<0.2	<0.2	<0.2	----	----
Thiodicarb	59669-26-0	0.2	µg/L		<0.2	<0.2	<0.2	----	----
Carbofuran	1563-66-2	0.2	µg/L		<0.2	<0.2	<0.2	----	----
Carbaryl	63-25-2	0.2	µg/L		<0.2	<0.2	<0.2	----	----
Methiocarb	2032-65-7	0.2	µg/L		<0.2	<0.2	<0.2	----	----
MW006: Faecal Coliforms & E.coli by MF									
Faecal Coliforms	----	1	CFU/100mL		**88**	**~9**	**12**	----	----
EP068S: Organochlorine Pesticide Surrogate									
Dibromo-DDE	21655-73-2	0.5	%		**59.1**	**62.4**	**54.0**	----	----
EP068T: Organophosphorus Pesticide Surrogate									
DEF	78-48-8	0.5	%		**62.1**	**62.7**	**54.9**	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**106**	**115**	**115**	----	----
Toluene-D8	2037-26-5	2	%		**98.6**	**104**	**103**	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	UPSTREAM	DWS1	DWS2	----	----
				Sampling date / time	13-Jan-2023 00:00	13-Jan-2023 00:00	13-Jan-2023 00:00	----	----
Compound	CAS Number	LOR	Unit		ES2301099-001	ES2301099-002	ES2301099-003	--------	--------
					Result	Result	Result	----	----
EP080S: TPH(V)/BTEX Surrogates - Continued									
4-Bromofluorobenzene	460-00-4	2	%		**97.5**	**105**	**104**	**----**	**----**
EP201S: Carbamate Surrogate									
4-Bromo-3.5-dimethylphenyl-N-methylcarbamate	672-99-1	0.2	%		**97.7**	**93.6**	**98.9**	**----**	**----**

Surrogate Control Limits

Sub-Matrix: **WATER**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP068S: Organochlorine Pesticide Surrogate			
Dibromo-DDE	21655-73-2	67	111
EP068T: Organophosphorus Pesticide Surrogate			
DEF	78-48-8	67	111
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	71	137
Toluene-D8	2037-26-5	79	131
4-Bromofluorobenzene	460-00-4	70	128
EP201S: Carbamate Surrogate			
4-Bromo-3.5-dimethylphenyl-N-methy lcarbamate	672-99-1	65	147

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES2035920**	Page	: 1 of 6
Client	: **EMM CONSULTING PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: Patrick Carolan	Contact	: Sepan Mahamad
Address	: 6/146 Hunter Street Newcastle 2300	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: 02 4907 4800	Telephone	: +61 2 8784 8555
Project	: J190749	Date Samples Received	: 14-Oct-2020 09:00
Order number	: ----	Date Analysis Commenced	: 14-Oct-2020
C-O-C number	: ----	Issue Date	: 21-Oct-2020 13:27
Sampler	: Callan Douchkov		
Site	: ----		
Quote number	: EN/112/20		
No. of samples received	: 6		
No. of samples analysed	: 6		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	OC_US	PIT	WMD	OC_Pond	OC_DS
			Client sampling date / time	13-Oct-2020 18:10	13-Oct-2020 17:40	13-Oct-2020 18:35	13-Oct-2020 18:45	13-Oct-2020 19:05
Compound	CAS Number	LOR	Unit	ES2035920-001	ES2035920-002	ES2035920-003	ES2035920-004	ES2035920-005
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.85**	**8.65**	**8.42**	**7.84**	**7.82**
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**851**	**5970**	**1550**	**764**	**782**
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**463**	**3290**	**780**	**388**	**398**
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	<5	**13**	**6**	**50**	**16**
EA045: Turbidity								
Turbidity	----	0.1	NTU	**12.6**	**3.1**	**4.3**	**19.7**	**6.4**
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	**148**	**604**	**185**	**98**	**119**
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	**0.001**
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	**0.001**	**0.002**	**0.002**	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	**0.027**	**0.002**	**0.002**	**0.144**	**0.026**
Nickel	7440-02-0	0.001	mg/L	<0.001	**0.003**	**0.001**	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L	**0.026**	<0.005	<0.005	<0.005	<0.005
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.03**	**0.01**	**0.01**	<0.01	<0.01
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	**0.13**	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	**6.38**	<0.01	**0.07**	**0.04**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	**6.51**	<0.01	**0.07**	**0.04**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.4**	**1.4**	**1.0**	**0.2**	**0.2**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	OC_US	PIT	WMD	OC_Pond	OC_DS
				Client sampling date / time	13-Oct-2020 18:10	13-Oct-2020 17:40	13-Oct-2020 18:35	13-Oct-2020 18:45	13-Oct-2020 19:05
Compound	CAS Number	LOR	Unit		ES2035920-001	ES2035920-002	ES2035920-003	ES2035920-004	ES2035920-005
					Result	Result	Result	Result	Result
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ **Total Nitrogen as N**	----	0.1	mg/L		**0.4**	**7.9**	**1.0**	**0.3**	**0.2**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.01**	<0.01	**0.03**	**0.01**	**0.01**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EP025: Oxygen - Dissolved (DO)									
Dissolved Oxygen	----	0.1	mg/L		**9.2**	**10.0**	**9.4**	**9.9**	**9.6**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	Sed_Pond	----	----	----	----
			Client sampling date / time	13-Oct-2020 18:20	----	----	----	----
Compound	CAS Number	LOR	Unit	ES2035920-006	--------	--------	--------	--------
				Result	----	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**8.05**	----	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**913**	----	----	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**478**	----	----	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C								
Suspended Solids (SS)	----	5	mg/L	**232**	----	----	----	----
EA045: Turbidity								
Turbidity	----	0.1	NTU	**64.1**	----	----	----	----
ED093F: SAR and Hardness Calculations								
Total Hardness as CaCO3	----	1	mg/L	**141**	----	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.001**	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L	<0.001	----	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.001**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	----	----	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	----	----	----	----
Boron	7440-42-8	0.05	mg/L	<0.05	----	----	----	----
Iron	7439-89-6	0.05	mg/L	**0.22**	----	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.09**	----	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	----	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.02**	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.02**	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**1.6**	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Sed_Pond	----	----	----	----
				Client sampling date / time	13-Oct-2020 18:20	----	----	----	----
Compound	CAS Number	LOR	Unit		ES2035920-006	--------	--------	--------	--------
					Result	----	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ **Total Nitrogen as N**	----	0.1	mg/L		**1.6**	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.12**	----	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	----	----	----	----
EP025: Oxygen - Dissolved (DO)									
Dissolved Oxygen	----	0.1	mg/L		**8.9**	----	----	----	----

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES2105076**	Page	: 1 of 6
Client	: **EMM CONSULTING PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: Patrick Carolan	Contact	: Sepan Mahamad
Address	: 6/146 Hunter Street Newcastle 2300	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: 02 4907 4800	Telephone	: +61 2 8784 8555
Project	: J190749	Date Samples Received	: 12-Feb-2021 18:20
Order number	: ----	Date Analysis Commenced	: 12-Feb-2021
C-O-C number	: ----	Issue Date	: 19-Feb-2021 18:24
Sampler	: Patrick Carolan		
Site	: ----		
Quote number	: EN/112/20 Primary work		
No. of samples received	: 8		
No. of samples analysed	: 8		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

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- Analytical Results

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Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW

General Comments

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Where moisture determination has been performed, results are reported on a dry weight basis.

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^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	OC_US	PIT1	WMD	OC_Pond	OD_DS
				Sampling date / time	12-Feb-2021 12:50	12-Feb-2021 12:10	12-Feb-2021 13:40	12-Feb-2021 13:50	12-Feb-2021 17:10
Compound	CAS Number	LOR	Unit		ES2105076-001	ES2105076-002	ES2105076-003	ES2105076-004	ES2105076-005
					Result	Result	Result	Result	Result
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		929	5990	1770	748	773
EA015: Total Dissolved Solids dried at 180 ± 5 °C									
Total Dissolved Solids @180°C	----	10	mg/L		472	3720	936	385	412
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		22	8	6	11	40
EA045: Turbidity									
Turbidity	----	0.1	NTU		42.5	2.3	4.9	27.5	67.9
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	107	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		38	256	169	16	16
Total Alkalinity as CaCO3	----	1	mg/L		38	363	169	16	16
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		51	366	21	30	36
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		241	1460	456	202	200
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		18	30	24	10	8
Magnesium	7439-95-4	1	mg/L		8	136	40	6	7
Sodium	7440-23-5	1	mg/L		142	1040	258	120	126
Potassium	7440-09-7	1	mg/L		2	22	14	2	2
ED093F: SAR and Hardness Calculations									
Total Hardness as CaCO3	----	1	mg/L		78	635	225	50	49
^ Sodium Adsorption Ratio	----	0.01	-		7.00	18.0	7.49	7.41	7.85
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		0.04	<0.01	<0.01	<0.01	0.02
Arsenic	7440-38-2	0.001	mg/L		<0.001	0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		0.014	<0.001	0.019	0.001	<0.001
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L		0.059	<0.001	0.006	0.047	0.038
Nickel	7440-02-0	0.001	mg/L		0.004	<0.001	0.001	<0.001	<0.001
Zinc	7440-66-6	0.005	mg/L		0.012	<0.005	0.007	<0.005	<0.005

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	OC_US	PIT1	WMD	OC_Pond	OD_DS
				Sampling date / time	12-Feb-2021 12:50	12-Feb-2021 12:10	12-Feb-2021 13:40	12-Feb-2021 13:50	12-Feb-2021 17:10
Compound	CAS Number	LOR	Unit		ES2105076-001	ES2105076-002	ES2105076-003	ES2105076-004	ES2105076-005
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Boron	7440-42-8	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	<0.05
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	<0.05	<0.05	<0.05
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.01**	<0.01	**0.05**	<0.01	**0.10**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	**0.12**	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.42**	**3.64**	<0.01	**0.29**	**0.22**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.42**	**3.76**	<0.01	**0.29**	**0.22**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.2**	**1.2**	**1.0**	<0.1	**0.2**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**0.6**	**5.0**	**1.0**	**0.3**	**0.4**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.04**	**0.13**	**0.03**	**0.01**	**0.04**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**8.62**	**56.0**	**16.7**	**6.64**	**6.71**
ø Total Cations	----	0.01	meq/L		**7.78**	**58.5**	**16.1**	**6.26**	**6.51**
ø Ionic Balance	----	0.01	%		**5.09**	**2.12**	**1.85**	**2.94**	**1.54**
EP025: Oxygen - Dissolved (DO)									
Dissolved Oxygen	----	0.1	mg/L		**8.8**	**10.5**	**9.8**	**8.6**	**8.0**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	Sed Pond	PIT1_D	PIT2	----	----
				Sampling date / time	12-Feb-2021 17:00	12-Feb-2021 16:00	12-Feb-2021 12:25	----	----
Compound	CAS Number	LOR	Unit		ES2105076-006	ES2105076-007	ES2105076-008	--------	--------
					Result	Result	Result	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		870	6000	5990	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C									
Total Dissolved Solids @180°C	----	10	mg/L		488	3790	3620	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	5	mg/L		33	10	7	----	----
EA045: Turbidity									
Turbidity	----	0.1	NTU		11.1	2.6	3.7	----	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		64	122	118	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		79	246	260	----	----
Total Alkalinity as CaCO3	----	1	mg/L		142	369	378	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		1	358	362	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		199	1460	1480	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		21	32	31	----	----
Magnesium	7439-95-4	1	mg/L		19	136	134	----	----
Sodium	7440-23-5	1	mg/L		116	1040	1030	----	----
Potassium	7440-09-7	1	mg/L		13	22	22	----	----
ED093F: SAR and Hardness Calculations									
Total Hardness as CaCO3	----	1	mg/L		131	640	629	----	----
^ Sodium Adsorption Ratio	----	0.01	-		4.41	17.9	17.9	----	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	<0.01	<0.01	----	----
Arsenic	7440-38-2	0.001	mg/L		0.002	<0.001	<0.001	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Copper	7440-50-8	0.001	mg/L		0.021	0.012	0.014	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Manganese	7439-96-5	0.001	mg/L		0.059	0.001	0.002	----	----
Nickel	7440-02-0	0.001	mg/L		0.008	0.004	0.006	----	----
Zinc	7440-66-6	0.005	mg/L		0.008	0.006	0.008	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	Sed Pond	PIT1_D	PIT2	----	----
				Sampling date / time	12-Feb-2021 17:00	12-Feb-2021 16:00	12-Feb-2021 12:25	----	----
Compound	CAS Number	LOR	Unit		ES2105076-006	ES2105076-007	ES2105076-008	--------	--------
					Result	Result	Result	----	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Boron	7440-42-8	0.05	mg/L		<0.05	<0.05	<0.05	----	----
Iron	7439-89-6	0.05	mg/L		**1.21**	<0.05	<0.05	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.07**	**0.05**	**0.04**	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	**0.12**	**0.12**	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	**3.62**	**3.57**	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	**3.74**	**3.69**	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.9**	**1.0**	**1.3**	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**0.9**	**4.7**	**5.0**	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.03**	<0.01	**0.02**	----	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	----	----
EN055: Ionic Balance									
ø Total Anions	----	0.01	meq/L		**8.47**	**56.0**	**56.8**	----	----
ø Total Cations	----	0.01	meq/L		**7.99**	**58.6**	**57.9**	----	----
ø Ionic Balance	----	0.01	%		**2.93**	**2.25**	**0.96**	----	----
EP025: Oxygen - Dissolved (DO)									
Dissolved Oxygen	----	0.1	mg/L		**12.1**	**11.0**	**11.2**	----	----

Appendix 12 - Laboratory Chain-of-Custody Documentation

URGENT

CHAIN OF CUSTODY FORM

4Pillars Environmental Consulting
Level 1, 5 George Street, North Strathfield NSW 2137
Contact Person: Manikshya Shrestha

Sampler: MS **Contact mob:** 0413 947 480

Email: Results: data@4pillars.com.au
Invoice: accounts@4pillars.com.au

4Pillars Project Name: 20220601KLF - June Quarry Water

4Pillars Accounting Code: Category 3

Date results required:
Turnaround time (standard) same day
1 day 2 day 3 day

COC Sequence Number

COC:	1	2	3	4	5	6	7
OF:	1	2	3	4	5	6	7

General Comments: Unless otherwise specified, please do not send the results directly to the project manager, please use the emails provided above.

Sample Information					Required Analysis																		Comments
Lab ID	Sample ID	Depth	Date sampled	Type of sample	Alkalinity, pH, BOD, TDS	Total Hardness, Turbidity	Al, Se, As, Fe, Cd, Cr, Co, Cu, Pb, Hg, Ni, Zn(dissolved)	Al, Se, As, Fe, Cd, Cr, Co, Cu, Pb, Hg, Ni, Mg, Zn(total)	Ca, Cl, K, Na (total)	COD	Nitrate, Nitrite, Ammonia	Conductivity (EC)	BTEX	Cyanide (total/dissolved)	OC & OP Pesticides	Phosphate, Phosphorus (total)	NOx (NO2 + NO3)	Nitrogen (total)	TRH	Hydrogen Sulphide	Oil and Grease	Multi residue pesticide	Faecal Coliforms	
	S1	1m	23/6/2022	WATER	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	13 Containers
	D1	9m	23/6/2022	WATER	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	13 Containers

Environmental Division
Sydney
Work Order Reference
ES2222130

Telephone : +61-2-8784 8555

Relinquished by (Company): 4Pillars Environmental Consulting	**Received by (Company):**	**Laboratory use only:**
Print Name: Manikshya Shrestha	**Print Name:**	**Samples Received: Cool or Ambient (circle one)**
Date & Time: 22/06/2022	**Date & Time:** 23/6/22 1540 10.2	**Temperature Received at:** (if applicable)
Signature:	**Signature:**	**Transported by:** Hand delivered / courier

CHAIN OF CUSTODY FORM

4Pillars ENVIRONMENTAL CONSULTING

4Pillars Environmental Consulting
Level 1, 5 George Street, North Strathfield NSW 2137
Contact Person: Manikshya Shrestha

Sampler: MS **Contact mob:** 0413 947 480

Email: Results: data@4pillars.com.au
Invoice: accounts@4pillars.com.au

4Pillars Project Name: 20220601KLF - July Quarry and Creek Water

4Pillars Accounting Code: Category 3

Date results required:
Turnaround time (standard) same day
1 day 2 day 3 day

COC Sequence Number
COC: (1) 2 3 4 5 6 7
OF: (1) 2 3 4 5 6 7

General Comments: Unless otherwise specified, please do not send the results directly to the project manager, please use the emails provided above.

Sample information					Required Analysis																		Comments
Lab ID	Sample ID	Depth	Date sampled	Type of sample	Alkalinity, pH, BOD, TDS	Total Hardness, Turbidity	Al, B, Ba, Se, As, Fe, Cd, Cr, Co, Cu, Pb, Hg, Ni, Zn(dissolved)	Al, Ba, B, Se, As, Fe, Cd, Cr, Co, Cu, Pb, Hg, Ni, Mg, Zn(total)	Ca, Cl, K, Na (total)	Hexavalent Chromium (total)	COD	Nitrate, Nitrite, Ammonia	Conductivity (EC)	BTEX	Cyanide (total/dissolved)	OC & OP Pesticides	Phosphate, Phosphorus (total)	NOx (NO2 + NO3)	Nitrogen (total)	TRH	Polycyclic Aromatic Hydrocarbons	Oil and Grease	Carbamates	Faecal Coliforms	
1	Quarry		22/7/2022	WATER	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	1	X	X	X	11 containers
2	Creek		22/7/2022	WATER	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	12 containers
																									Please filter for dissolved metals.

URGENT

Environmental Division
Sydney
Work Order Reference
ES2226007

Telephone : +61-2-8784 8555

Relinquished by (Company): 4Pillars Environmental Consulting	Received by (Company): AES	For laboratory use only:
Print Name: Manikshya Shrestha	Print Name: Jack	
Date & Time: 22/7/2022	Date & Time: 22/7/22 1700	
Signature:	Signature:	Transported by: Hand delivered / courier

CUSTODY FORM

ntal Consulting	**4Pillars Project Name:** 20220601KLF - July Quarry and Creek Water
Street, North Strathfield NSW 2137	
Contact Person: anikshya Shrestha	**4Pillars Accounting Code:** Category 3
Sampler: MS **Contact mob:** 0413 947 480	
Email: Results: data@4pillars.com.au Invoice: accounts@4pillars.com.au	**Date results required:** Turnaround time (standard) same day 1 day 2 day 3 day

4Pillars ENVIRONMENTAL CONSULTING

COC Sequence Number

COC:	1	2	3	4	5	6	7
OF:	1	2	3	4	5	6	7

General Comments: Unless otherwise specified, please do not send the results directly to the project manager, please use the emails provided above.

Sample information					Required Analysis																		Comments
Lab ID	Sample ID	Depth	Date sampled	Type of sample	Alkalinity, pH, BOD, TDS	Total Hardness, Turbidity	Al, B, Ba, Se, As, Fe, Cd, Cr, Co, Cu, Pb, Hg, Ni, Zn(dissolved)	Al, Ba, B, Se, As, Fe, Cd, Cr, Co, Cu, Pb, Hg, Ni, Mg, Zn(total)	Ca, Cl, K, Na (total)	Hexavalent Chromium (total)	COD	Nitrate, Nitrite, Ammonia	Conductivity (EC)	BTEX	Cyanide (total/dissolved)	OC & OP Pesticides	Phosphate, Phosphorus (total)	NOx (NO2 + NO3)	Nitrogen (total)	TRH	[redacted]	Oil and Grease	Carbamates	Faecal Coliforms	
1	Quarry		16/8/22	Water	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	12 Containers
2	Creek		16/8/22	Water	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	12 Containers

PLEASE

URGENT

Environmental Division Sydney
Work Order Reference
ES2229178

Telephone : +61-2-8784 8555

Relinquished by (Company): 4Pillars Environmental Consulting	**Received by (Company):** 4P	Laborato
Print Name: Manikshya Shrestha	**Print Name:** Jack	Samples Received: Cool or Ambient (circle one)
Date & Time: 16/8/2022 2pm	**Date & Time:** 16/8/22 1720	Temperature Received at: (If applicable)
Signature:	**Signature:**	Transported by: Hand delivered / courier

CHAIN OF CUSTODY FORM

4Pillars Environmental Consulting
Level 1, 5 George Street, North Strathfield NSW 2137

Contact Person: Manikshya Shrestha

Sampler: MS **Contact mob:** 0413 947 480

Email: Results: data@4pillars.com.au
Invoice: accounts@4pillars.com.au

4Pillars Project Name: 20220601KLF - UPSTREAM AND DOWNSTREAM OAKY CREEK

4Pillars Accounting Code: Category 3

Date results required:
Turnaround time (standard) same day
1 day 2 day 3 day

COC Sequence Number

COC:	1	2	3	4	5	6	7
OF:	1	2	3	4	5	6	7

General Comments: Unless otherwise specified, please do not send the results directly to the project manager, please use the emails provided above.

Sample information					Required Analysis																	Comments
Lab ID	Sample ID	Depth	Date sampled	Type of sample	Alkalinity, pH, BOD, TDS	Total Hardness, Turbidity	Al, B, Ba, Se, As, Fe, Cd, Cr, Co, Cu, Pb, Hg, Ni, Zn(dissolved)	Al, Ba, B, Se, As, Fe, Cd, Cr, Co, Cu, Pb, Hg, Ni, Mg, Zn(total)	Ca, Cl, K, Na (total)	Hexavalent Chromium (total)	COD	Nitrate, Nitrite, Ammonia	Conductivity (EC)	BTEX	Cyanide (total/dissolved)	OC & OP Pesticides	Phosphate, Phosphorus (total)	NOx (NO2 + NO3)	Nitrogen (total)	TRH	Oil and Grease	Carbamates	Faecal Coliforms	
1	UPSTREAM		13/01/2023	WATER	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	12 bottles
2	DWS1		↓	↓	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	↓
3	DWS2		↓	↓	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	↓

URGENT

HT

Relinquished by (Company): 4Pillars Environmental Consulting	Received by (Company): AES	Lab
Print Name: Manikshya Shrestha	Print Name: Jack	Samples Received: Cool or Ambient (circle one)
Date & Time: 13/01/2023 12:50pm	Date & Time: 13/01/23 1750 pm	Temperature Received at: (if applicable)
Signature:	Signature:	Transported by: Hand delivered / courier

Environmental Division
Sydney
Work Order Reference
ES2301099

Telephone : + 61-2-8784 8555

CHAIN OF CUSTODY

ALS Laboratory: please tick →

ADELAIDE 21 Burma Road Pooraka SA 5095 Ph: 08 8359 0890 E: adelaide@alsglobal.com

BRISBANE 2 Byth Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com

GLADSTONE 46 Callemondah Drive Clinton QLD 4680 Ph: 07 7471 5600 E: gladstone@alsglobal.com

MACKAY 78 Harbour Road Mackay QLD 4740 Ph: 07 4944 0177 E: mackay@alsglobal.com

MELBOURNE 2-4 Westall Road Springvale VIC 3171 Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com

MUDGEE 1/29 Sydney Road Mudgee NSW 2850 Ph: 02 6372 6735 E: mudgee.mail@alsglobal.com

NEWCASTLE 5/585 Maitland Road Mayfield West NSW 2304 Ph: 02 4014 2500 E: samples.newcastle@alsglobal.com

NOWRA 4/13 Geary Place North Nowra NSW 2541 Ph: 02 4423 2063 E: nowra@alsglobal.com

PERTH 10 Hod Way Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsglobal.com

SYDNEY 277-289 Woodpark Road Smithfield NSW 2164 Ph: 02 8784 8555 E: samples.sydney@alsglobal.com

TOWNSVILLE 14-15 Desma Court Bohle QLD 4818 Ph: 07 4796 0600 E: townsville.environmental@alsglobal.com

WOLLONGONG 99 Kenny Street Wollongong NSW 2500 Ph: 02 4225 3125 E: wollongong@alsglobal.com

CLIENT: EMM Consulting Pty Ltd		TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g.. Ultra Trace Organics)	☐ Standard TAT (List due date):
OFFICE: Newcastle			☐ Non Standard or urgent TAT (List due date):
PROJECT: J190749	PROJECT NO.:	ALS QUOTE NO.: EN/112/20	
ORDER NUMBER:	PURCHASE ORDER NO.:	COUNTRY OF ORIGIN: Australia	
PROJECT MANAGER: Patrick Carolan	CONTACT PH: 0439 694 514		
SAMPLER: Callan Douchkov	SAMPLER MOBILE: 0401 663 352		
COC Emailed to ALS? (YES / NO)	EDD FORMAT (or default):		
Email Reports to: pcarolan@emmconsulting.com.au; emmconsulting@esdat.net			
Email Invoice to: pcarolan@emmconsulting.com.au			

COC SEQUENCE NUMBER (Circle)

COC: 1 2 3 4 5 6 7

OF: 1 2 3 4 5 6 7

FOR LABORATORY USE ONLY (Circle)

Custody Seal Intact?	Yes	No
Free Ice / frozen ice bricks present upon receipt?	Yes	No
Random Sample Temperature on Receipt:		°C
Other comment:		

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
Callan Douchkov	FAST		
DATE/TIME:	DATE/TIME: 14/10/20 9am	DATE/TIME:	DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL: pH requires same day testing

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	pH, Electrical Conductivity, Dissolved Oxygen, TDS, TSS, Turbidity and Hardness	Ammonia, nitrate, nitrite, Nox, TKN, TN, TP and Reactive P	Aluminium, arsenic, boron, cadmium, chromium, copper, iron, lead, manganese, nickel, zinc						Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
1	OC_US	13/10/2020 18:10	w		3	x	x	x						pH requires same day analysis to meet ho time. All metals dissolved.
2	PIT	13/10/2020 17:40	w		3	x	x	x						pH requires same day analysis to meet ho time. All metals dissolved.
3	WMD	13/10/2020 18:35	w		3	x	x	x						pH requires same day analysis to meet ho time. All metals dissolved.
4	OC_Pond	13/10/2020 18:45	w		3	x	x	x						pH requires same day analysis to meet ho time. All metals dissolved.
5	OC_DS	13/10/2020 19:05	w		3	x	x	x						pH requires same day analysis to meet ho time. All metals dissolved.
6	Sed_Pond	13/10/2020 18:20	w		3	x	x	x						pH requires same day analysis to meet ho time. All metals dissolved.
				TOTAL	18									

HT

Environmental Division
Sydney
Work Order Reference
ES2035920

Telephone : + 61-2-8784 8555

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag; LI = Lugols Iodine Preserved Bottles; STT = Sterile Sodium Thiosulfate Preserved Bottles.

CHAIN OF CUSTODY

ALS Laboratory: please tick →

ADELAIDE 21 Burma Road Pooraka SA 5095 Ph: 08 8359 0890 E: adelaide@alsglobal.com

BRISBANE 2 Byth Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com

GLADSTONE 46 Callemondah Drive Clinton QLD 4680 Ph: 07 7471 5600 E: gladstone@alsglobal.com

MACKAY 78 Harbour Road Mackay QLD 4740 Ph: 07 4944 0177 E: mackay@alsglobal.com

MELBOURNE 2-4 Westall Road Springvale VIC 3171 Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com

MUDGEE 1/26 Sydney Road Mudgee NSW 2850 Ph: 02 6372 6735 E: mudgee.mail@alsglobal.com

NEWCASTLE 5/585 Maitland Road Mayfield West NSW 2304 Ph: 02 4014 2500 E: samples.newcastle@alsglobal.com

NOWRA 4/13 Geary Place North Nowra NSW 2541 Ph: 02 4423 2063 E: nowra@alsglobal.com

PERTH 10 Hod Way Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsglobal.com

SYDNEY 277-289 Woodpark Road Smithfield NSW 2164 Ph: 02 8784 8555 E: samples.sydney@alsglobal.com

TOWNSVILLE 14-15 Desma Court Bohle QLD 4818 Ph: 07 4796 0600 E: townsville.environmental@alsglobal.com

WOLLONGONG 99 Kenny Street Wollongong NSW 2500 Ph: 02 4225 3125 E: wollongong@alsglobal.com

CLIENT: EMM Consulting Pty Ltd	**TURNAROUND REQUIREMENTS :** (Standard TAT may be longer for some tests e.g., Ultra Trace Organics)	☐ Standard TAT **(List due date):**	**FOR LABORATORY USE ONLY (Circle)**
OFFICE: Newcastle		☐ Non Standard or urgent TAT **(List due date):**	Custody Seal Intact? Yes No N/A
PROJECT: J190749 **PROJECT NO.:**	**ALS QUOTE NO.: EN/112/20**	**COC SEQUENCE NUMBER (Circle)**	Free ice / frozen ice bricks present upon receipt? Yes No N/A
ORDER NUMBER: **PURCHASE ORDER NO.:**	**COUNTRY OF ORIGIN: Australia**	COC: 1 2 3 4 5 6 7	Random Sample Temperature on Receipt: °C
PROJECT MANAGER: Patrick Carolan **CONTACT PH: 0439 694 514**		OF: 1 2 3 4 5 6 7	Other comment: 12.1

SAMPLER: Patrick Carolan	**SAMPLER MOBILE: 0439 694 514**	**RELINQUISHED BY:**	**RECEIVED BY:**
COC Emailed to ALS? (YES)	**EDD FORMAT (or default):**	*Patrick Carolan*	
Email Reports to: pcarolan@emmconsulting.com.au; emmconsulting@esdat.net		DATE/TIME:	DATE/TIME: 12/1/21 6:20 PM
Email Invoice to: pcarolan@emmconsulting.com.au		*12/02/21 18:30*	

RELINQUISHED BY:	**RECEIVED BY:**
DATE/TIME:	DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL: DO and turbidity lowest holding times

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where **Metals** are required, specify **Total** (unfiltered bottle required) or **Dissolved** (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE *(refer to codes below)*	TOTAL BOTTLES	Electrical Conductivity, DO, TDS, TSS, Turbidity and Hardness	Ammonia, nitrate, nitrite, Nox, TKN, TN, TP and Reactive P	Aluminium, arsenic, boron, cadmium, chromium, copper, iron, lead, manganese, nickel, zinc	Major Cations and Anions	SAR				Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
1	OC_US	12/02/2021 12:50	w		3	x	x	x	x	x				DO and turbidity shortest holding time
2	PIT1	12/02/2021 12:10	w		3	x	x	x	x	x				DO and turbidity shortest holding time
3	WMD	12/02/2021 13:40	w		3	x	x	x	x	x				DO and turbidity shortest holding time
4	OC_Pond	12/02/2021 13:50	w		3	x	x	x	x	x				DO and turbidity shortest holding time
5	OC_DS	12/02/2021 17:10	w		3	x	x	x	x	x				DO and turbidity shortest holding time
6	Sed_Pond	12/02/2021 17:00	w		3	x	x	x	x	x				DO and turbidity shortest holding time
7	PIT1_D	12/02/2021 16:00	w		3	x	x	x	x	x				DO and turbidity shortest holding time
8	PIT2	12/02/2021 12:25	w		3	x	x	x	x	x				DO and turbidity shortest holding time
				TOTAL	24									

Environmental Division
Sydney
Work Order Reference
ES2105076

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = A
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserv
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag; LI = Lugols Iodine Preserved Bottles; STT = Sterile S

c Preserved Plastic; F = Formaldehyde Preserved Glass;

SAMPLE RECEIPT INFORMATION & BOTTLE TYPE

WORKORDER No: ES2105070

To be completed by Sample Receipt

Sorting Times *(Only record for BP, Mobil & URS)*

Time Sorting Commenced:

Time Placed in Fridge:

Sorting to Fridge Target Time <1 Hour

Temperature Details

Sample Temp: 12.1 °C

..... °C

..... °C

Chilling Method -

☑ ~~Ice~~

☐ Ice Bricks

☐ No Chilling

Packaging

Security Seal Intact? ***Circle below***

☐ **YES** (Security seal intact)

☐ **NO** (Security seal broken)

☑ ~~**NA** (No security seal used)~~

Packaging Type	No.
Hard Esky	1
Foam Esky	

Other:

Courier Details (Mandatory for Quarantine)

Carrier: CLIENT

Con Note:

Samples checked, labelled and put in trays by: Initial: A.M 12/2/21

Client Code: EMMCAM

Sample Receipt Advice Comments - To be completed by Sorting Staff

VOC analysis may be compromised as sample containers contained **headspace** *(list)*:

Details of any samples damaged during transit:

Other Information (eg. Were bottles received that weren't completely filled) (eg. If sample temperature is above 6'C add further detail here - Internal use only - Not for SRN):

Tray Numbers: W495 M 143AB P89L

Appendix 13 - Water Review Report by EMM Consulting

Luddenham Quarry

Water review (September 2021 - August 2022)

Prepared for Luddenham Operations Pty Ltd

September 2022

Luddenham Quarry

Water review (September 2021 - August 2022)

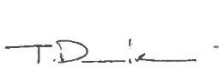
Luddenham Operations Pty Ltd

J190749 RP#71

September 2022

Version	Date	Prepared by	Approved by	Comments
1	23/09/2022	Adrian Ma	Tess Davies	Draft for client review
1	28/09/2022	Adrian Ma	Tess Davies	Final

Approved by



Tess Davies
Senior Water Resources Engineer
28 September 2022

Level 3 175 Scott Street
Newcastle NSW 2300

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1 Introduction

1.1 Overview

Luddenham Quarry is located at 275 Adams Road, Luddenham NSW (Lot 3 in DP 623799, 'the site') within the Liverpool City Council municipality. The existing shale/clay quarry is approved by State significant development (SSD) consent DA 315-7-2003, issued by the NSW Minister for Planning under the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). The site is owned by CFT No 13 Pty Ltd, a member of the Coombes Property Group (CPG).

Luddenham Operations Pty Ltd is operating the quarry in accordance with Modification 5 (MOD 5) of DA 315-7-2003 which was granted on 24 May 2021.

1.2 Purpose of this report

This report outlines water balance modelling and water quality monitoring undertaken by EMM Consulting Pty Ltd (EMM) to support the Luddenham Quarry annual review report being prepared by Luddenham Operations Pty Ltd (Luddenham Operations), for the annual review period of 1 September 2021 to 31 August 2022.

1.3 Report structure

The following sections set out:

- an overview of EMM's understanding of the site operations (Section 2);
- the methodology and data applied to this assessment (Section 3);
- water balance results for the annual review period (Section 4);
- water quality results for the annual review period (Section 5); and
- a summary of work undertaken and recommendations for environmental compliance (Section 6).

2 Background

2.1 Overview

This section describes EMM's understanding of the site operations, water management and water quality monitoring program.

2.2 Summary of site operations

During the annual review period, the site has commenced reestablishment with the stockpiling of materials and reestablishment of internal access roads being undertaken during the last six months. Quarrying activities are yet to recommence. Luddenham Operations has advised that during the annual review period:

- no transfers between the water management dam and the quarry pit were undertaken;
- no dust suppression activities were undertaken; and
- no discharges were observed to occur from the water management dam to Oaky Creek.

2.3 Water quality monitoring program

A water quality monitoring program was developed for the Soil and Water Management Plan (SWMP) (EMM 2021) for the site. The program commenced in March 2022 and involves quarterly groundwater and annual surface water monitoring (refer Appendix A for monitoring locations). The following sections outline the program details.

2.3.1 Surface water monitoring locations

The surface water monitoring program consists of the following locations (refer Appendix A):

- Oaky Creek upstream of the site;
- Oaky Creek downstream of the site;
- water stored within the quarry pit; and
- water stored within the water management dam.

2.3.2 Groundwater monitoring locations

A groundwater monitoring bore network was installed before quarrying to understand the hydrogeology at the site and to monitor for potential impacts. Three monitoring bores were drilled and installed to a depth of approximately 30 m into the Bringelly Shale with the overlying unconsolidated material cased off. The monitoring bores were sited with one bore up-hydraulic gradient (BSM1) as a background bore (to the quarry footprint) and two bores down-hydraulic gradient of the pit (BSM2 and BSM3). The two down-hydraulic gradient bores are located along the eastern downslope perimeter of the quarry, outside the 40 m vegetated riparian zone associated with the western banks of Oaky Creek.

The BSM2 monitoring bore was reportedly damaged and is receiving rainfall and runoff, resulting in unrepresentative groundwater quality results. The most recent sampling round on 31 August 2022 found that the BSM1 monitoring bore was likely destroyed (refer Section 4.1). Before the commencement of any future monitoring, BSM1 and BSM2 should be rehabilitated or replaced with equivalent monitoring bores.

2.3.3 Analytes

The analytical suite for the surface and groundwater monitoring program are presented in Table 2.1. Physical and chemical stressors (except for total suspended solids) are monitored in the field with a calibrated hand-held water quality meter. All other parameters are analysed at a laboratory accredited by the National Association of Testing Authorities (NATA).

Table 2.1 Surface and groundwater quality analytes

Category	Parameters	Analysis method
Physical and chemical stressors	Dissolved oxygen, electrical conductivity, pH, total dissolved solids	In the field with a calibrated hand-held water quality meter
	Total suspended solids	Analysis undertaken at NATA accredited laboratory
Nutrients	Ammonia, nitrate, nitrite, 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, oil and grease	Analysis undertaken at NATA accredited laboratory

3 Water balance

3.1 Methodology and data

The site water balance model that was developed for the MOD5 approval (EMM 2020) was updated to assess the water management system during the annual review period. The following sections outline the model updates.

3.1.1 GoldSim representation

The water balance model was developed in GoldSim version 12.1. The model was created by representing the water cycle as a series of elements, each containing pre-set rules and data, that were linked together to simulate the interaction of these elements over the annual review period from 1 September 2021 to 31 August 2022.

To undertake the modelling the following simplifications and assumptions were made:

- No pumped water transfers between the water management dam and the quarry pit, dust suppression or irrigation was applied to the model (as advised by Luddenham Operations).
- A simulation timeframe was set from 12 February 2021 to 31 August 2022, as the last known quarry pit water level was observed on 12 February 2021.
- The initial water level in the water management dam was assumed to be 40% full at the beginning of the simulation. This assumption results in no discharges from the water management dam in line with advice from Luddenham Operations.

3.1.2 Data

i Climatic data

Daily rainfall and evaporation data from Bureau of Meteorology's Badgerys Creek AWS weather station (station number 67108) was adopted for the water balance model simulation period.

ii Catchment runoff

Surface runoff was estimated using the Australian Water Balance Model (AWBM). The AWBM was developed by Boughton (2004) and is widely used across Australia to estimate runoff. The hydrological model calculates runoff and baseflow components from rainfall after allowing for relevant losses and storage. The AWBM was incorporated into the GoldSim water balance model for the site.

For each surface type present on site, the AWBM was parameterised to achieve long-term average volumetric runoff coefficients (Cv) based on typical values. The assumed catchment breakdown and Cv applied to each surface type are provided in Table 3.1.

Table 3.1 Catchment runoff parameters

Surface type	Management areas	Area (ha)	Cv
Impervious – high runoff potential	Roofs, weighbridge, sealed roads	0.8	0.9
Disturbed – moderate runoff potential	Unsealed roads, stockpiles	9.7	0.6
Pasture – low runoff potential	Grassed catchments, vegetated bunds	2.8	0.4

iii Groundwater inflows

The predicted quantity of groundwater to be intercepted by the quarry pit was assumed to be a constant 5 m^3/day, based on the original groundwater assessment undertaken for the quarry (Douglas Nicolaisen & Associates 2003).

3.2 Water balance results

The water management system for Luddenham Quarry was modelled from 12 February 2021 to 31 August 2022. The estimated values for each of the inputs and outputs of the water management system for the annual review period (1 September 2021 to 31 August 2022) are provided in Figure 3.1. A summary of the estimated annual inputs and outputs of the water management systems is presented in Table 3.2. Total results have been rounded to 1 ML/year.

As shown in Table 4.1, there was an overall net increase of water predicted to be stored within the quarry pit and water management dam over the annual review period, which is consistent with site observations made at the beginning and end of the period. There were no modelled discharges from the water management dam into Oaky Creek during the annual review period.

Table 3.2 Summary of site water balance

Water management element	Volume (ML/year)
INPUTS	
Groundwater inflows	2
Rainfall	24
Catchment runoff	27
Total Inputs	**53**
OUTPUTS	
Evaporation	23
Total Outputs	**23**
CHANGE IN STORAGE	
Quarry pit	28
Water management dam	2
Total change in storage	30
BALANCE	**0**

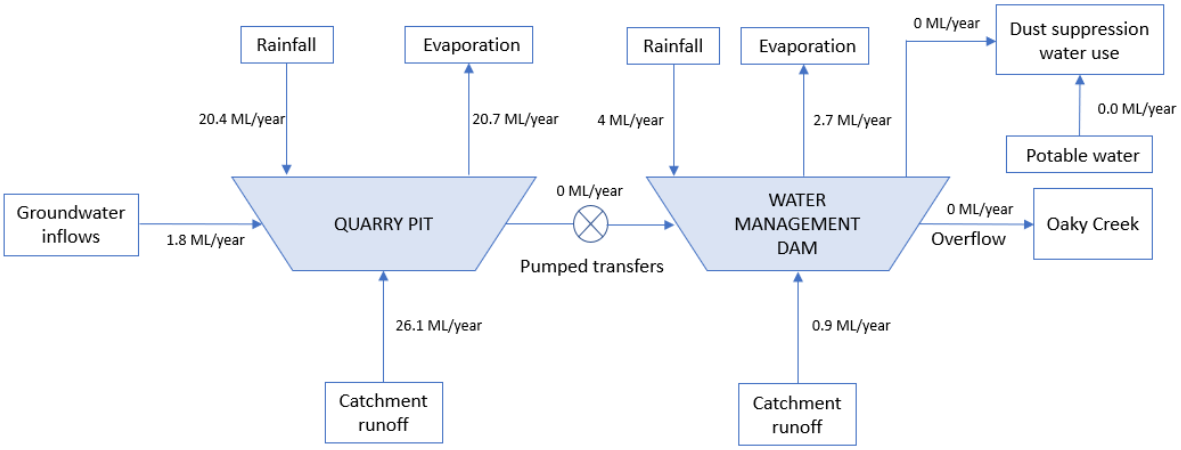

Figure 3.1 Water balance results

4 Water quality monitoring

4.1 Monitoring overview

The following monitoring rounds were undertaken for this annual review period:

- Groundwater monitoring – 11 March 2022. All three groundwater monitoring sites were sampled. However, it was found that BSM2 was damaged and receiving rainfall and runoff ingress, leading to unrepresentative results.
- Surface water and groundwater monitoring – 31 August 2022. Four surface water sites were sampled along with one groundwater monitoring site. BMS2 was noted to remain out of service and BSM1 was not found onsite. It is suspected that BSM1 has been destroyed during the construction of new internal access roads.

4.2 Rainfall context

The Bureau of Meteorology operates a rain gauge at Badgerys Creek (approximately 3 km from the site – Station number: 067108). The preceding one, three and five-day rainfall totals to 9:00 am on 31 August 2022 are presented in Table 4.1.

Table 4.1 Rainfall before 31 August 2022

Gauge location	One-day prior rainfall total (mm)	Three-day prior rainfall total (mm)	Five-day prior rainfall total (mm)
Badgerys Creek AWS	0	0.8	10.6

4.3 Completed monitoring

The following sections describe the completed monitoring and field observations. Key results are discussed in Section 4.6.

4.3.1 Groundwater

Field observations for completed groundwater monitoring is presented in Table 4.2.

Table 4.2 Field observations (groundwater monitoring)

Time of sample	Monitoring point	Site description	Field comments/context
Groundwater sampling locations			
11/03/2022 – 12:24 PM	BSM1	Upgradient bore to measure background contamination levels.	Clear, some suspended solids, no smell.
11/03/2022 – 09:10 AM	BSM2	Bore which is down hydraulic gradient to the quarry pit and BSM1.	Bore requires rehabilitation or replacement – Sample taken, however not considered representative.
11/03/2022 – 11:23 AM	BSM3	Bore which is down hydraulic gradient to the quarry pit and BSM1.	Mostly clear, some suspended solids, no smell.

Table 4.2 Field observations (groundwater monitoring)

Time of sample	Monitoring point	Site description	Field comments/context
Groundwater sampling locations			
31/08/2022	BSM1	Upgradient bore to measure background contamination levels.	Bore not found (suspected to be destroyed) – No sample taken.
31/08/2022	BSM2	Bore which is down hydraulic gradient to the quarry pit and BSM1.	Bore requires rehabilitation or replacement – No sample taken.
31/08/2022 – 10:08 AM	BSM3	Bore which is down hydraulic gradient to the quarry pit and BSM1.	Mostly clear, slight hydrogen sulphide smell.

4.3.2 Surface water

Field observations for completed surface water monitoring is presented in Table 4.3.

Table 4.3 Field observations (surface water)

Time of sample	Monitoring point	Site description	Field comments/context
Surface water management ponds			
31/08/2022 – 12:04 PM	Quarry Pit	Large storage body in the central part of the site. Stored water is used for dust suppression and storage of sediment-laden water.	Relatively clear, green tinge
31/08/2022 – 09:41 AM	Water management dam	Located toward the north-eastern edge of the site. Stored water is used for dust suppression and storage of sediment-laden water. Excess water from this dam discharges into Oaky Creek.	Muddy
31/08/2022 – 12:22 PM	Upstream	Oaky Creek, upstream of the site	Stagnant water, muddy, sediment floating on top
31/08/2022 – 12:49 PM	Downstream	Oaky Creek, downstream of the site	Stagnant water, cloudy and turbid.

4.4 Laboratory analysis

Water samples were transported to a NATA-accredited laboratory (Australian Laboratory Services (ALS) in Smithfield, NSW) for analysis. All laboratory analytes that were not additionally measured in situ (ie pH, electrical conductivity (EC), dissolved oxygen and oxidation-reduction potential) were received by the laboratory within the maximum holding times.

4.5 Quality assurance/quality control

Samples were collected in laboratory-provided sample containers with appropriate preservation. Samples were collected and sent to the laboratory under appropriate chain of custody protocols.

The field QA/QC procedures used to establish accurate, reliable, and precise results included:

- calibration of equipment by the supplier before use;

- keeping samples chilled;
- submitting laboratory samples within holding times; and
- wearing fresh disposable nitrile gloves during sampling at each sampling location.

4.6 Sampling results (annual review period)

Monitoring results for the annual review period are detailed in the following appendices:

- surface water monitoring results are provided in Appendix B; and
- groundwater quality results are provided in Appendix C.

Results were compared to trigger values presented in the SWMP for the site (EMM 2021).

Key results observations from the March 2022 groundwater monitoring event include:

- BSM3 slightly exceeded upgradient bore trigger values in ammonia, total nitrogen, total Kjeldahl nitrogen, nickel and turbidity.
- BSM3 exceeded upgradient bore trigger values in total phosphorus, reactive phosphorus and iron.

Key results observations from the August 2022 groundwater monitoring event include:

- BSM3 exceeded the lower bound trigger values for pH during the August monitoring round.
- Comparison of EC and nutrient trigger values to an upgradient bore was not possible due to the compromised quality of BSM1.

Key results observations from the August 2022 surface water monitoring event include:

- The quarry pit water showed elevated EC, ammonia, oxidised nitrogen, total nitrogen and phosphorus relative to the trigger values. There were slight elevations in aluminium, copper, and zinc concentrations.
- The water management dam had a slightly lower pH compared to trigger values, and elevated oxidised nitrogen concentration, with slightly elevated levels of ammonia and total nitrogen.
- Oaky Creek upstream water quality included slightly elevated EC and elevated levels of ammonia, oxidised nitrogen, total nitrogen and copper concentrations. However, results have the potential to be skewed by low flow conditions.
- Oaky Creek downstream water quality included elevated levels of oxidised nitrogen, total nitrogen and phosphorus. However, results have the potential to be skewed by low flow conditions.

5 Recommendations

The following recommendations are made:

- BSM1 and BSM2 require rehabilitation/replacement to be compliant with approval conditions. Comparison of groundwater quality to an upgradient bore is not possible while BSM1 remains out of service.
- Records of site water management transfers, dust suppression and levels within the quarry pit and water management should be made ahead of the next water balance model review to enable better results estimates.
- During the annual surface water monitoring event, Oaky Creek should be targeted during flow events to allow for more representative results.

6 References

EMM 2020, *Luddenham Quarry – Modification 5: Surface Water Assessment*, prepared by EMM Consulting Pty Limited for Coombes Property Group and KLF Holdings Pty Ltd.

– 2021, *Luddenham Quarry – Soil and Water Management Plan*, prepared by EMM Consulting Pty Limited for Luddenham Operations Pty Ltd.

Appendix A
Water quality monitoring locations

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KEY

- Study area
- Cadastral boundary
- Watercourse
- Water quality monitoring location
- Groundwater monitoring bore

Water quality monitoring locations

Source: EMM (2021); DFSI (2017); GA (2011); ASGC (2006); Nearmap (2020)

0 100 200 m

GDA 1994 MGA Zone 56

N

Luddenham Quarry
Water Management Plan
Figure 4.1

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\\Emmsvr1\emm\Jobs\2019\J190749 - CPG Luddenham Quarry\GIS\02 Maps\Modification Reporting\Surface Water\Water Management\SWM003 WQMonitoringLocations 20210526 02.mxd 26/05/2021

Appendix B
Surface water quality results

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Table B.1 Water quality results – surface water

Group	Parameter	Units	LOR	Trigger value	Baseline data range	Oaky Creek upstream	Oaky Creek downstream	Quarry pit	Water management dam
Field	Temp	°C		–	–	12.8	12.4	16	14.7
	EC	µS/cm		125–2,200	773–5,990	2,272	1,118	3,986	341
	pH	–		6.5–8.5	7.82–8.65	6.57	6.87	8.01	6.16
	Dissolved oxygen (DO)	% sat		85%–110%	–	95.1	70.3	97.1	47.1
	DO	mg/L		–	8–10.5	9.93	7.47	9.47	4.74
	Redox potential	mV		–	–	-190	-185.4	-185.6	-140.2
	Total dissolved solids (TDS)	mg/L		–	398–3,720	1,475	728	2593	222
Nutrients	Ammonia as N	mg/L	0.01	0.02	<0.01–0.1	0.15	0.02	0.06	0.03
	Nitrite + nitrate as N	mg/L	0.01	0.04	<0.01–6.51	8.95	0.29	0.99	1.55
	Total Kjeldahl nitrogen	mg/L	0.1	–	0.2–1.4	2.8	1	2.3	0.5
	Nitrite (as N)	mg/L	0.01	–	<0.01–0.13	0.1	<0.01	<0.01	0.04
	Nitrate (as N)	mg/L	0.01	–	<0.01–6.38	8.85	0.29	0.99	1.51
	Nitrogen (total)	mg/L	0.1	0.5	0.2–7.9	11.8	1.3	3.3	2
	Phosphorus (total)	mg/L	0.01	0.05	<0.01–0.13	0.05	0.11	0.36	<0.01
	Reactive phosphorus (as P)	mg/1	0.01	0.02	<0.01–<0.01	<0.010	<0.010	0.010	<0.010
Metals (dissolved)	Aluminium	mg/L	0.01	0.055	<0.01–0.04	0.030	<0.010	0.080	0.010
	Arsenic	mg/L	0.001	0.013	<0.001–0.001	<0.001	<0.001	<0.001	0.001
	Boron	mg/L	0.05	0.37	<0.05–<0.05	<0.050	<0.050	<0.050	<0.050
	Cadmium	mg/L	0.0001	0.0002	<0.0001–<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
	Chromium	mg/L	0.001	0.001	<0.001–0.0005	<0.001	<0.001	<0.001	<0.001

Table B.1 Water quality results – surface water

Group	Parameter	Units	LOR	Trigger value	Baseline data range	Oaky Creek upstream	Oaky Creek downstream	Quarry pit	Water management dam
	Copper	mg/L	0.001	0.0014	<0.001 - 0.019	0.002	0.003	0.008	0.001
	Iron	mg/L	0.05	0.3	<0.05– <0.05	0.080	<0.05	0.130	<0.05
	Lead	mg/L	0.001	0.0034	<0.001– <0.001	<0.001	<0.001	<0.001	<0.001
	Manganese	mg/L	0.001	1.9	<0.001– 0.059	1.790	0.330	0.015	<0.001
	Nickel	mg/L	0.001	0.011	<0.001– 0.004	0.002	0.001	0.003	<0.001
	Zinc	mg/L	0.005	0.008	<0.005– 0.026	<0.005	0.005	0.009	0.005
Other	Oil and grease	mg/L	5	Above detection	<5	<5	<5	<5	<5
	Total suspended solids (TSS)	mg/L	5	–	–	252	47	11	74
	Total hardness as $CaCO_3$	mg/L	1	–	–	303	154	426	71

Note: Results in red indicate an exceedance of the trigger value.

LOR = limit of reporting.

Appendix C
Groundwater quality results

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C.1 Groundwater quality results – March 2022

Table C.1 Water quality results - Groundwater

Group	Parameter	Units	LOR	Trigger value	Baseline median	BSM1	BSM3
Field	Temp	°C		–	20.5	24.10	19.5
	EC	µS/cm		Comparison with upgradient bore	23,100	25,681	25,332
	pH	–		6.5–8.5	6.7	6.71	6.96
	DO	% sat		–	–	14.40	22.5
	DO	mg/L		–	1.5	1.09	1.89
	Redox potential	mV		–	–	68.80	-88.1
	TDS	mg/L		–	–	16.69	16.46
Nutrients	Ammonia as N	mg/L	0.01	Comparison with upgradient bore		8.02	8.03
	Nitrite + nitrate as N	mg/L	0.01	Comparison with upgradient bore	–	0.28	0.16
	Total Kjeldahl nitrogen	mg/L	0.1	–	–	9.8	10.8
	Nitrite (as N)	mg/L	0.01	–	<0.005	<0.01	<0.01
	Nitrate (as N)	mg/L	0.01	–	0.01	0.28	0.16
	Nitrogen (total)	mg/L	0.1	Comparison with upgradient bore	–	10.1	11.0
	Phosphorus (total)	mg/L	0.01	Comparison with upgradient bore	0.05	0.05	0.28
	Reactive phosphorus (as P)	mg/1	0.01	Comparison with upgradient bore	0.4	<0.01	0.12
Metals (dissolved)	Aluminium	mg/L	0.01	0.055	–	<0.01	<0.01
	Arsenic	mg/L	0.001	0.013	<0.001	<0.001	<0.001
	Boron	mg/L	0.05	0.37	–	<0.05	<0.05
	Cadmium	mg/L	0.0001	0.0002	<0.0001	<0.0001	<0.0001
	Chromium	mg/L	0.001	0.001	0.002	<0.001	<0.001
	Copper	mg/L	0.001	0.0014	<0.001	0.005	<0.001
	Iron	mg/L	0.05	0.3	8.5	<0.05	0.44
	Lead	mg/L	0.001	0.0034	<0.001	<0.001	<0.001
	Manganese	mg/L	0.001	1.9	–	0.36	0.34
	Nickel	mg/L	0.001	0.011	0.006	0.002	0.008
	Zinc	mg/L	0.005	0.008	0.06	0.052	0.011

Table C.1 Water quality results - Groundwater

Group	Parameter	Units	LOR	Trigger value	Baseline median	BSM1	BSM3
Other	Oil and grease	mg/L	5	Above detection	<5	<5	<5
	Turbidity	NTU	0.1	Comparison with upgradient bore	–	32.4	38.4

Note: Results in red indicate an exceedance of the trigger value.

LOR = limit of reporting.

C.2 Groundwater quality results – August 2022 sampling round

Group	Parameter	Units	LOR	Trigger Value	Baseline median	BSM3
Field	Temp	°C		–	20.5	17.7
	EC	µS/cm		Comparison with upgradient bore	23,100	27,929
	pH	–		6.5–8.5	6.7	6.28
	DO	% sat		–	–	39.9
	DO	mg/L		–	1.5	3.42
	Redox potential	mV		–	–	-164.8
	TDS	mg/L		–	–	18,154
Nutrients	Ammonia as N	mg/L	0.01	Comparison with upgradient bore	–	7.25
	Nitrite + nitrate as N	mg/L	0.01	Comparison with upgradient bore	–	<0.01
	Total Kjeldahl nitrogen	mg/L	0.1	–	–	7.6
	Nitrite (as N)	mg/L	0.01	–	<0.005	<0.01
	Nitrate (as N)	mg/L	0.01	–	0.01	<0.01
	Nitrogen (total)	mg/L	0.1	Comparison with upgradient bore	–	7.6
	Phosphorus (total)	mg/L	0.01	Comparison with upgradient bore	0.05	<0.05
	Reactive phosphorus (as P)	mg/1	0.01	Comparison with upgradient bore	0.4	<0.01
Metals (dissolved)	Aluminium	mg/L	0.01	0.055	–	<0.01
	Arsenic	mg/L	0.001	0.013	<0.001	<0.001
	Boron	mg/L	0.05	0.37	–	<0.05
	Cadmium	mg/L	0.0001	0.0002	<0.0001	<0.0001
	Chromium	mg/L	0.001	0.001	0.002	<0.001
	Copper	mg/L	0.001	0.0014	<0.001	0.001
	Iron	mg/L	0.05	0.3	8.5	1.66
	Lead	mg/L	0.001	0.0034	<0.001	<0.001
	Manganese	mg/L	0.001	1.9	–	0.308
	Nickel	mg/L	0.001	0.011	0.006	0.002
	Zinc	mg/L	0.005	0.008	0.06	0.006
Other	Oil and grease	mg/L	5	Above detection	<5	<5
	Total suspended solids	mg/L	5	–	–	57

Note: Results in red indicate an exceedance of the trigger value.

LOR = limit of reporting.

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Appendix 14 - Surface Water Assessment by EMM Consulting

APPENDIX G – SURFACE WATER ASSESSMENT

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Luddenham Quarry Modification Report
DA 315-7-2003 MOD5

Surface Water Assessment

Prepared for Coombes Property Group & KLF Holdings Pty Ltd
August 2020

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Luddenham Quarry - Modification 5

Surface Water Assessment

Report Number

J190749 RP10

Client

Coombes Property Group and KLF Holdings Pty Ltd

Date

6 August 2020

Version

v1 Final

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6 August 2020

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Executive Summary

ES1 Introduction

Coombes Property Group in partnership with KLF Holdings Pty Ltd are seeking to reactivate quarrying operations of an existing clay/shale quarry at 275 Adams Road Luddenham (the site) through a modification of the existing State significant development consent (SSD) DA 317-7-2003. The modification also includes a new stockpiling area, weighbridge and other site infrastructure, as well as other administrative changes. The modification does not seek to increase the quarry life, production rate or the approved area or depth of the quarry footprint.

This Surface Water Assessment has been prepared to support the Modification Report for the reactivation of Luddenham Quarry.

ES2 Existing environment

The site is adjacent to the future Western Sydney Airport. Construction of the airport (including road infrastructure upgrades) has commenced. Commonwealth-owned land which will form part of the airport bounds the eastern and southern boundaries of the site.

The site is located within the Oaky Creek catchment. Oaky Creek forms the eastern boundary of site and has a total contributing catchment area of approximately 382 ha adjacent to the quarry. The creek rises approximately 2 km south of the site and flows generally in a northerly direction. The creek continues downstream of the site for approximately 0.9 km before joining Cosgroves Creek.

The flow regimes of Oaky Creek and downstream watercourses have been extensively modified by land clearing, agriculture, extractive activities and urban and industrial development in the catchment, including the current Western Sydney Airport development.

Water quality monitoring results indicate that water within the water management system during the previous operation of the quarry had similar characteristics to Oaky Creek upstream of the site.

ES3 Proposed water management

The key objectives of the proposed water management system are:

- minimise the use of potable water from the public supply for purposes where non-potable water is acceptable and available;
- maximise the separation of clean and dirty water;
- minimise the risk of discharges from the site; and
- minimise the potential for water quality impacts associated with chemical and hydrocarbon spills.

The key water management strategy adopted across the site is containment and management of potentially sediment-laden runoff from disturbed areas and reuse where feasible. The key features of the water management system include:

- diversion of runoff from undisturbed catchments away from disturbed areas and off site;

- collection of all potentially sediment-laden runoff from disturbed areas of the site within the quarry pit and the Water Management Dam;
- use of captured runoff for dust suppression of unsealed roads and disturbed areas; and
- discharge of excess water from the site via a licensed discharge point to Oaky Creek.

Potable water for the offices, and amenities will be sourced from the Sydney Water potable water supply network. Potable water will also be used for dust suppression activities when demand exceeds the supply from water stored within the Water Management Dam. Wastewater generated by on-site amenities will be discharged to a septic holding tank, which will be pumped out by an approved licensed contractor when required.

ES4 Residual impacts

Discharges will occur due to overflows from the Water Management Dam into Oaky Creek. The dam will receive runoff from a minor catchment as well as pumped transfers from the quarry pit, which will capture the majority of catchment runoff. Reuse of stored runoff for dust suppression of unsealed roads will reduce the volume and frequency of discharges. Discharges will occur most frequently following periods of rainfall, at which time there is expected to be dilution by coincident flows in Oaky Creek.

Water balance modelling results predicted that captured catchment runoff would provide approximately 81% of the demand for dust suppression activities under median (50th percentile) rainfall conditions, reducing the demand from potable water supply and the volume and frequency of discharges off-site. Discharges were predicted by the water balance model to occur over eight days per year with total volume of 4.4 ML/year under median rainfall conditions.

The water quality of discharges from the Water Management Dam into Oaky Creek is expected to have similar characteristics to the water quality within the creek upstream of the site. Occasional discharges from the Water Management Dam are not expected to materially change or degrade the water quality of Oaky Creek.

Flood modelling undertaken as part of the environmental impact statement for the Western Sydney Airport predicted that the disturbed areas of the site would remain above the limit of flooding along Oaky Creek for all events up to and including the probable maximum flood. The Water Management Dam was predicted to be periodically inundated by overflows from Oaky Creek. This would correspond with times of discharge from the Water Management Dam.

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1 Introduction

1.1 Background

CFT No 13 Pty Ltd, a member of Coombes Property Group (CPG), has recently acquired the property at 275 Adams Road, Luddenham NSW (Lot 3 in DP 623799, 'the site') within the Liverpool City Council municipality. The site is host to an existing shale/clay quarry.

CPG owns, develops, and manages a national portfolio of office, retail, entertainment, land, and other assets. The company's business model is to retain long-term ownership and control of all its assets. CPG has the following staged vision to the long-term development of the site:

- Stage 1 Quarry Reactivation: **Solving a problem**. CPG intends to responsibly avoid the sterilisation of the remaining natural resource by completing the extraction of shale which is important to the local construction industry as raw material used by brick manufacturers in Western Sydney. Following the completion of approved extraction activities, the void will be prepared for rehabilitation.

- Stage 2 Advanced Resource Recovery Centre and Quarry Rehabilitation: **A smart way to fill the void**: CPG in partnership with KLF Holdings Pty Ltd (KLF) and in collaboration between the circular economy industry and the material science research sector, intends to establish a technology-led approach to resource recovery, management, and reuse of Western Sydney's construction waste, and repurposing those materials that cannot be recovered for use to rehabilitate the void. This will provide a sustainable and economically viable method of rehabilitating the void for development.

- Stage 3 High Value Employment Generating Development: **Transform the land to deliver high value agribusiness jobs**. CPG intends to develop the rehabilitated site into a sustainable and high-tech agribusiness hub supporting food production, processing, freight transport, warehousing, and distribution, whilst continuing to invest in the resource recovery R&D initiatives. This will deliver the vision of a technology-led agribusiness precinct as part of the Aerotropolis that balances its valuable assets including proximity to the future Western Sydney Airport (WSA) and Outer Sydney Orbital.

This report relates to a modification application relating to the delivery of Stage 1 above.

1.2 Project description

CPG in partnership with KLF are seeking to reactivate quarrying operations of an existing clay/shale quarry at the site through a modification of the existing State significant development (SSD) consent SSD DA 315-7-2003 (the proposed modification). CPG/KLF have no relationship to the previous site owners/operators.

The existing consent has been modified three times (MOD1 to MOD3). A fourth modification application (MOD4) was withdrawn. The consent allows quarrying with a production rate of 300,000 tonnes per annum until 31 December 2024.

The consent includes quarry components that are on Commonwealth-owned land, which was leased by the previous operator, including the site access road, quarry support facilities and stockpiling areas. These quarry components on Commonwealth-owned land are no longer available for use by the quarry.

Figure 1.1 presents the location of the site in the regional context and Figure 1.2 presents the site in its local context.

Quarry reactivation will require an approved modification (MOD5) to SSD DA 317-7-2003. The scope of the proposed modification is described in detail in Chapter 2 of the Proposed Modification Report and is summarised as follows:

- the use of the existing site access road from Adams Road by quarry vehicles;
- new stockpiling area, weighbridge and other site infrastructure within Lot 3 DP 623799;
- removal of activities on Lot 1 DP 838361 (adjacent to the eastern boundary of the site); and
- administrative modification of some other conditions of consent to align with current government policy and/or site conditions (ie reduced development footprint).

While the modification does not seek to increase the approved quarry life, area or depth of the quarry footprint, a recent resource estimation has indicated that the remaining resource in the approved quarry footprint is approximately 2 million tonnes. Based on the currently approved maximum extraction rate of 300,000 tonnes, extraction of clay-shale within the approved footprint could maintain production for approximately seven years from the recommencement of quarrying operations.

1.3 Report objectives

This surface water assessment has been prepared to support the Proposed Modification Report for the reactivation of the site. It characterises the existing environment as relevant to surface water based on a combination of desktop-based assessments and field investigations and documents the ways in which issues relating to surface water have been considered in the design of the proposed modification. This surface water assessment provides commitments to ongoing management and mitigation measures to minimise impacts to surface water and assesses unavoidable residual impacts.

The specific objectives of this surface water assessment are to:

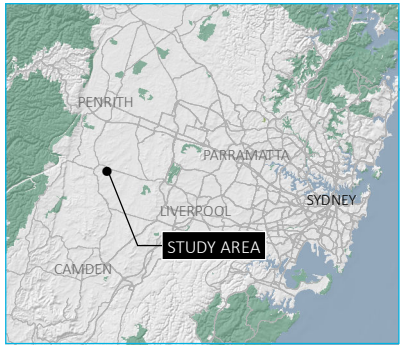
- describe and characterise the existing surface water environment;
- detail the surface water management system at the site;
- identify and assess impacts to surface water as a result of the proposed modification; and
- develop management and mitigation measures to reduce the impacts to surface water resources associated with the proposed modification.

1.4 Report structure

An overview of the structure of the surface water assessment is provided below:

- **Executive summary** provides a brief overview of the proposed modification and the key findings of the assessment.
- **Chapter 1** introduces the key elements of the proposed modification and outlines the objectives of the assessment.
- **Chapter 2** describes the assessment requirements and provides an overview of relevant industry and government guidelines.
- **Chapter 3** provides a characterisation of the existing environment at the site.

- **Chapter 4** describes the proposed water management system.
- **Chapter 5** provides the results of site water balance modelling.
- **Chapter 6** assesses the residual impacts of the proposed modification on surface water resources.
- **Chapter 7** details proposed monitoring, inspection and maintenance arrangements.
- **Chapter 8** addresses water licensing requirements.
- **Chapter 9** provides a summary of the key findings of the assessment.



KEY

- Study area
- Western Sydney Airport
- Major road
- Minor road
- Vehicular track
- Watercourse/drainage line
- NPWS reserve (see inset)
- State forest (see inset)

Source: EMM (2020); DFSI (2017); ASGC (2006); Nearmap (2020)

0 0.5 1 km

GDA 1994 MGA Zone 56

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Site locality

Luddenham Quarry - Modification 5
Surface Water Assessment
Figure 1.1

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KEY

- Study area
- Cadastral boundary

Proposed site modifications

- Approved extraction footprint
- Existing noise bunds
- Existing stockpiling area
- Extended stockpiling area
- Internal road
- Site entry infrastructure (incl. offices, amenities, weighbridge)
- Equipment laydown area

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

0 50 100 m

GDA 1994 MGA Zone 56

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Proposed modification

Luddenham Quarry - Modification 5
Surface Water Assessment
Figure 1.2

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2 Assessment framework

2.1 Relevant legislation

2.1.1 *Protection of the Environment Operations Act 1997*

The NSW *Protection of the Environment Operations Act 1997* (POEO Act) is administered by the NSW Environment Protection Authority (EPA), which is the primary environmental regulator for NSW. Under the POEO Act, an environment protection licence (EPL) is required for 'scheduled activities', generally activities with potentially significant environmental impacts. Licence conditions may relate to pollution prevention and monitoring and can control the air, noise, water and waste impacts of an activity.

The quarry is a scheduled premise covered by EPL 12863, which has been suspended. Consultation with the EPA has commenced to determine whether reactivation and subsequent variation of this EPL or application for a new EPL is appropriate.

2.1.2 *Water Management Act 2000*

The NSW *Water Management Act 2000* (WM Act) is based on the principles of ecologically sustainable development and the need to share and manage water resources for future generations. The WM Act recognises that water management decisions must consider economic, environmental, social, cultural and heritage factors. It recognises that sustainable and efficient use of water delivers economic and social benefits to the state of NSW. The WM Act provides for water sharing between different water users, including environmental, basic landholder rights and licence holders. The licensing provisions of the WM Act 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 WSPs relevant to the site are:

- *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011* – the Upper South Creek Management Zone within the Hawkesbury and Lower Nepean Rivers Water Source applies to the surface water in the vicinity of the site; and
- *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011* – the Sydney Basin Central Groundwater Source applies to groundwater in the vicinity of the site.

A 40 m buffer zone along the eastern boundary of Oaky Creek will be maintained. No works are proposed within the buffer, which forms the waterfront land of the creek, as part of the modification.

2.2 Local planning instruments

The Liverpool Local Environment Plan 2008 and Development Control Plan 2008 (DCP) guide planning decisions through zoning and development controls, which include considerations for development on flood prone land. The DCP also provides design guidance for stormwater management and erosion and sediment control. These local planning instruments have been considered in the preparation of this surface water assessment.

2.3 Relevant guidelines

2.3.1 Erosion and sediment control guidelines

Managing Urban Stormwater: Soils and Construction – Volume 1 (Landcom 2004) outlines the basic principles for the design, construction and implementation of sediment and erosion control measures to improve stormwater management and mitigate the impacts of land disturbance activities on soils and receiving waters.

Additional guidelines on specific aspects of development and the application of erosion and sediment controls are also available. *Managing Urban Stormwater: Soils and Construction – Volume 2E Mines and Quarries* (DECC 2008) provides specific guidelines, principles and minimum design standards for good management practice in erosion and sediment control during the construction and operation of quarries.

2.3.2 NSW water quality and river flow objectives

The *NSW Water Quality and River Flow Objectives* (DECCW 2006) provides agreed environmental values and long-term targets for water quality and river flow in each catchment in NSW. The objectives are intended to be considered in assessing and managing the potential impacts of activities associated with waterways.

Water quality objectives have been agreed for fresh and estuarine surface waters and are consistent with the national framework for assessing water quality provided in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG 2018). River flow objectives are the agreed high-level goals for surface water flow management that identify the key elements of the flow regime that protect river health and water quality for ecosystems and human uses.

The site is located within the Hawkesbury-Nepean catchment. Although there are no specified objectives for this catchment, the typical water quality and river flow objectives for uncontrolled streams in other catchments in NSW are provided in Table 2.1 for reference.

Table 2.1 Water quality and river flow objectives

Environmental value	Objective	Application to proposed modification
Water quality objectives		
Aquatic ecosystems	Maintaining or improving the ecological condition of water bodies and their riparian zones over the long term.	There are aquatic ecosystems downstream of the site within Oaky Creek. The protection of aquatic ecosystems is the primary water quality objective to be met.
Visual amenity	Aesthetic qualities of waters.	There are no public views or access to Oaky Creek adjacent to the site or immediate downstream areas.
Secondary contact recreation	Maintaining or improving water quality for activities such as boating or wading, where there is a low probability of water being swallowed.	There is no public access to Oaky Creek adjacent to the site or immediate downstream areas.
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 no public access to Oaky Creek adjacent to the site or immediate downstream areas.
Livestock water supply	Protecting water quality to maximise the production of healthy livestock.	Some downstream users may extract water from Oaky Creek or downstream watercourses for agricultural purposes.

Table 2.1 Water quality and river flow objectives

Environmental value	Objective	Application to proposed modification
Irrigation water supply	Protecting the quality of waters applied to crops or pasture.	Some downstream users may extract water from Oaky Creek or downstream watercourses for agricultural purposes.
Homestead water supply	Protecting water quality for domestic use in homesteads, including drinking, cooking and bathing.	It is unlikely that any downstream users extract from Oaky Creek or downstream watercourses for homestead water supply.
Drinking water at point of supply – disinfection only	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 objectives also apply to sub-catchments or groundwater used for town water supplies.	Town water supply in the region is provided by Sydney Water. The site is not located within Sydney's drinking water catchment. Oaky Creek drains to the Hawkesbury-Nepean system downstream of Warragamba Dam. No water is extracted from downstream of the site for town water supply.
Drinking water at point of supply – clarification and disinfection		
Drinking water at point of supply – groundwater		
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 Oaky Creek or downstream watercourses. However, the trigger values for aquatic foods apply to aquaculture not recreational fishing. The required level of protection will be provided by meeting the objective for aquatic ecosystems.
River flow objectives		
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 Oaky Creek and downstream watercourses have been extensively modified by land clearing, agriculture, extractive activities and urban and industrial development in the catchment, including the current Western Sydney Airport development. Discharges from the site will enter Oaky Creek. Hence, site operations have the potential to impact existing flow regimes in Oaky Creek.
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.	No instream structures are proposed.

2.3.3 Australian and New Zealand guidelines for fresh and marine water quality

The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG 2018) provides guidance on monitoring, assessing and managing ambient water quality in a wide range of water resource types and according to specified environmental values, such as aquatic ecosystems, primary industries, recreation and drinking water. The guidelines provide a framework for:

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

Environmental values associated with the waterways and water sources surrounding the site include primary industry, aquatic ecosystems, recreational users, irrigation and stock watering. Water quality monitoring results have been compared to default guideline values (DGVs) recommended by ANZG (2018) for the protection of aquatic ecosystems. Oaky Creek is considered to be a 'slightly to moderately disturbed' system, due to the impact of disturbance in the catchment associated with past and ongoing agriculture and urban development, including the current development of Western Sydney Airport. The creek is also classified as a 'lowland river' as the elevation of the site is less than 150 m.

DGVs provided by ANZG (2018) for toxicants (including metals) are usually derived from ecotoxicity testing using a species sensitivity distribution of chronic toxicity data. The reliability of the DGVs is classified as very high, high, moderate, low, very low or unknown. Classification is primarily based on the number and type (chronic, acute or a mix of both) of data used to derive the guideline value, as well as the fit of the statistical model (species sensitivity distribution) to the data.

DGVs are provided by ANZG (2018) for 99%, 95%, 90% and 80% species protection. For most toxicants, the level of species protection assigned for slightly to moderately disturbed systems is the 95% species protection DGV. For parameters that potentially bioaccumulate, DGVs for 99% species protection are recommended by ANZG (2018) for slightly to moderately disturbed systems.

DGVs for slightly to moderately disturbed ecosystems recommended by ANZG (2018) are presented in Table 2.2. DGVs for physical and chemical stressors and nutrients provided by ANZECC (2000) have been used as these parameters have not yet been updated by ANZG (2018). DGVs for metals are based on the 95% species protection value recommended for slightly to moderately disturbed systems, unless otherwise noted.

Table 2.2 Default guideline values for the assessment of water quality

Parameter	Units	DGV	Additional information
Physical and chemical stressors			
Electrical conductivity	µS/cm	125–2,200	DGV for lowland river in south-east Australia (Table 3.3.3; ANZECC 2000)
pH	pH units	6.5–8.5	DGV for lowland river in south-east Australia (Table 3.3.2; ANZECC 2000)
Nutrients			
Reactive phosphorus	mg/L	0.02	DGV for lowland river in south-east Australia (Table 3.3.2; ANZECC 2000)
Total phosphorus	mg/L	0.05	DGV for lowland river in south-east Australia (Table 3.3.2; ANZECC 2000)
Dissolved metals			
Arsenic	mg/L	0.013	Moderate reliability DGV for As(V)

Table 2.2 Default guideline values for the assessment of water quality

Parameter	Units	DGV	Additional information
Cadmium	mg/L	0.0002	Very high reliability DGV
Chromium	mg/L	0.001	Very high reliability DGV for Cr(VI)
Copper	mg/L	0.0014	High reliability DGV
Lead	mg/L	0.0034	Moderate reliability DGV
Mercury	mg/L	0.00006	Moderate reliability DGV for 99% species protection level recommended for slightly to moderately disturbed systems due to the potential for bioaccumulation
Nickel	mg/L	0.011	Low reliability DGV
Zinc	mg/L	0.008	Very high reliability DGV

2.3.4 Bunding and spill management guidelines

The following NSW Government guidelines detail best practice storage, handling and spill management procedures for liquid chemicals:

- *Liquid Chemical Storage, Handling and Spill Management: Review of Best Practice Regulation* (DEC 2005); and
- *Storing and Handling Liquids: Environmental Protection: Participant's Manual* (DECC 2007).

2.4 Relevant studies

2.4.1 Updated South Creek Flood Study

The *Updated South Creek Flood Study* (WorleyParsons 2015) was prepared for Penrith, Liverpool, Fairfield and Blacktown City Councils and is used to inform floodplain management within the South Creek catchment. The flood study involved the development of hydrologic and hydraulic models to define flood behaviour of South Creek and its tributaries.

Although Luddenham Quarry is located within the South Creek catchment, the flood study did not model the site in sufficient detail for the purposes of this assessment. In addition, the upstream portions of the Oaky Creek catchment are currently undergoing earthworks related to the construction of the Western Sydney Airport, changing the local hydrology in this area.

2.4.2 Western Sydney Airport assessments

As part of the environmental impact statement (EIS) for the Western Sydney Airport, which is adjacent to the site, assessment of the impacts on surface water hydrology, flooding and geomorphology (GHD 2016) were undertaken. Relevant outcomes from this study have been included in this assessment where appropriate (refer Section 4.8).

3 Existing environment

3.1 Land use

The site is adjacent to the future Western Sydney Airport. Construction of the airport (including road infrastructure upgrades) has commenced. Commonwealth-owned land which will form part of the airport bounds the eastern and southern boundaries of the site.

Other surrounding land uses include:

- agricultural – grazing and intensive agriculture (eg poultry);
- rural residences – the closest occupied residence is approximately 70 m north of the site access road; and
- Hubertus Country Club and pistol range – immediately west of the site.

3.2 Topography

The site elevation is approximately 80 m Australian Height Datum (m AHD) and predominantly flat, with gently sloping relief falling generally from the south-west to the north-east. There is an approximately 10 m fall across the 500 m distance between the western and eastern site boundaries.

3.3 Climate

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 consist of interpolated estimates based on historically observed data from Bureau of Meteorology (BOM) weather stations. For this assessment, SILO data was obtained for the Badgerys Creek McMasters F.Stn station (BOM station number 67068), which is located 1 km north-east of the site.

Table 3.1 presents key information and statistical data from the historical SILO patched point data between 1889 and 2019. Figure 3.1 presents the average daily rainfall and evaporation rates determined from the SILO data.

Table 3.1 Key climate statistics

Key annual statistic	Units	Rainfall	Evaporation
Average	mm/year	756	1,470
Minimum	mm/year	330	1,169
5th percentile	mm/year	424	1,340
10th percentile	mm/year	477	1,400
Median	mm/year	737	1,472
90th percentile	mm/year	1,044	1,522
95th percentile	mm/year	1,164	1,581
Maximum	mm/year	1,695	1,746

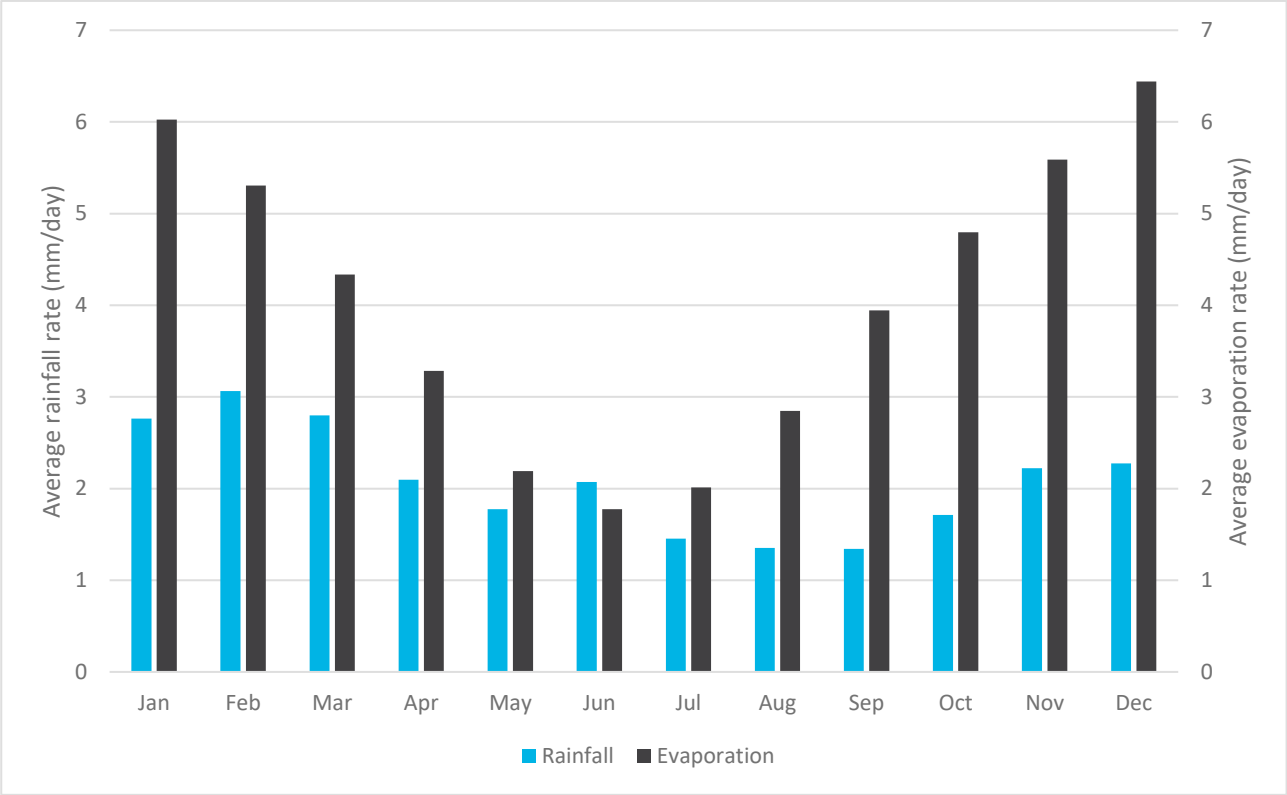

Figure 3.1 Average daily rainfall and evaporation rates

3.4 Geology

The Luddenham area lies within the central part of the Sydney Basin, which is comprised of several sedimentary strata including the thick coal seams in the greater region and extensive and continuous Hawkesbury Sandstone. These sandy sediments and the regional depression of the basin allowed the formation of shaly and silty strata (Wianamatta group) which includes the Ashfield and Bringelly Shales that are several hundred metres thick and form the bulk of the mineral resource of the site.

3.5 Hydrology

The site is located within the Oaky Creek catchment. Oaky Creek forms the eastern boundary of site and has a total contributing catchment area of approximately 382 ha. The creek rises approximately 2 km south of the site and flows generally in a northerly direction. The creek continues downstream of the site for approximately 0.9 km before joining Cosgroves Creek. Downstream of the confluence with Oaky Creek, Cosgroves Creek flows for approximately 7 km before its confluence with South Creek, which ultimately contributes to the Hawkesbury River and Broken Bay. The total catchment area of Cosgroves Creek at the confluence with South Creek is approximately 2,163 ha.

Watercourses and associated stream orders in the vicinity of Luddenham Quarry are presented in Figure 3.2.

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

GDA 1994 MGA Zone 56

Watercourses

Luddenham Quarry - Modification 5
Surface Water Assessment
Figure 3.2

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3.6 Water quality

3.6.1 Sampling program

Water quality monitoring at the site has historically been undertaken at the following locations, as shown in Figure 3.3:

- Oaky Creek upstream of the site;
- Oaky Creek downstream of the site;
- water stored within the quarry pit; and
- water stored within water management dams (the dams previously referred to as Sediment Dam 1 and Sediment Dam 2).

Sampling results are available between 2010 and 2018, during the previous operation of the quarry.

3.6.2 Monitoring results

A summary of median water quality results is presented in Table 3.2. All monitoring data is presented in Appendix A. Where an analytical result was below the detection limit, then the numerical value of half the detection limit was used in the analysis, unless otherwise specified. Results that exceed the relevant DGV (refer Table 2.2) are highlighted in bold.

A limited number of monitoring results were available for the majority of parameters, with limited information on the environmental conditions or context at the time of sampling such as methodology and flow within Oaky Creek. Whilst the extent of the water quality data available is insufficient to enable specific conclusions to be formed, it is considered to be able to provide a reasonable indication of ambient water quality during quarrying operations on site.

Key results are summarised as follows:

- Salinity (as indicated by electrical conductivity) was elevated on site and for Oaky Creek upstream of the quarry compared to the DGVs. This is typical for inland watercourses in NSW that have catchments dominated by agricultural land uses.
- pH within Oaky Creek, both upstream and downstream of the quarry, was within the DGV range. Water stored within the quarry pit and water management dams was elevated compared to Oaky Creek.
- Total suspended solids were generally reported to be low (typically below 50 mg/L), however elevated concentrations were recorded following significant rainfall events, particularly within the water management dams and at the Oaky Creek upstream site.
- Nutrient levels were generally low, with the exception of phosphorus concentrations at the Oaky Creek upstream site that exceeded the DGVs.
- Metals were generally found to be below DGVs for all sites, with slight exceedances of the relevant DGVs for dissolved iron at the Oaky Creek upstream site; dissolved nickel and zinc within the quarry pit; and copper and zinc within the water management dams.

KEY

- Study area
- Cadastral boundary
- Watercourse
- Water quality monitoring location

Water quality monitoring locations

Luddenham Quarry - Modification 5
Surface Water Assessment
Figure 3.3

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

0 100 200 m

GDA 1994 MGA Zone 56

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Table 3.2 Summary of surface water quality monitoring results

Parameter	Units	Upstream		Downstream		Quarry pit		Water management dams	
		Count	Median	Count	Median	Count	Median	Count	Median
Physical and chemical stressors									
Dissolved oxygen	mg/L	1	3.9	1	6.8	4	11.5	4	12.4
Electrical conductivity	µS/cm	1	**11,000**	2	1,870	4	**14,405**	6	**5,545**
pH	pH units	26	7.0	26	6.9	9	**8.6**	22	8.5
Total dissolved solids	mg/L	1	6,720	1	1,420	4	9,120	4	2,400
Total suspended solids	mg/L	26	37	26	14	7	6	21	15
Major ions									
Calcium	mg/L	1	53	1	36	4	97	4	51
Chloride	mg/L	1	3,500	1	670	4	4,700	4	2,400
Magnesium	mg/L	1	280	1	69	4	395	4	210
Potassium	mg/L	1	16	1	14	4	49	4	34
Sodium	mg/L	1	2,600	1	480	4	3,300	4	1,750
Sulfate	mg/L	1	130	1	83	4	495	4	310
Total alkalinity	mg/L	1	440	1	130	4	375	4	240
Nutrients									
Nitrate	mg/L	1	<0.005	1	<0.005	4	6.2	4	0.75
Nitrite	mg/L	1	<0.005	1	<0.005	4	0.098	4	0.049
Total Kjeldahl nitrogen	mg/L	1	3.7	1	0.6	4	0.5	4	1.3
Reactive phosphorus	mg/L	1	**0.174**	1	0.02	4	0.007	4	0.008
Total phosphorus	mg/L	1	**0.4**	1	<0.05	4	0.025	4	0.025
Dissolved metals									
Arsenic	mg/L	1	0.002	1	<0.001	4	0.003	4	0.0005

Table 3.2 Summary of surface water quality monitoring results

Parameter	Units	Upstream		Downstream		Quarry pit		Water management dams	
		Count	Median	Count	Median	Count	Median	Count	Median
Cadmium	mg/L	1	<0.0001	1	<0.0001	4	0.00005	4	0.00005
Chromium	mg/L	1	0.001	1	<0.001	4	0.0005	4	0.0005
Copper	mg/L	1	<0.001	1	<0.001	4	**0.002**	4	**0.002**
Iron	mg/L	1	**2.2**	1	0.2	4	0.005	4	0.01
Lead	mg/L	1	<0.001	1	<0.001	4	0.0005	4	0.0005
Mercury	mg/L	1	<0.00005	1	<0.00005	4	0.000025	4	0.000025
Nickel	mg/L	1	0.002	1	0.002	4	**0.012**	4	0.002
Zinc	mg/L	1	0.002	1	0.002	4	0.007	4	0.003
Total metals									
Iron	mg/L	1	5	1	0.6	4	0.04	4	0.1
Other parameters									
Biochemical oxygen demand	mg/L	25	5	25	2	5	2	18	5
Oil and grease	mg/L	25	2.5	25	2.5	6	2.5	19	2.5

4 Water management

4.1 Approved operations

Approved operations of the quarry include the extraction of shale and clay, followed by direct dispatching of product to the trucks and storing off-site for the purpose of brick making. Stockpiling within the approved quarry footprint and stockpile area (Lot 3 DP 623799) and within Commonwealth land (portions of Lot 1 DP 838361) was approved as part of MOD 3.

The Commonwealth land was leased by the previous operator. Operational components located on Commonwealth land included site access off Elizabeth Drive, quarry support facilities and stockpiling areas. The quarry components on Commonwealth land are no longer available for use by the quarry.

Approved quarry operations are below natural ground level, with added 3 m high noise attenuation bunds to the north and west of the quarry void. The approved quarrying method involves the use of rubber tyred scrapers for most of the winning and stockpiling, as per the original consent. A bulldozer is approved to rip some of the harder product and to push the scrapers. Rubber tyred loaders are approved for loading from stockpiles onto road transporters. Shale and clay were stockpiled separately and loaded out for sale using an excavator or front-end loader.

A 40 m buffer zone has been maintained along the eastern boundary of Oaky Creek. A lower and narrower 1 m bund wall was approved along the quarry's edge on the eastern side.

The consent also includes approval of bunded fuel storage, plant nursery, weighbridge, bridge, conveyor and hoppers.

The original EIS (Douglas Nicolaisen & Associates 2003) outlines that ongoing rehabilitation will occur during the life of the quarry. This will include placing and levelling of quarry spoils, covering them with topsoil and planting of grasses. However, ultimate rehabilitation will depend largely on the final land use designation. Small scale non-composting activities were approved on site for the implementation of rehabilitation, vegetation and landscaping plans. Composting activities were carried out on Commonwealth land (Lot 1 DP 838361).

4.2 Local hydrology

The site and immediate surrounds are comprised of four main sub-catchments:

- A well vegetated grassed paddock of approximately 2.8 ha is situated to the north of the quarry. This clean water catchment area drains to a depression in the north-east of the site adjacent to the internal road, where it is diverted via an open drain and piped drainage system to the northern boundary of the site at Oaky Creek, downstream of the Water Management Dam. Photograph 4.1 shows the grassed paddock and downstream depression.

- A portion of the unsealed internal road along the northern boundary and adjacent to the Water Management Dam drains to the dam. Including the Water Management Dam surrounds, this totals an area of 0.8 ha. Photograph 4.2 shows the Water Management Dam and adjacent internal road.

- Oaky Creek is an ephemeral watercourse bordering the eastern boundary of the site. The creek is characterised by a meandering shallow channel surrounded by dense vegetation, debris and scoured pools. At the north-eastern corner of the site, Oaky Creek drains to an online dammed storage, assumed to be built 50 to 70 years ago. Although partially within the site boundary, this online storage is not part of the site's water management system. Photograph 4.3 and Photograph 4.4 show the Oaky Creek headwaters adjacent the site and the downstream storage respectively.

- The remaining site areas including the existing and proposed stockpiling areas, proposed equipment laydown area, site entry infrastructure and remaining internal roads, extraction footprint and a minor portion of a neighbouring properties grassed area all drain to the quarry pit. These areas are predominantly disturbed catchment, totalling 12.9 ha. Photograph 4.5 shows the quarry pit and disturbed area surrounds.

Photograph 4.1 Diverted clean water catchment north of the quarry pit

Photograph 4.2 Water Management Dam and adjacent haul road

Photograph 4.3 Oaky Creek adjacent to the quarry pit

Photograph 4.4 Oaky Creek looking downstream at online storage

Photograph 4.5 Quarry pit and surrounding disturbed areas

4.3 Water management strategy

Table 4.1 summarises the water management objectives and approach that have been applied to establish the proposed water management system.

Table 4.1 Water management objectives and approach

Water management objective		Approach
1	Minimise the use of potable water from the public supply for purposes where non-potable water is acceptable and available.	• Water captured in the quarry pit and Water Management Dam is used preferentially for dust suppression over potable water.
2	Maximise the separation of clean and dirty water.	• Diversion channels and drains divert clean water around disturbed areas on site as far as reasonable and feasible. • All sediment-laden runoff is directed into the internal water management system.
3	Minimise the risk of discharges from the site.	• Erosion and sediment control structures sized and maintained generally in accordance with Landcom (2004) and DECC (2008). • Water captured in the quarry pit and Water Management Dam is used for dust suppression on site.
4	Minimise the potential for water quality impacts associated with chemical and hydrocarbon spills.	• Chemical and hydrocarbon products will be stored in bunded areas in accordance with relevant Australian Standard AS1940:2004.

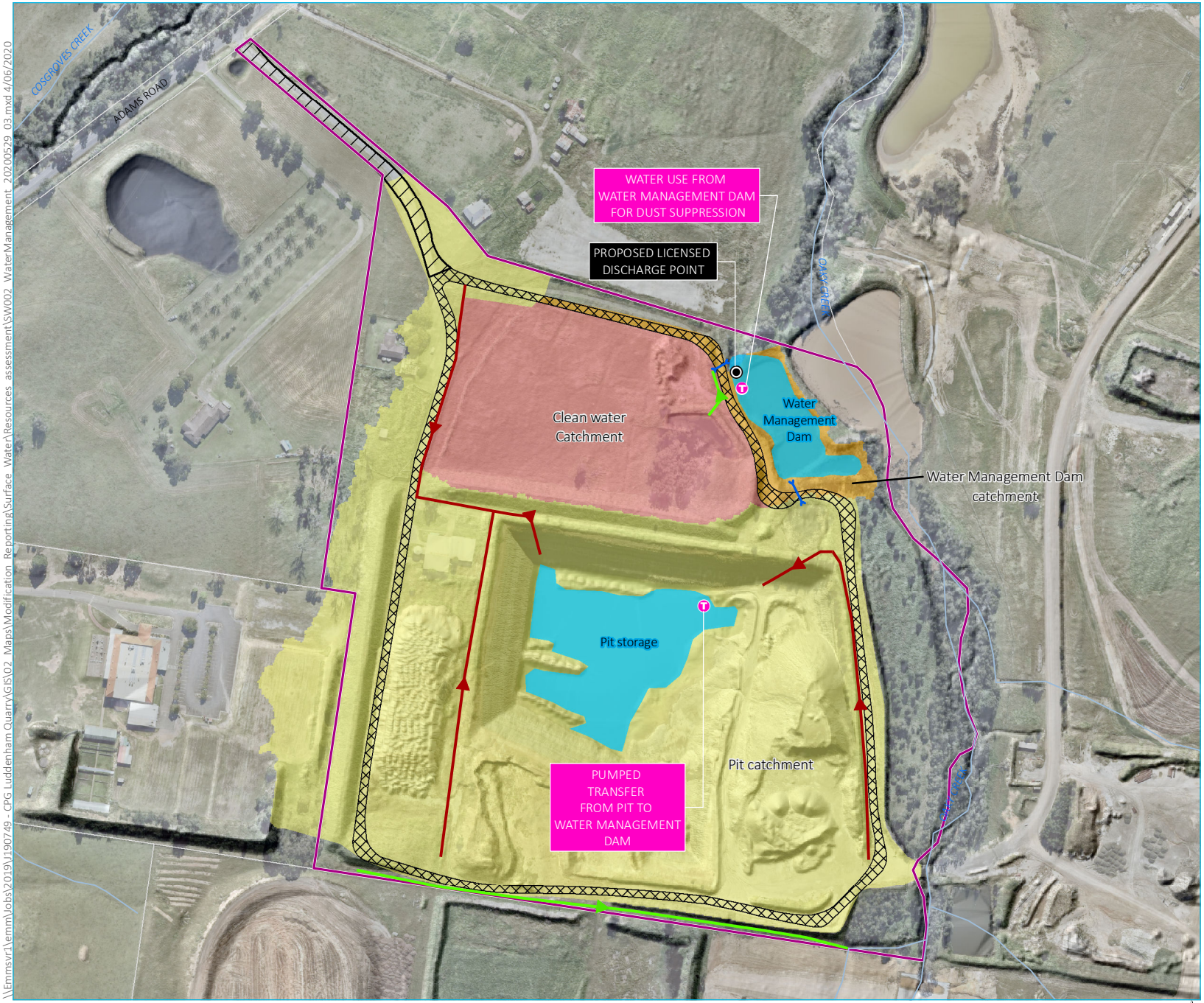
The proposed water management system for the site is presented in Figure 4.1. The key water management strategy adopted across the site is containment and management of potentially sediment-laden runoff from disturbed areas and reuse where feasible. The key features of the water management system include:

- diversion of runoff from undisturbed catchments away from disturbed areas and off site;
- collection of all potentially sediment-laden runoff from disturbed areas of the site within the quarry pit and the Water Management Dam;
- use of captured runoff for dust suppression of unsealed roads and disturbed areas; and
- discharge of excess water from the site via a licensed discharge point (LDP) to Oaky Creek.

4.4 Drainage network

The following diversion structures are in place at the site and will be maintained as part of the modification to divert clean runoff around disturbed areas and direct sediment-laden runoff to the water management storages:

- bunds placed around the southern and western quarry boundaries which incorporate a diversion drain to divert clean water around the site;
- quarry walls which act as diversion drains to direct runoff into the quarry pit;
- bund placed on the eastern side of the quarry which incorporates a drain to divert runoff from this area into the quarry pit; and
- drains have also been constructed on the northern and eastern sides of the quarry extraction area to prevent runoff from the quarry leaving the extraction area.



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

Proposed water management system layout

Luddenham Quarry - Modification 5
Surface Water Assessment
Figure 4.1

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4.5 Water management storages

The water management strategy for the reactivation of quarrying activities, as discussed in Section 4.3, involves the active management of water captured in the quarry pit and the Water Management Dam. This dam was previously referred to as Sediment Dam 2 and is estimated to have a maximum capacity of 4 ML.

The majority of catchment runoff is directed to the quarry pit, which will then be directed to the Water Management Dam via a pumped transfer to minimise the accumulation of water within the quarry pit. Water stored within the Water Management Dam will be used to supply dust suppression of unsealed roads and disturbed areas, with excess water discharged from the site to Oaky Creek. An oil and water separator and sediment trap will be installed immediately upstream of the Water Management Dam to assist in removing oil and grease and sediment from runoff.

Table 4.2 presents a summary of the key water management storage details. The storage volumes are compared to minimum design volumes that were calculated for a Type D/F storage using the methods recommended in *Managing Urban Stormwater: Soils and Construction – Volume 1* (Landcom 2004). The sediment storage zone was calculated using the Revised Universal Soil Loss Equation (RUSLE). The following parameters were used to determine the minimum design volumes:

- the 90th percentile, five-day rainfall depth of 48.8 mm for Wallacia;
- volumetric runoff coefficient (Cv) of 0.79 for soil hydrologic group D soils with high runoff potential (Table F2; Landcom 2004);
- rainfall erosivity factor (R-factor) of 2500 based on the site location and the rainfall erosivity maps presented in Appendix B of *Managing Urban Stormwater: Soils and Construction – Volume 1* (Landcom 2004);
- soil erodibility factor (K-factor) of 0.05 based on mapping in the eSPADE database (OEH 2016);
- slope length/gradient factor (LS-factor) (Table A1; Landcom 2004):
    - 5.32 for the quarry pit assuming average slope gradient of 30% over 30 m; and
    - 0.78 for the Water Management Dam catchment assuming average slope gradient of 3.5% over 80 m;
- erosion control practice factor (P-factor) of 1.3 for compacted and smooth surfaces (Table A2; Landcom 2004); and
- ground cover and management factor (C-factor) of 1 for recently disturbed soil with no grass cover (Figure A5; Landcom 2004).

As indicated in Table 4.2, the existing water management storage for the site within the Water Management Dam and the quarry pit exceeds the minimum volume required to manage the 90th percentile, five-day rainfall depth.

Table 4.2 Water management storage details

Element	Water Management Dam	Quarry pit
Estimated capacity	4 ML	165 ML[1]
Contributing catchment	0.4 ha	12.9 ha
Settling zone volume required	154 m^3	4,973 m^3

Table 4.2 Water management storage details

Element	Water Management Dam	Quarry pit
Sediment zone volume required	7 m^3	1,458 m^3
Total volume required	161 m^3	6,431 m^3
	0.2 ML	6.4 ML

[1] Based on a nominal minimum volume considered practical within the quarry pit area; however, the volume will vary with the location of stockpiles and operation of the open pit area.

There is a sediment dam (previously referred to as Sediment Dam 1) located to the south of the Water Management Dam. This dam has not been actively maintained for at least 18 months while the quarry has been inactive and is overgrown with vegetation, impeding the capacity of the dam. This dam is planned to be decommissioned in preparation for the future development at the site (yet to be approved) and as such does not form part of the proposed water management system for the quarry.

4.6 Potable water and wastewater

Potable water for the offices, equipment laydown area and amenities will be sourced from the Sydney Water potable water supply network. Prior to the site being connected to mains water, potable water will be supplied by tanker if required. Potable water will also be used for dust suppression activities when demand exceeds the supply from water stored within the Water Management Dam. Wastewater generated by on-site amenities will be discharged to a septic holding tank, which will be pumped out by an approved licensed contractor when required.

4.7 Chemical and hydrocarbon storage

Fuel and any hazardous chemicals will be stored in bunded facilities in accordance with NSW government guidelines (refer Section 2.3.4) and Australian Standard AS1940:2004.

4.8 Flooding

4.8.1 Previous studies

As part of the EIS for the Western Sydney Airport, assessment of the impacts on surface water hydrology, flooding and geomorphology (GHD 2016) was undertaken. A flood model was prepared using MIKE21 software, informed by DRAINS and XPRAFTS hydrology models.

Results of the flooding assessment have been utilised to inform this assessment.

4.8.2 Proposed assessment conditions

The Western Sydney Airport development is broken into two stages, the Stage 1 development and the long-term development. Construction of the Stage 1 development commenced in late 2018, involving significant earthworks to level the central and northern portions of the airport site (known as the construction impact zone) for the runway and related Stage 1 infrastructure. The construction impact zone is situated across the Oaky Creek headwaters, south of the Luddenham Quarry site. Figure 4.2 shows the Stage 1 development layout.

The Stage 1 development is expected to service demand for annual passenger movements up until 2030. Therefore, the Stage 1 development flood results (GHD 2016) are considered to provide a reasonable estimate of flooding

conditions likely to be experienced along Oaky Creek for the remaining life of the quarry, through to the end of 2024.

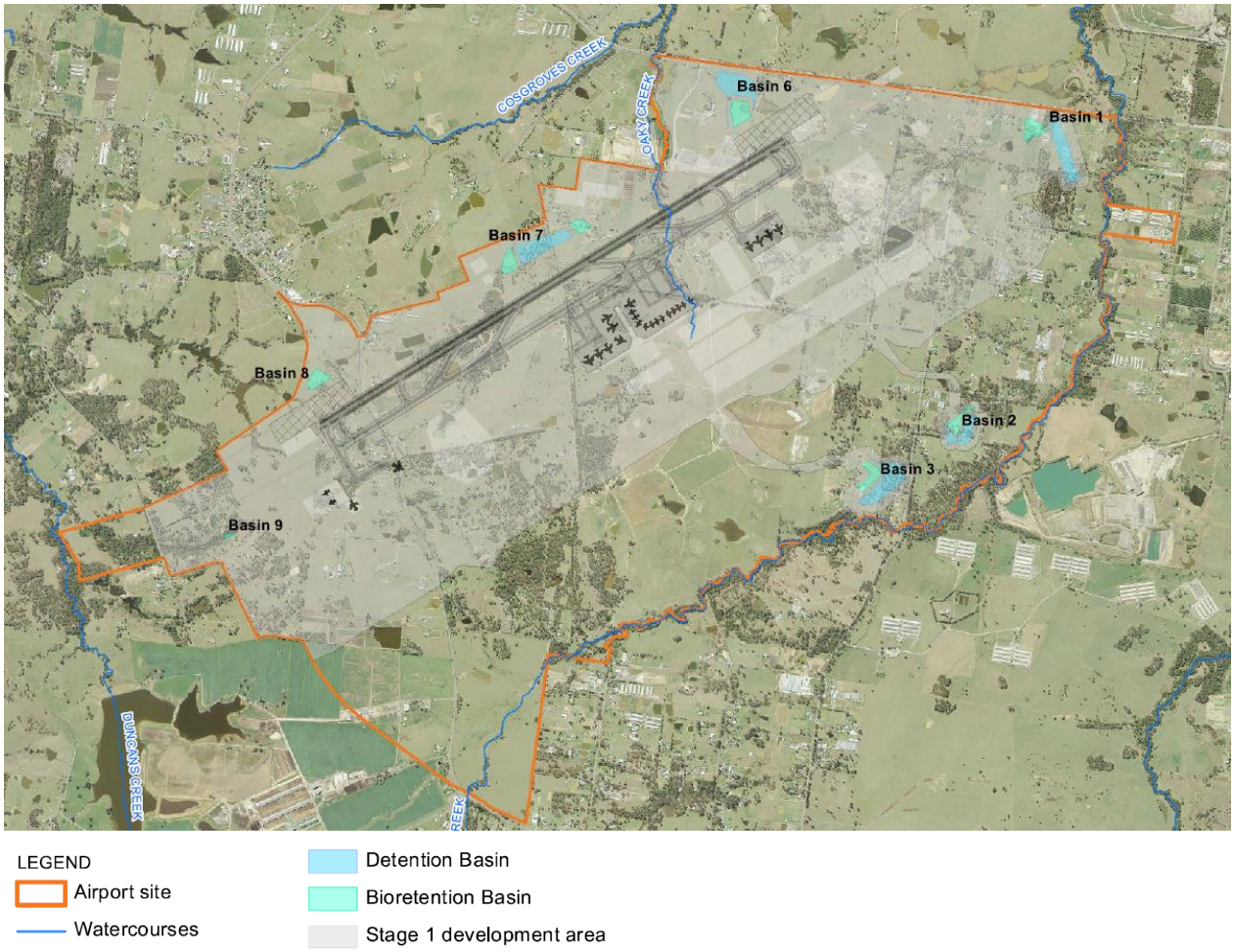


Figure 4.2 Western Sydney Airport - Stage 1 development (GHD 2016)

4.8.3 Hydrological conditions

Significant earthworks are currently underway within the Oaky Creek catchment upstream of the site. To provide a level surface for the runway and associated infrastructure, areas of the Oaky Creek headwaters are being regraded to drain away from the site, in a north-east direction to Basin 6 and to the south-east to Basin 3. The catchment area draining to Oaky Creek upstream of the site will be reduced by 75 ha as a result of the development. Figure 4.3 shows the proposed catchment boundaries that will result from the current earthworks.

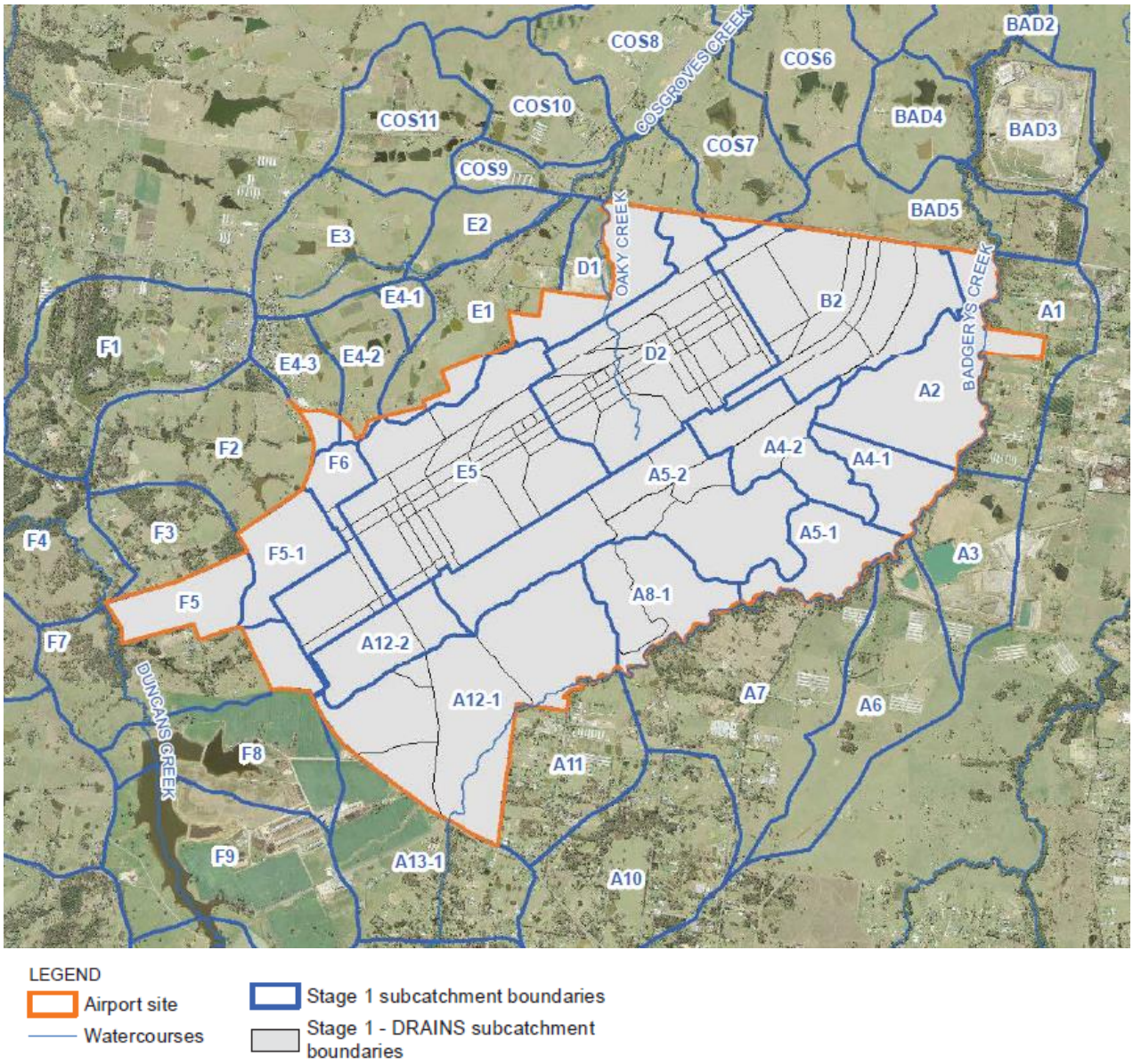


Figure 4.3 Western Sydney Airport - Stage 1 catchment boundaries (GHD 2016)

An increase in impervious catchment associated with the airport runway will be offset by the significant catchment area reductions to Oaky Creek upstream of the quarry site. Figure 4.4 and Figure 4.5 present the changes in flow as a result of Stage 1 of the airport development. It is expected that Stage 1 will reduce pre-development peak flows at the quarry site by approximately 4.5 m^3/s during a one-year average recurrence interval (ARI) event and 22 m^3/s during a 100-year ARI event.

The 100-year ARI peak flow at the quarry site is expected to be approximately 13 m^3/s for the Stage 1 airport development. The probable maximum flood (PMF) event was also simulated for the Western Sydney Airport EIS, where the PMF peak flow is expected to be approximately 40 m^3/s adjacent the site and approximately 200 m^3/s downstream of the site at Elizabeth Drive.

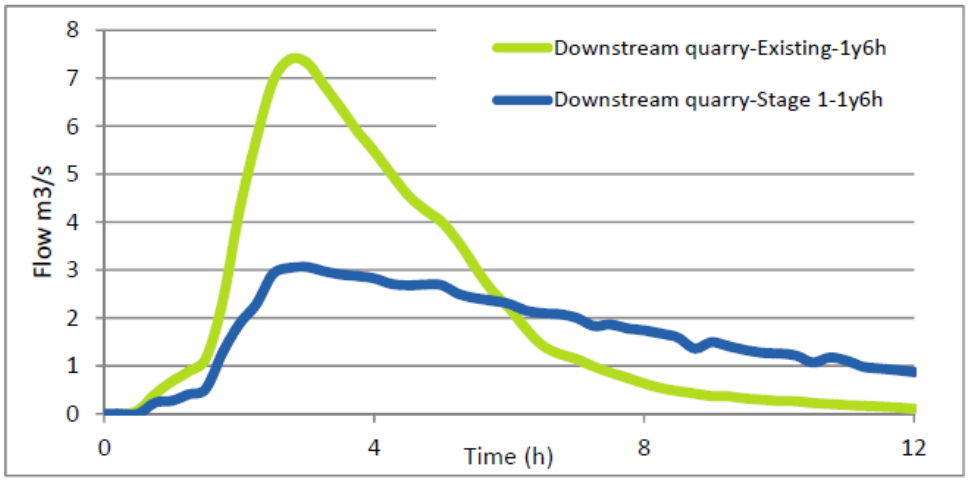


Figure 4.4 **Comparison of existing and Stage 1 flows for Oaky Creek (one-year average recurrence interval event) (GHD 2016)**

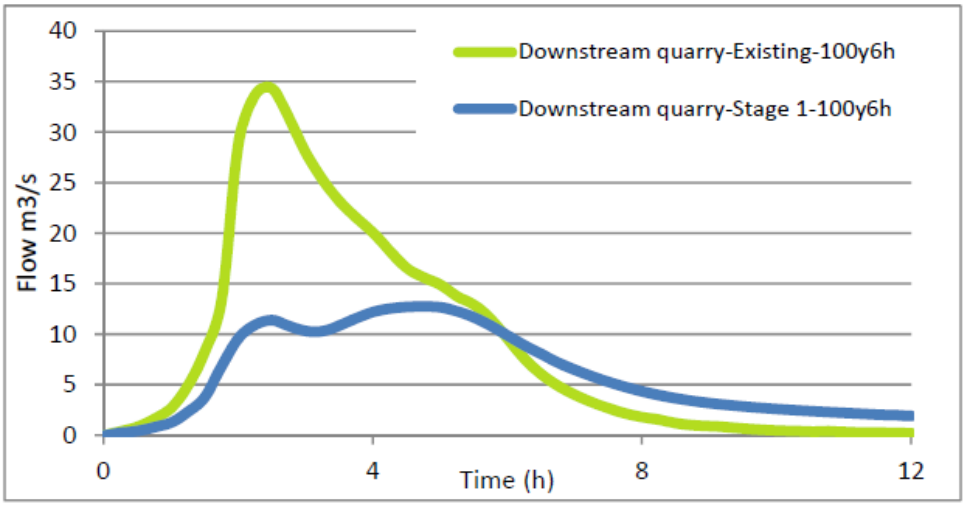
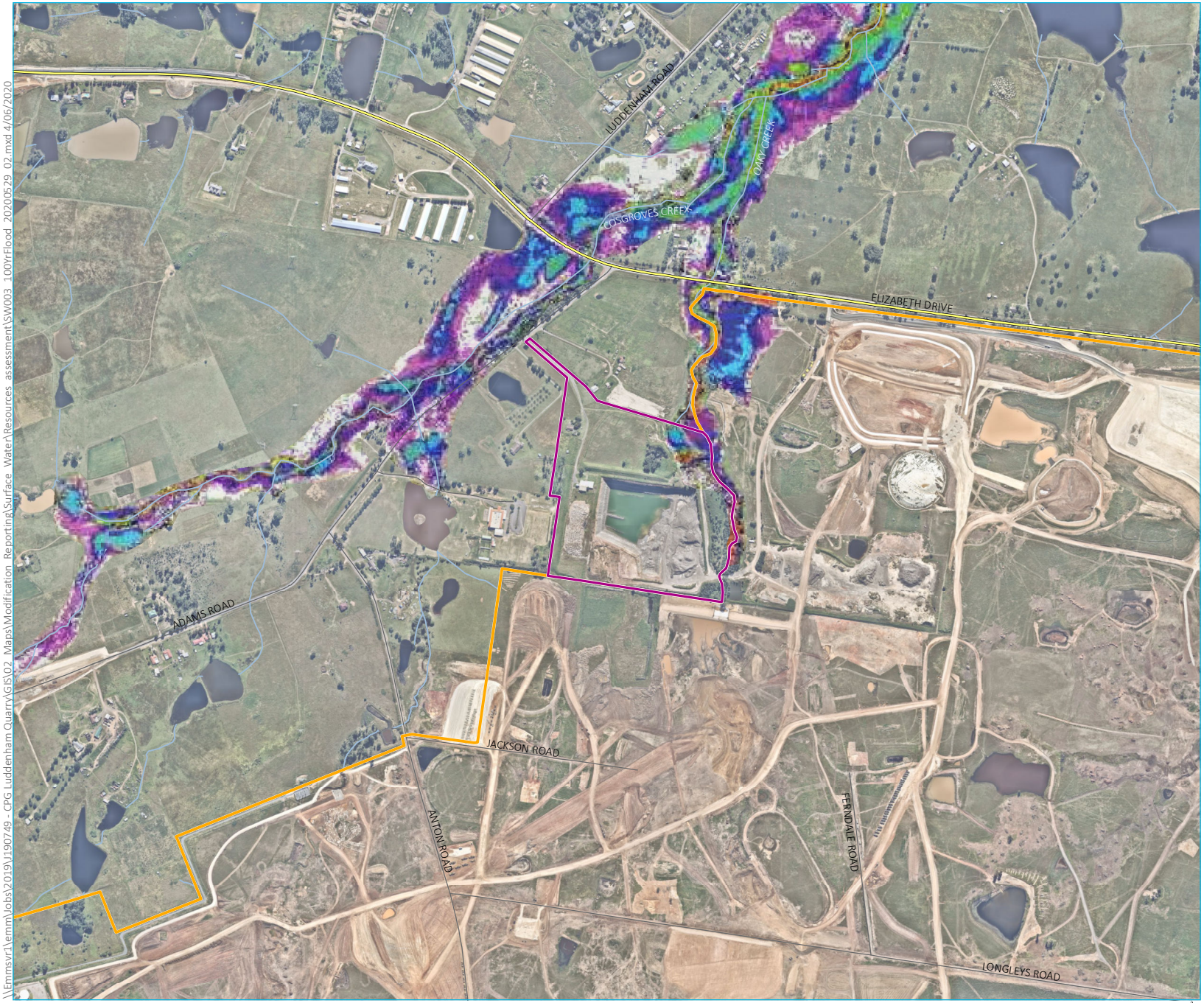


Figure 4.5 **Comparison of existing and Stage 1 flows for Oaky Creek (100-year average recurrence interval event) (GHD 2016)**

4.8.4 Stage 1 development hydraulics

The disturbed areas of the site are expected to remain above the limit of flooding along Oaky Creek in all events including the PMF event for the Stage 1 development conditions. The Water Management Dam is predicted to be periodically inundated by flows from Oaky Creek, in events as frequent as a 1-year ARI. Figure 4.6 and Figure 4.7 present the peak flood depths for the Stage 1 development for the 100-year ARI and PMF events respectively. Flood depths within Oaky Creek are estimated to be around 0.4 m to 0.6 m for a 100-year ARI event and 0.6 m to 0.8 m for the PMF event.



KEY

- Study area
- Western Sydney Airport

Flood depth (m)

- 0.1 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 2.5
- 2.5 - 3
- 3 - 4
- > 4

Flooding Data Source:GHD (2016a) Western Sydney Airport: Surface Water Hydrology and Geomorphology, prepared by GHD Pty Ltd for Commonwealth Department of Infrastructure and Regional Development.

Source: EMM (2020); DFSI (2017); GA (2011); Nearmap (2020); GHD (2016)

0 200 400 m

GDA 1994 MGA Zone 56

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100-year average recurrence interval flood depth

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Figure 4.6

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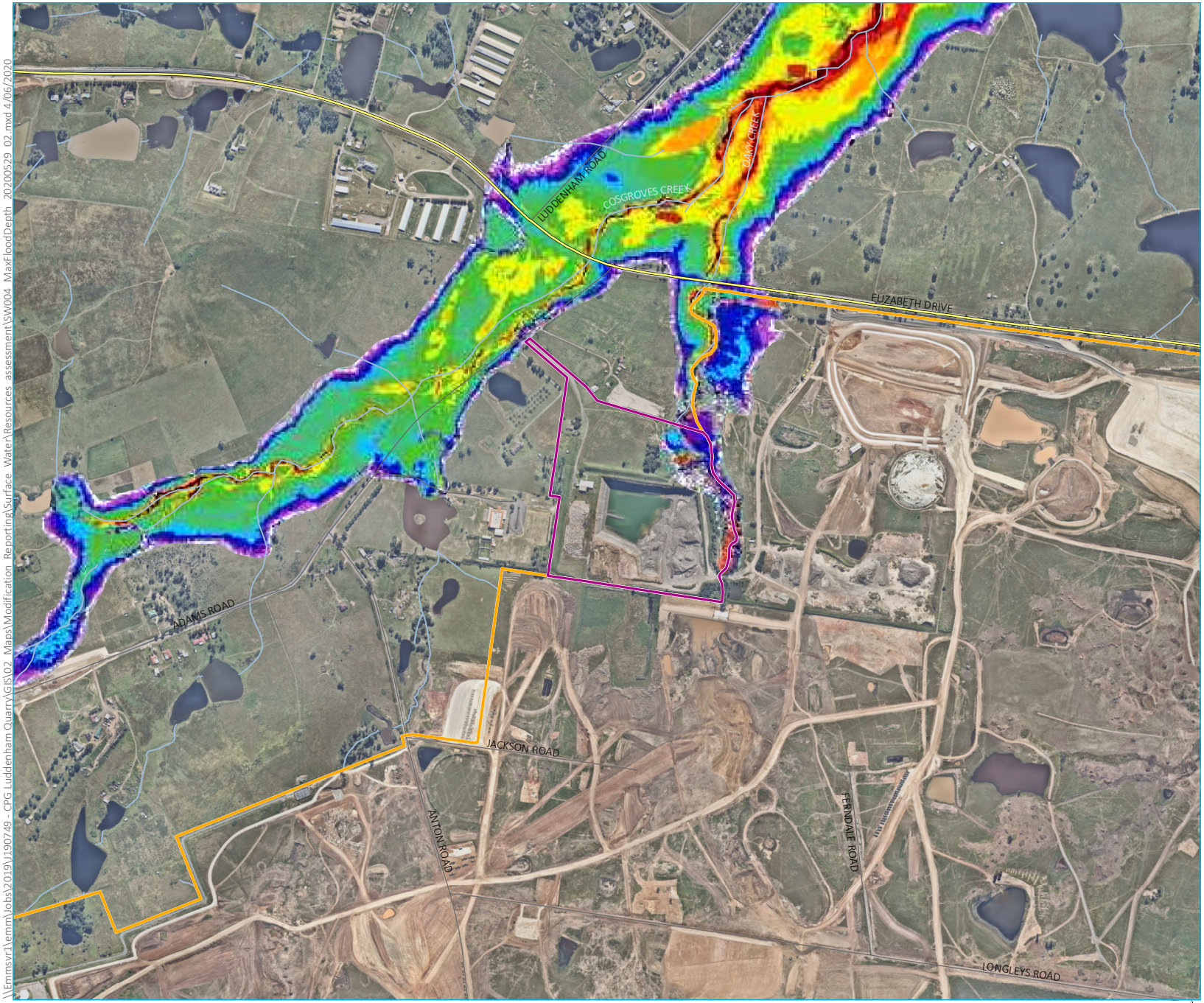

Study area
Western Sydney Airport

Flood depth (m)

- 0.1 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1
- 1 - 1.5
- 1.5 - 2
- 2 - 2.5
- 2.5 - 3
- 3 - 4
- > 4

Flooding Data Source:GHD (2016a) Western Sydney Airport: Surface Water Hydrology and Geomorphology, prepared by GHD Pty Ltd for Commonwealth Department of Infrastructure and Regional Development.

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Source: EMM (2020); DFSI (2017); GA (2011); Nearmap (2020); GHD (2016)

0 200 400 m

GDA 1994 MGA Zone 56

N

Probable maximum flood depth

Luddenham Quarry - Modification 5
Surface Water Assessment
Figure 4.7

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5 Site water balance

A water balance model was developed for the proposed water management system. The objectives of the model were to estimate the volume of water that is captured by the water management system and used for dust suppression and site discharge volumes.

5.1 Modelling methodology

The water balance model was developed in GoldSim version 12.1 (GoldSim Technologies 2017). The model applies a continuous simulation methodology that assesses the performance of the modelled water management system under a range of rainfall and evaporation sequences. The model was created by representing the water cycle as a series of elements, each containing pre-set rules and data, that were linked together to simulate the interaction of these elements.

The inputs to the water management system were modelled to consist of:

- direct rainfall onto the surface of storages;
- runoff from contributing catchments as a result of rainfall;
- groundwater intercepted by the quarry pit; and
- potable water used to supplement water used for dust suppression activities.

The outputs from the water management system were modelled to consist of:

- evaporation from the surface of storages;
- dust suppression of unsealed haul roads and disturbed areas; and
- discharges from the Water Management Dam to Oaky Creek.

Inflows to the quarry pit were modelled to be pumped to the Water Management Dam on a daily basis. To minimise the risk of off-site discharges, transfers from the pit to the Water Management Dam were limited to the available capacity within the dam. Inflows into the Water Management Dam from Oaky Creek were not represented in the water balance, as these are expected to occur during or shortly following high rainfall conditions when the Water Management Dam is at capacity and already discharging to Oaky Creek.

5.2 Data

5.2.1 Climatic data

A 131-year simulation period was adopted for the water balance model using historical daily rainfall and evaporation data from the Badgerys Creek McMasters station (BOM station number 67068) between 1889 and 2019, as discussed in Section 3.3.

5.2.2 Catchment runoff

Surface runoff was estimated using the Australian Water Balance Model (AWBM). The AWBM was developed by Boughton (2004) and is widely used across Australia to estimate runoff. The hydrological model calculates runoff

and baseflow components from rainfall after allowing for relevant losses and storage. The AWBM was incorporated into the GoldSim water balance model for the site.

For each surface type present on site, the AWBM was parameterised to achieve long-term average volumetric runoff coefficients (Cv) based on typical values. The assumed catchment breakdown and Cv applied to each surface type is provided in Table 5.1.

Table 5.1 Catchment runoff parameters

Surface type	Management areas	Area (ha)	Cv
Impervious – high runoff potential	Roofs, weighbridge, sealed roads	0.8	0.9
Disturbed – moderate runoff potential	Unsealed roads, stockpiles	9.7	0.6
Pasture – low runoff potential	Grassed catchments, vegetated bunds	2.8	0.4

5.2.3 Dust suppression

As discussed in Section 4.3, harvested runoff will be used for dust suppression on unsealed roads and disturbed areas. Water is supplied from the Water Management Dam, with supplementary water sourced as potable water from Sydney Water. Prior to the site being connected to mains water, potable water will be supplied by tanker if required. Dust suppression application rates were calculated on a daily timestep as a function of the evaporation rate, prevailing rainfall and an application area. The following equation was applied to the water balance:

Dust suppression (t) = [(Evaporation (t)) – Rainfall (t) + Loss factor] x Application area

Where:

Evaporation (t) = Evaporation rate (mm/day)

Rainfall (t) = Rainfall depth (mm/day)

Loss factor = Dust suppression loss factor 3 mm/day

Application area = 0.8 ha

5.2.4 Groundwater inflows

The predicted quantity of groundwater to be intercepted by the quarry pit was assumed to be a constant 5 m^3/day, based on the original groundwater assessment undertaken for the quarry (Douglas Nicolaisen & Associates 2003).

5.3 Modelling results

The distribution of water across the site estimated by the water balance model for typical dry (10th percentile), median (50th percentile) and wet (90th percentile) rainfall years is presented in Figure 5.1, Figure 5.2 and Figure 5.3 respectively.

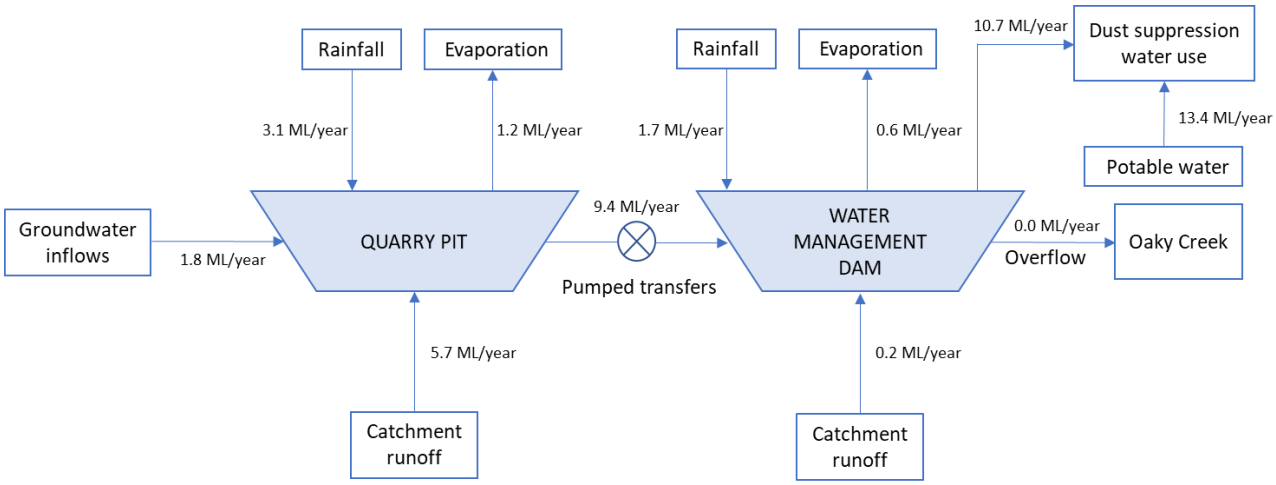

Figure 5.1 **Water balance results – typical dry rainfall year**

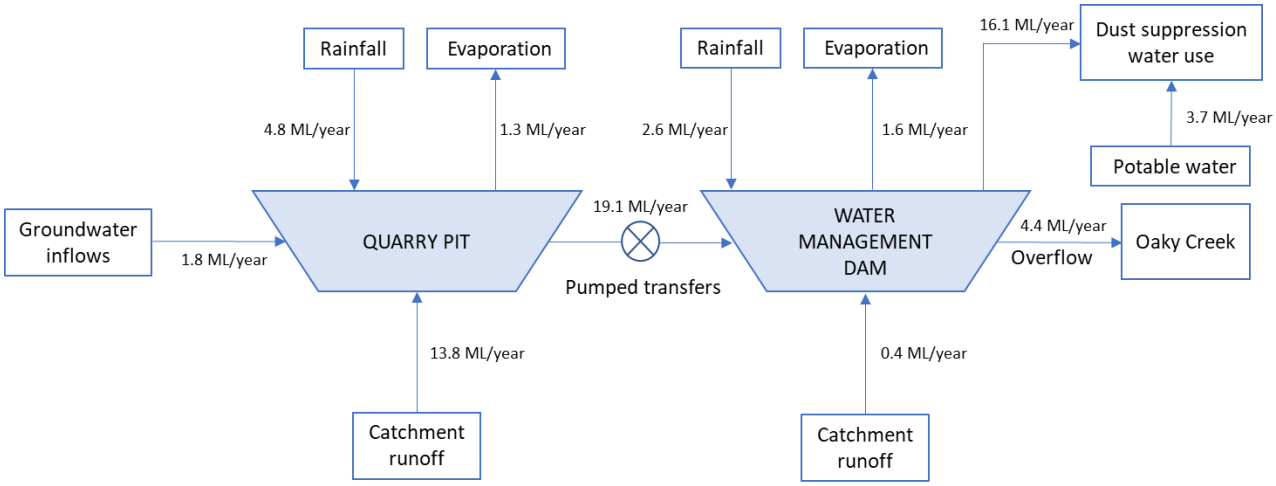

Figure 5.2 **Water balance results – typical median rainfall year**

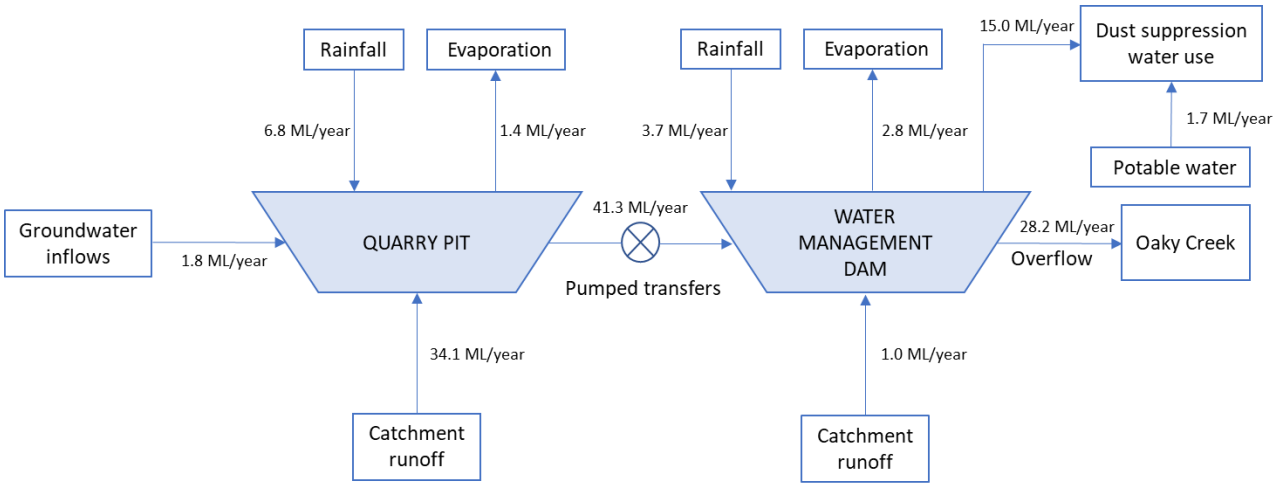

Figure 5.3 **Water balance results – typical wet rainfall year**

Table 5.2 provides an overview of the overall inputs and outputs for the water management system for a typical dry (10th percentile), median (50th percentile) and wet (90th percentile) rainfall year.

Table 5.2 Summary of annual water balance results

	Dry (10th percentile) rainfall year	Median (50th percentile) rainfall year	Wet (90th percentile) rainfall year
	ML/year	ML/year	ML/year
INPUTS			
Rainfall and runoff	10.7	21.6	45.6
Groundwater inflows into quarry pit	1.8	1.8	1.8
Potable water supply	13.4	3.7	1.7
Total inputs	25.9	27.1	49.1
OUTPUTS			
Evaporation	1.8	2.9	4.2
Dust suppression	24.1	19.8	16.7
Discharge to Oaky Creek	0.0	4.4	28.2
Total outputs	25.9	27.1	49.1

The water balance results show that approximately 81% of the demand for dust suppression is supplied by harvested catchment runoff, under median (50th percentile) rainfall conditions. The use of water captured in the quarry pit and Water Management Dam to supply dust suppression activities minimises the demand from potable water supply and reduces the volume and frequency of discharges off-site to Oaky Creek.

For the typical median (50th percentile) rainfall year, discharges to Oaky Creek from the Water Management Dam were predicted to occur over eight days in the year with total volume of 4.4 ML/year. Analysis of the daily results for the entire 131-year simulation period indicated that discharges were modelled to occur on 3.2% of days, with the maximum daily discharge estimated at 8.8 ML/day.

6 Residual impacts

6.1 Water quality

Discharges will occur due to overflows from the Water Management Dam into Oaky Creek. The dam will receive runoff from a minor catchment as well as pumped transfers from the quarry pit, which will capture the majority of catchment runoff. An oil and water separator and sediment trap will be installed immediately upstream of the Water Management Dam to assist in removing oil and grease and sediment from runoff. Reuse of stored runoff for dust suppression of unsealed roads will reduce the volume and frequency of discharges. Discharges will occur most frequently following periods of rainfall, at which time there is expected to be dilution by coincident flows in Oaky Creek.

Periodically during discharges, Oaky Creek is predicted to flow into the Water Management Dam, further diluting discharges. There is potential for entrainment of sediment particles from the Water Management Dam when this occurs. However, the water quality of Oaky Creek under flood conditions is expected to be similar with a high sediment load.

Water quality monitoring results presented in Section 3.6 indicates that water within the water management dams during the previous operation of the quarry had similar characteristics to Oaky Creek upstream of the site. Therefore, occasional discharges from the Water Management Dam are not expected to materially change or degrade the water quality of Oaky Creek.

Water quality monitoring will be undertaken within Oaky Creek, upstream and downstream of the site, and within the quarry pit and Water Management Dam (discussed further in Chapter 7). The monitoring will be used to identify water quality impacts associated with dam overflows. If water quality impacts are identified, the following contingency measures are recommended to be implemented:

- application of coagulating and/or flocculating agents, such as gypsum, polyacrylamides and alum, to enhance sediment removal prior to discharge; and/or
- dewatering of the Water Management Dam into the quarry pit via pumped transfer to minimise discharge, if sufficient capacity exists.

Sediment settling times are recommended to be analysed once the site is fully operational to determine the actual settling time of the Water Management Dam. Jar testing is recommended to determine appropriate coagulating and/or flocculating agent, if required, and the application rate for treatment. The application rate is required to be sufficiently high enough to remove suspended solids and allow discharge of water without polluting receiving waters with the coagulating/flocculating agent itself.

6.2 NSW water quality and river flow objectives

Table 6.1 provides an assessment of the proposed water management system against the typical water quality and river flow objectives for uncontrolled streams in NSW.

Table 6.1 Assessment of water quality and river flow objectives

Environmental value	Objective	Application to proposed modification
Water quality objectives		
Aquatic ecosystems	Maintaining or improving the ecological condition of water bodies and their riparian zones over the long term.	No impacts to aquatic ecosystems are expected as the water quality of discharges is expected to be similar to the water quality of Oaky Creek upstream of the site.
Visual amenity	Aesthetic qualities of waters.	No impacts to the visual amenity of Oaky Creek is expected as the water quality of discharges is expected to be similar to the water quality of Oaky Creek upstream of the site. In particular, discharges are not expected to have elevated concentrations of oils, petrochemicals or floating debris or nuisance organisms such as algae.
Secondary contact recreation	Maintaining or improving water quality for activities such as boating or wading, where there is a low probability of water being swallowed.	No impacts to primary or secondary contact recreation activities are expected as the water quality of discharges is expected to be similar to the water quality of Oaky Creek upstream of the site. In particular, discharges are not expected to have elevated concentrations of faecal coliforms, enterococci or protozoans as there is no source of these pollutants within the water management system.
Primary contact recreation	Maintaining or improving water quality for activities such as swimming in which there is a high probability of water being swallowed.	
Livestock water supply	Protecting water quality to maximise the production of healthy livestock.	No impacts to downstream users for agricultural purposes are expected as the water quality of discharges is expected to be similar to the water quality of Oaky Creek upstream of the site.
Irrigation water supply	Protecting the quality of waters applied to crops or pasture.	
Homestead water supply	Protecting water quality for domestic use in homesteads, including drinking, cooking and bathing.	It is unlikely that downstream users extract water from Oaky Creek or downstream watercourses for homestead water supply. Therefore, impacts to homestead water supply have not been assessed.
Drinking water at point of supply – disinfection only	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 objectives also apply to sub-catchments or groundwater used for town water supplies.	Town water supply in the region is provided by Sydney Water. The site is not located within Sydney's drinking water catchment. Oaky Creek drains to the Hawkesbury-Nepean system downstream of Warragamba Dam. No water is extracted from downstream of the quarry for town water supply. Therefore, impacts to drinking water supply have not been assessed.
Drinking water at point of supply – clarification and disinfection		
Drinking water at point of supply – groundwater		
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 Oaky Creek and downstream watercourses. However, the trigger values for aquatic foods apply to aquaculture not recreational fishing. The required level of protection will be provided by meeting the objective for aquatic ecosystems.
River flow objectives		
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 Oaky Creek and downstream watercourses have been extensively modified by land clearing, agriculture, extractive activities and urban and

Table 6.1 Assessment of water quality and river flow objectives

Environmental value	Objective	Application to proposed modification
Protect natural low flows	Share low flows between the environment and water users and fully protect very low flows.	industrial development in the catchment, including the current Western Sydney Airport development.
Protect important rises in water levels	Protect or restore a proportion of moderate flows and high flows.	No extraction of surface water from Oaky Creek is proposed as part of the proposed modification.
Maintain wetland and floodplain inundation	Maintain or restore the natural inundation patterns and distribution of floodwater supporting natural wetland and floodplain ecosystems.	Occasional discharges from the Water Management Dam to Oaky Creek will occur when the water stored on site exceeds the demand of dust suppression activities. The water balance model predicted a total discharge of 4.4 ML/year for the typical median (50th percentile) rainfall events.
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.	No instream structures are proposed.

6.3 Flood impacts

As discussed in Section 4.8, the proposed site disturbance area lies above the limit of flooding along Oaky Creek for all events up to and including the PMF event. As a result, there is no potential for adverse flood impacts.

7 Monitoring, inspection and maintenance programs

Following approval of the proposed modification, the water management plan for the site will be updated to include the new water management strategy for the quarry, in consultation with the NSW Department of Planning, Industry and Environment – Water and the EPA. The updated water management plan will address any specific development consent or licence conditions and is recommended to include:

- baseline monitoring data results;
- objectives and performance criteria including trigger levels for investigating any potentially adverse impacts associated with water management;
- details of the monitoring, inspection and maintenance programs;
- reporting procedures for the results of the monitoring program; and
- plans to respond to any exceedances of the performance criteria.

7.1 Monitoring program

The objective of the monitoring plan is to collect data to:

- assess the effectiveness of the water management system;
- identify and quantify water quality impacts to receiving waters; and
- assess compliance with any relevant development consent and licence conditions.

Surface water quality monitoring is recommended to be undertaken at the following locations:

- Oaky Creek upstream of the site;
- Oaky Creek downstream of the site;
- water stored within the quarry pit; and
- water stored within Water Management Dam.

Table 7.1 presents an indicative analytical suite for the site. Samples are recommended to be analysed quarterly and once during or after any discharge events. Physical and chemical stressors (with the exception of 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 7.1 Recommended surface water quality monitoring program

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
Nutrients	Ammonia, nitrate, nitrite, 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, oil and grease	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).

Reporting requirements for the surface water quality monitoring program, including appropriate assessment criteria and triggers for response and action, will be developed as part of the updated water management plan.

7.2 Inspection and maintenance program

Site inspections of the water management system will be undertaken informally on a regular basis and formally on a quarterly basis. The water management structures will be visually inspected for capacity, structural integrity and effectiveness. Maintenance, such as the removal of excessive sediment accumulation or macrophyte growth from the Water Management Dam and drainage lines, will be implemented as required.

8 Water licensing

8.1 *Protection of the Environment Operations Act 1997*

The previous LDP for the quarry (EPL 12863 LDP) was revoked in May 2020. A new LDP is proposed to be the outflow point of the Water Management Dam into Oaky Creek (refer to Figure 4.1). Consultation will be undertaken with the EPA to determine any appropriate licence conditions.

8.2 *Water Management Act 2000*

Catchment runoff captured by the quarry pit and the Water Management Dam will be either used for dust suppression of unsealed haul roads or discharged to Oaky Creek. Water take from the Water Management Dam is excluded works under Schedule1, item 3 of the Water Management (General) Regulation 2018 (dams solely for the capture, containment or recirculation of drainage). Dams used for the containment and reuse of catchment runoff consistent with industry best practice to prevent the contamination of a watercourse is also excluded from harvestable rights calculations. Accordingly, the proposed modification is not expected to have any requirements for licensing of surface water take.

9 Summary

9.1 Proposed modification context

CPG/KLF propose to reactivate operations at an existing shale and clay quarry at 275 Adams Road, Luddenham. A modification to the existing development consent SSD DA 317-7-2003 is required to facilitate quarry reactivation, including a new site access road, new stockpiling area, weighbridge and other site infrastructure, as well as other administrative changes. The modification does not seek to increase the production rate, approved quarry life or the approved area or depth of the quarry footprint.

9.2 Water management overview

The key water management strategy adopted across the site is containment and management of potentially sediment-laden runoff from disturbed areas and reuse where feasible. The key features of the water management system include:

- diversion of runoff from undisturbed catchments away from disturbed areas and off site;
- collection of all potentially sediment-laden runoff from disturbed areas of the site within the quarry pit and the Water Management Dam;
- use of captured runoff for dust suppression of unsealed roads and disturbed areas; and
- discharge of excess water from the site via an LDP to Oaky Creek.

9.3 Expected outcomes

The proposed water management system is expected to achieve the following outcomes:

- captured catchment runoff was predicted by the water balance model to provide 81% of the demand for dust suppression under median (50th percentile) rainfall conditions, reducing the demand from potable water supply and the volume and frequency of discharges off-site to Oaky Creek;
- discharges to Oaky Creek from the Water Management Dam were predicted by the water balance model to occur over eight days per year with total volume of 4.4 ML/year under median (50th percentile) rainfall conditions;
- the Water Management Dam is expected to be periodically inundated by flows when Oaky Creek is in flood. This is likely to coincide with the predicted discharges from the Water Management Dam, further diluting flows;
- the water quality of discharges is expected to have similar characteristics to the water quality within Oaky Creek upstream of the site, with discharges not expected to materially change or degrade the water quality of Oaky Creek; and
- the quarry's disturbance footprint is expected to remain above the limit of flooding along Oaky Creek in all events up to and including the PMF event.

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Abbreviations

AHD	Australian Height Datum
ARI	average recurrence interval
AWBM	Australian Water Balance Model
BOM	Bureau of Meteorology
CPG	Coombes Property Group
DCP	development control plan
DGV	default guideline value
EIS	environmental impact statement
EPA	Environment Protection Authority
EPL	environment protection licence
KLF	KLF Holdings Pty Ltd
LDP	licensed discharge point
NATA	National Association of Testing Authorities
PMF	probable maximum flood
POEO Act	*Protection of the Environment Operations Act 1997*
RUSLE	Revised Universal Soil Loss Equation
SILO	Scientific Information for Land Owners
SSD	State significant development
WM Act	*Water Management Act 2000*
WSP	water sharing plan

Appendix A

Water quality monitoring results

Table A.1 Water quality results – Upstream monitoring site

Parameter	Units	19/08/2010	20/09/2010	21/10/2010	22/11/2010	20/01/2011	22/03/2011	20/06/2011	21/07/2011	23/08/2011	20/12/2011	19/01/2012	20/02/2012	21/03/2012	19/04/2012	18/02/2013	18/09/2013	18/11/2013	16/04/2014	18/08/2014	16/10/2014	19/05/2015	04/07/2016	06/10/2016	06/03/2017	04/04/2017	22/08/2017
Physical and chemical stressors																										
Dissolved oxygen	mg/L																									3.9
Electrical conductivity	µS/cm																									**11,000**
pH	pH units	7.3	7.1	7.2	6.5	7.1	6.6	6.7	6.6	6.9	7.1	7.2	6.9	7.3	7.0	6.5	7.5	**5.7**	6.8	6.7	7.0	6.8	6.9	7.3	7.1	7.2	7.6
Total dissolved solids	mg/L																									6,720
Total suspended solids	mg/L	13	143	31	30	9	280	165	280	329	55	104	39	12	29	46	21	43	61	627	230	35	3	13	11	7	17
Major ions																										
Calcium	mg/L																									53
Chloride	mg/L																									3,500
Magnesium	mg/L																									280
Potassium	mg/L																									16
Sodium	mg/L																									2,600
Sulfate	mg/L																									130
Total alkalinity	mg/L																									440
Nutrients																										
Nitrate	mg/L																									<0.005
Nitrite	mg/L																									<0.005
Total Kjeldahl nitrogen	mg/L																									3.7
Reactive phosphorus	mg/L																									**0.17**
Total phosphorus	mg/L																									**0.4**

Table A.1 Water quality results – Upstream monitoring site

Parameter	Units	19/08/2010	20/09/2010	21/10/2010	22/11/2010	20/01/2011	22/03/2011	20/06/2011	21/07/2011	23/08/2011	20/12/2011	19/01/2012	20/02/2012	21/03/2012	19/04/2012	18/02/2013	18/09/2013	18/11/2013	16/04/2014	18/08/2014	16/10/2014	19/05/2015	04/07/2016	06/10/2016	06/03/2017	04/04/2017	22/08/2017
Dissolved metals																											
Arsenic	mg/L																										0.002
Cadmium	mg/L																										<0.0001
Chromium	mg/L																										0.001
Copper	mg/L																										<0.001
Iron	mg/L																										**2.2**
Lead	mg/L																										<0.001
Mercury	mg/L																										<0.00005
Nickel	mg/L																										0.002
Zinc	mg/L																										0.002
Total metals																											
Iron	mg/L																										5
Other parameters																											
Biochemical oxygen demand	mg/L		17	14	13	7	86	1	4	4	5	3	5	8	8	2	7	39	7	2	2	2	<2	2	4	3	9
Oil and grease	mg/L		<5	<5	22	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	10	5	5	6	<5	<5	<5	<5	<5

Table A.2 Water quality results – Downstream monitoring site

Parameter	Units	19/08/2010	20/09/2010	21/10/2010	22/11/2010	20/01/2011	22/03/2011	21/07/2011	23/08/2011	20/12/2011	19/01/2012	20/02/2012	21/03/2012	19/04/2012	18/02/2013	18/09/2013	18/11/2013	16/04/2014	18/08/2014	16/10/2014	19/05/2015	17/11/2015	4/07/2016	6/10/2016	6/03/2017	4/04/2017	22/08/2017
Physical and chemical stressors																										
Dissolved oxygen	mg/L																									6.8
Electrical conductivity	µS/cm																				1,280					**2,460**
pH	pH units	6.9	6.6	6.8	6.9	7.2	7.3	6.8	6.6	7.1	6.9	6.9	7.3	7.0	6.6	7.0	6.9	6.8	7.0	7.0	7.1	7.4	6.9	7.1	6.8	7.3	6.9
Total dissolved solids	mg/L																									1,420
Total suspended solids	mg/L	28	68	14	6	69	9	4	31	34	6	57	14	64	14	12	8	3	48	41	6	7	2	7	15	17	<1
Major ions																										
Calcium	mg/L																									36
Chloride	mg/L																									670
Magnesium	mg/L																									69
Potassium	mg/L																									14
Sodium	mg/L																									480
Sulfate	mg/L																									83
Total alkalinity	mg/L																									130
Nutrients																										
Nitrate	mg/L																									<0.005
Nitrite	mg/L																									<0.005
Total Kjeldahl nitrogen	mg/L																									0.6
Reactive phosphorus	mg/L																									0.02
Total phosphorus	mg/L																									<0.05

Table A.2 Water quality results – Downstream monitoring site

Parameter	Units	19/08/2010	20/09/2010	21/10/2010	22/11/2010	20/01/2011	22/03/2011	21/07/2011	23/08/2011	20/12/2011	19/01/2012	20/02/2012	21/03/2012	19/04/2012	18/02/2013	18/09/2013	18/11/2013	16/04/2014	18/08/2014	16/10/2014	19/05/2015	17/11/2015	4/07/2016	6/10/2016	6/03/2017	4/04/2017	22/08/2017
Dissolved metals																											
Arsenic	mg/L																										<0.001
Cadmium	mg/L																										<0.0001
Chromium	mg/L																										<0.001
Copper	mg/L																										<0.001
Iron	mg/L																										0.2
Lead	mg/L																										<0.001
Mercury	mg/L																										<0.00005
Nickel	mg/L																										0.002
Zinc	mg/L																										0.002
Total metals																											
Iron	mg/L																										0.6
Other parameters																											
Biochemical oxygen demand	mg/L		12	6	7	31	12	2	3	2	2	4	7	9	2	2	7	2	2	2	2	<2	<2	<2	2	5	<2
Oil and grease	mg/L		<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	10	5	5	7	<5	<5	<5	<5	<5	<5

Table A.3 Water quality results – Quarry pit

Parameter	Units	18/02/2010	19/06/2013	23/07/2013	15/05/2014	16/12/2014	5/05/2017	22/08/2017	14/11/2017	6/02/2018
Physical and chemical stressors										
Dissolved oxygen	mg/L						9.8	11.9	12.4	11.1
Electrical conductivity	µS/cm						**5,940**	**8,610**	**20,200**	**45,900**
pH	pH units	8.0	**8.6**	8.3	**8.7**	**8.7**	**8.9**	**8.7**	8.4	8.1
Total dissolved solids	mg/L						3,650	5,440	12,800	31,200
Total suspended solids	mg/L	5	6	4	6	9			28	8
Major ions										
Calcium	mg/L						45	74	120	210
Chloride	mg/L						1,600	2,600	6,800	17,000
Magnesium	mg/L						130	220	570	1,400
Potassium	mg/L						27	33	64	120
Sodium	mg/L						1,400	2,100	4,500	9,500
Sulfate	mg/L						280	380	610	950
Total alkalinity	mg/L						280	380	410	370
Nutrients										
Nitrate	mg/L						11	10	2.3	0.85
Nitrite	mg/L						0.11	0.099	0.096	0.041
Total Kjeldahl nitrogen	mg/L						0.4	0.3	1.2	0.6
Reactive phosphorus	mg/L						<0.01	0.01	<0.005	0.008
Total phosphorus	mg/L						<0.05	<0.05	<0.05	<0.05
Dissolved metals										
Arsenic	mg/L						0.002	0.003	0.002	0.005
Cadmium	mg/L						<0.0001	<0.0001	<0.0001	0.0002

Table A.3 Water quality results – Quarry pit

Parameter	Units	18/02/2010	19/06/2013	23/07/2013	15/05/2014	16/12/2014	5/05/2017	22/08/2017	14/11/2017	6/02/2018
Chromium	mg/L						<0.001	<0.001	<0.001	<0.001
Copper	mg/L						**0.002**	**0.002**	<0.001	**0.007**
Iron	mg/L						<0.01	<0.01	<0.01	<0.01
Lead	mg/L						<0.001	<0.001	<0.001	<0.001
Mercury	mg/L						<0.00005	<0.00005	<0.00005	<0.00005
Nickel	mg/L						0.005	0.010	**0.013**	**0.021**
Zinc	mg/L						0.002	0.002	**0.012**	**0.017**
Total metals										
Iron	mg/L						0.01	0.02	0.05	0.15
Other parameters										
Biochemical oxygen demand	mg/L			2	2	2			9	<2
Oil and grease	mg/L		<5	<5	<5	<5			<5	<5

Table A.4 Water quality results – Water management dams

Parameter	Units	Sediment Dam 1															Sediment Dam 2						
		18/02/2010	21/07/2010	19/08/2010	20/09/2010	21/10/2010	22/11/2010	20/01/2011	22/03/2011	20/06/2011	20/02/2012	18/02/2013	9/02/2016	20/06/2011	21/11/2012	18/02/2013	17/11/2015	9/02/2016	6/03/2017	5/05/2017	22/08/2017	14/11/2017	6/02/2018
Physical and chemical stressors																							
Dissolved oxygen	mg/L																			8.5	12.4	14.7	12.3
Electrical conductivity	µS/cm																**5,490**		**5,600**	**4,520**	**5,360**	**11,100**	**14,700**
pH	pH units	7.8	7.2	7.6	**8.6**	**8.9**	7.1	8.1	8.1	**9.1**	7.6	**9.2**	**8.9**	8.4	8.4	**8.6**	8.5	**9.1**	**9.1**	8.3	8.5	**8.9**	**8.9**
Total dissolved solids	mg/L																			2,920	3,180	6,510	7,980
Total suspended solids	mg/L	27	33	13	15	1	76	68	63	10	173	11	8	9	9	12	10	12	17		16	36	17
Major ions																							
Calcium	mg/L																			37	47	54	57
Chloride	mg/L																			1,100	1,500	3,300	3,900
Magnesium	mg/L																			110	130	290	330
Potassium	mg/L																			25	24	42	44
Sodium	mg/L																			990	1,100	2,400	2,400
Sulfate	mg/L																			190	210	410	420
Total alkalinity	mg/L																			160	200	280	320
Nutrients																							
Nitrate	mg/L																			1.5	0.67	0.83	<0.005
Nitrite	mg/L																			0.35	0.014	0.084	<0.005
Total Kjeldahl nitrogen	mg/L																			1.4	1.5	1	1.2
Reactive phosphorus	mg/L																			<0.01	0.01	<0.005	**0.05**
Total phosphorus	mg/L																			<0.05	<0.05	<0.05	<0.05

Table A.4 Water quality results – Water management dams

Parameter	Units	Sediment Dam 1																	Sediment Dam 2			
		18/02/2010	21/07/2010	19/08/2010	20/09/2010	21/10/2010	22/11/2010	20/01/2011	22/03/2011	20/06/2011	20/02/2012	18/02/2013	9/02/2016	20/06/2011	21/11/2012	18/02/2013	17/11/2015	9/02/2016	6/03/2017	5/05/2017	22/08/2017	14/11/2017	6/02/2018
Dissolved metals																						
Arsenic	mg/L																			<0.001	<0.001	<0.001	0.005
Cadmium	mg/L																			<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L																			<0.001	<0.001	<0.001	<0.001
Copper	mg/L																			**0.003**	**0.002**	**0.002**	<0.001
Iron	mg/L																			0.01	0.01	0.01	0.01
Lead	mg/L																			<0.001	<0.001	<0.001	<0.001
Mercury	mg/L																			<0.00005	<0.00005	<0.00005	<0.00005
Nickel	mg/L																			0.002	0.002	0.002	0.002
Zinc	mg/L																			<0.001	<0.001	**0.009**	0.005
Total metals																							
Iron	mg/L																			0.09	0.2	0.03	0.1
Other parameters																							
Biochemical oxygen demand	mg/L		4		8	5	8	19	27	4	6	2	2	4		2	<2	2	3		6	13	6
Oil and grease	mg/L		<5		<5	<5	<5	<5	<5	<5	12	<5	<5	<5	<5	<5	<5	<5	<5		<5	<5	<5

Appendix 15 - Treatment Options Cost Documentation by Victory Engineering

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Email: stewart@victoryeng.com
Ph: 0420 350 926

To: Manikshya Shrestha (4Pillars), James Hammond (4Pillars)

From: Stewart Reeve (Victory Engineering)

Re: Luddenham Quarry: Quarry Pit Water Treatment Strategy Summary (Rev1)

Date: 31 / 10 / 22

Executive Summary

- The Luddendam Quarry pit contains ~170ML of contaminated water, with additional inflows of ~30ML per year. It is assumed that ~200ML of water would be need to be processed during a dewatering campaign.
- Victory Engineering and Emerald Process Engineering determined that an advanced water treatment system would be required to reduce the Conductivity of the Luddenham Quarry pit water from ~3,500 us/cm to ~1,100 us/cm, due to the relatively high concentrations of Sodium Chloride salt. A Reverse Osmosis (RO) treatment system was selected and evaluated.
- Conventional treatments to precipitate and remove some of the pit water's dissolved contaminants and conductivity were determined by software evaluation to provide grossly insufficient net reductions in the pit water Conductivity.
- The proposed RO-based strategy involves blending produced high-quality RO water ('permeate', at ~300 us/cm) with pre-treated (nutrient-polished only) pit water upon discharge, to maximise the pit dewatering rate;
    - Blending ratios would probably be upwards of ~65% RO permeate.
- The high-salinity 'brine' produced by the RO system is proposed to be reduced to solid salts in a relatively large onsite evaporation pond; dried salts can be buried/landfilled. Mechanical/thermal systems for accelerated/enhanced brine volume reduction are available, but are generally expensive to purchase/rent and operate.
- An RO system producing in the order of 500 L/min of high-quality water is estimated to cost (excluding GST and freight); all costs are estimates only, and are subject to change:
    - *Note: it should be understood that a 500 L/min system is still a substantial flow rate.*
    - Rent: ~$145K per month;
        - Does not include ~$500K once-off fee for engineering.
    - Purchase: ~$8M +/- 50%;
        - This includes all engineering and procurement-administration costs.
    - ~$96K in consumables for processing ~200ML of pit water; and,
    - For rental or purchase: ~$15K per month for technical monitoring and servicing of the RO system;
    - A once-off ~$132K mobilisation and demobilisation cost would also apply.
    - Note that a 1,000 L/min RO system would only be moderately more expensive.
- The 500 L/min system is estimated to take 9-14 months to process the ~200ML of pit water.
- The pit water is required to have nutrient concentrations significantly reduced prior to processing through the RO system – the following costs exclude freight and GST:
    - Victory propose this be accomplished by passively pre-treating the pit water with 'Diatomix', a diatom-algae micro-nutrient.
    - Assuming 35,000m2 of pit water surface area, initial treatment costs are ~$1,800 per week (9-litres per week) for the Diatomix, which reduces proportionally as pit water nutrient concentrations decrease; application can be manual or automatic.
    - Pit water de-stratification would also be required – probably a pumped system.
- Further data collection would be required in parallel to progression of the RO system design.

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Discussion: Pit Water Treatment Background, Strategy and Modelling Summary

4Pillars engaged Victory Engineering to provide treatment options for the quarry pit water for KLF Holding's Luddenham Quarry. Victory engaged sub-consultant Emerald Process Engineering to assist with part of the water treatment evaluation and strategy development.

Via information provided by 4Pillars, Victory understand the following about the Luddenham Quarry Pit water, the treatment discharge criteria, and the operational context:

- Elevated salinity (~3,500 us/cm): 'brackish' pit water.
- Initial target salinity of approximately 1,100 us/cm.
- Slightly elevated dissolved heavy metal concentrations.
- Slightly elevated dissolved nutrients concentrations.
- In excess of 170ML of water to be treated and discharged, in a desired timeframe of 6-12 months.
- That a discharge flowrate of approximately 500-1,000 litres per minute had already been roughly identified by 4Pillars and the client as a practical balance between cost and the dewatering campaign duration.
- Quarry pit currently has a surface area of ~3.5 hectares (~35,000m2).
- Limited real estate / footprint available.
- No access to Trade Waste for Wastewater disposal.

After engagement, Victory initially identified and advised:

- That:
    - Conductivity reduction was going to be the main treatment challenge, due to the relatively high dissolved salt content (Sodium Chloride) of the brackish pit water.
    - Nutrient reduction to low levels was probable via a simple, passive, in-pit treatment process ('Diatomix' liquid micro-nutrient application).
    - Heavy metals reduction should be relatively simple.
    - An advanced water treatment process would likely be required for adequate Conductivity reduction, due to the elevated salt concentrations; conventional treatments were unlikely to achieve adequate Conductivity reductions, but would be evaluated anyway.
- Two possible treatment options for Conductivity reduction:
    - Advanced treatment: probably Reverse Osmosis;
        - Pit water pre-treated for nutrient reduction, via an in-pit passive micro-biological treatment ('Diatomix').
    - Conventional treatment: reduction and precipitation of some species, mainly:
        - Nutrients (via Diatomix application);
        - Hardness (Magnesium and Calcium), via precipitation;
        - Alkalinity, via precipitation with hardness.

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Victory and Emerald conducted discussions and subsequent desktop and software modelling to evaluate the two general above options, and produce the following general results:

- Passive nutrient reduction via Diatomix application:
    - Probably necessary for discharge compliance;
        - Particularly necessary if an advanced treatment system is to be deployed.
    - Conducted via desktop study by supplier, in conduction with Victory.
    - Achievable and practical.
    - Assumed an initial pit water surface area of 35,000m2.
    - Initial dose rate of approximately 9 litres per week of Diatomix micro-nutrient into the pit; dose rate reduces with time, in proportion to the decreasing nutrient concentration;
        - Can be applied manually or automatically;
        - Pumped de-stratification of the pit water body is recommended during this time;
        - Substantial nutrient reduction should be achieved in ~2-6 months, depending on the rate and effectiveness of destratification.
    - Initial dose cost of ~$1,800 per week (excl GST, excl freight), and reducing with time as nutrient concentrations reduce;
        - Assumes de-stratification does not increase nutrient concentrations (which is actually possible).
    - May also provide minor reductions in heavy metals, alkalinity, pH, and Conductivity.

- Precipitation treatment:
    - A number of different, conventional scenarios were considered.
    - Estimates via software modelling indicated only minor net reductions (5-10%) of total Conductivity were achieved via precipitation of heavy metals, and some hardness and alkalinity;
        - That is, Conductivity remained dominated by dissolved Sodium Chloride, which is largely unaffected by the conventional precipitation processes, with substantial secondary contributions to Conductivity from the remaining hardness and alkalinity.
    - Victory deemed this method insufficiently effective, and did not pursue it further to costing.
    - No further information is provided.

- Advanced treatment: Reverse Osmosis:
    - Assumes very low nutrients in feed water (pre-treatment in pit), to minimise micro-biological RO membrane fouling, requiring disinfection and cleaning.
    - 500 L/min produced high-quality water from the RO unit (known as ‘permeate’).

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- Successful software modelling, producing a treated water stream:
  - pH: 7.2-7.8;
  - Conductivity: 200-400 us/cm;
  - Very low heavy metals concentration;
  - Very low hardness;
  - Very low salinity.
- Waste brine (salt concentrate) from the RO system is assumed to be managed via an evaporation pond/s;
  - Further machinery and consumables to evaporate the brine are not factored in.
  - Evaporation pond/s size/s not calculated here, but is expected to be 'somewhat large' to facilitate storage of the ~25ML of brine produced during the pit dewatering campaign, plus incident rainfall.
  - Note that brine volumes can be reduced further by increasing the RO % recovery, which means pushing the design harder, but also increases the probability of system fouling and failure, slight increases in capital costs, increases in operational costs, and probably increases in service fees to minimise the probability of system failure;
    - But these things are achievable.
  - Note that mechanical and/or thermal methods can be used to increase the evaporation rate and minimise the size of the evaporation pond/s required (discussed further at the end of this section).
- To maximise the overall pit dewatering rate, produced RO water can be mixed with pre-treated pit water to achieve the desired final Conductivity upon discharge – for example, consider the follow results table for water mixing ratios:

Pit Water	3500	us/cm
Permeate	300	us/cm

% RO Permeate	% Pre-Treated Pit Water	Resultant Conductivity* (us/cm)
50	50	1,900
60	40	1,580
67	33	1,356
75	25	1,100
80	20	940

** Assumes no chemical changes upon mixing*

- Cost estimates (excl GST and excl freight), for the 500 L/min RO permeate water system – subject to change due to water chemistry and/or market forces:

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- Rental cost: $145K per month, plus once-off $132K mobilisation/demobilisation charge.
- Purchase option: $2.1M +/- 50%:
  - 2 x 40ft containers;
  - 2 x skids, external to containers: chemical dosing skid, media-filtration + cartridge filtration skid;
  - Automatic control system, with remote monitoring and control.
- Operational cost (rental or purchase): ~$480 per ML pit water, with stated average characteristics (see Appendix B) – includes:
  - Chemical;
  - Power (costs may fluctuate with fuel costs);
  - Cartridge filter consumables;
  - For 200ML, this equates to $96K.
- Contracted plant operation: $15K per month – includes:
  - Preventative maintenance;
  - Membrane and other cleaning, as required;
  - Changing of cartridge filters;
  - Replenishment of chemicals.
  - Excludes:
    - Industrial disposal of membrane cleaning wastewater, as required.
- Generator rental/purchase costs not included in the above.

- Appendix A features example images of the various Reverse Osmosis process units.
- The proposed Reverse Osmosis process strategy, and options, are outlined in the following process diagram:

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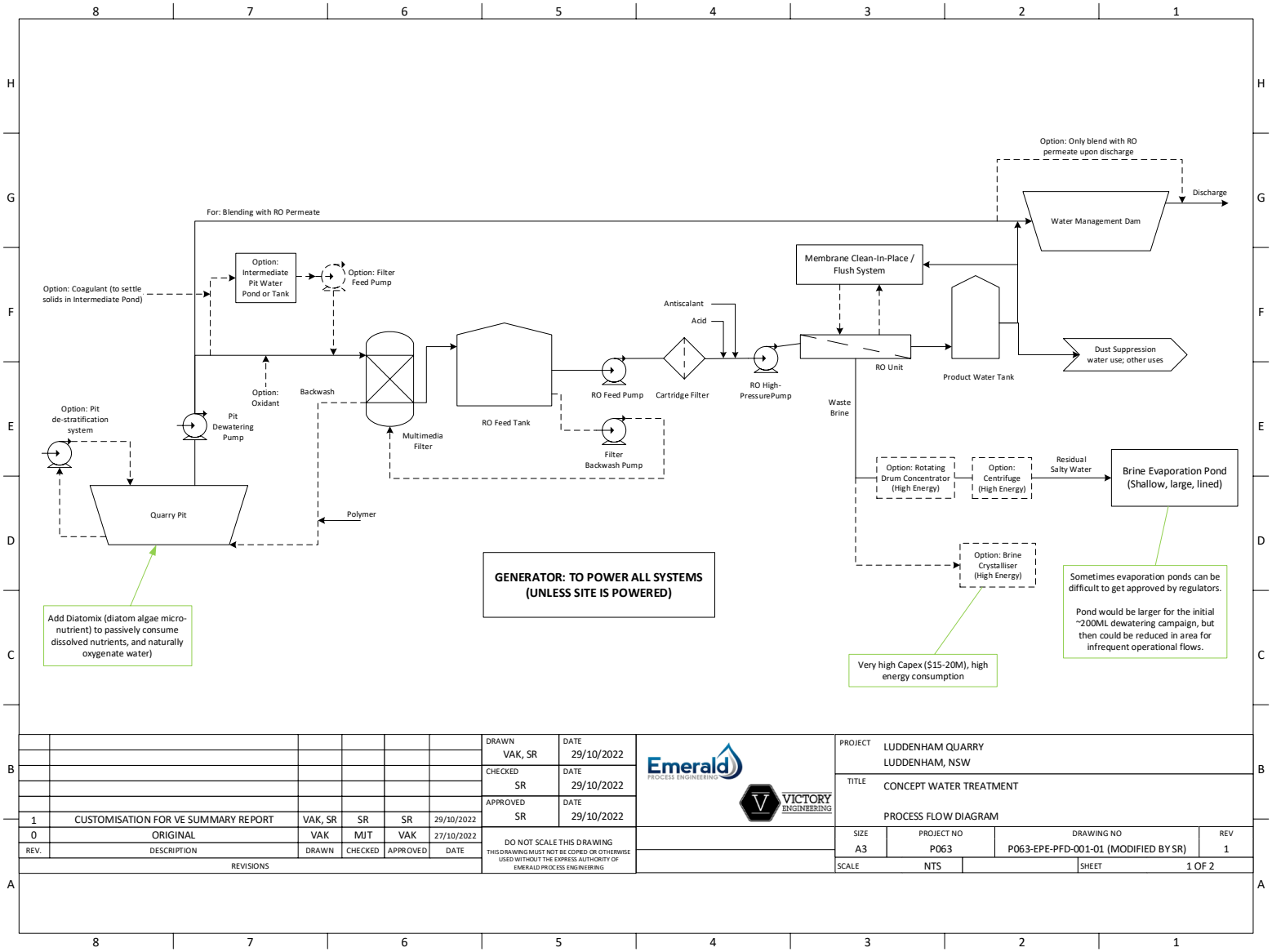

REV.	DESCRIPTION	DRAWN	CHECKED	APPROVED	DATE
1	CUSTOMISATION FOR VE SUMMARY REPORT	VAK, SR	SR	SR	29/10/2022
0	ORIGINAL	VAK	MJT	VAK	27/10/2022

REVISIONS

DRAWN	VAK, SR	29/10/2022
CHECKED	SR	29/10/2022
APPROVED	SR	29/10/2022

DO NOT SCALE THIS DRAWING
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PROJECT	LUDDENHAM QUARRY LUDDENHAM, NSW
TITLE	CONCEPT WATER TREATMENT PROCESS FLOW DIAGRAM

SIZE	PROJECT NO	DRAWING NO	REV
A3	P063	P063-EPE-PFD-001-01 (MODIFIED BY SR)	1
SCALE	NTS	SHEET	1 OF 2

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Emerald PE also provided the following table regarding waste brine management options:

Brine Management	PRO	CON
Brine Crystalliser	Minimal Footprint Produces a salt that can be landfilled directly	High Capital Cost ($15-20 M) No option to rent High Energy Consumption
Evaporation Pond	Low Capital Investment Low OPEX cost	Large Footprint Environmental regulations regarding pond liners and disposal
Rotating Vacuum Drum Concentrator followed by Evaporation Pond	Small Footprint due to decreased size of evaporation pond (due to mechanical volume reduction)	High OPEX cost due to energy consumption
Rotating Vacuum Drum Concentrator followed by Centrifuge	Small Footprint Produces a salt that can be landfilled directly	Capital Cost (still significant lower than Crystalliser) Higher Energy Consumption

Optional strategy component:

- Irrigate haul roads and stockpiles with pit water, to increase the evaporation rate.
- However, this will also increase the concentration of contaminants in the pit water, due to the water salts inevitably being washed back in to the pit by stormwater;
    - This can be accommodated for by designing the RO system accordingly, which will increase the capital and operational costs.

If required, Victory and Emerald are able to assist with further tailoring the process to suit the needs of the client.

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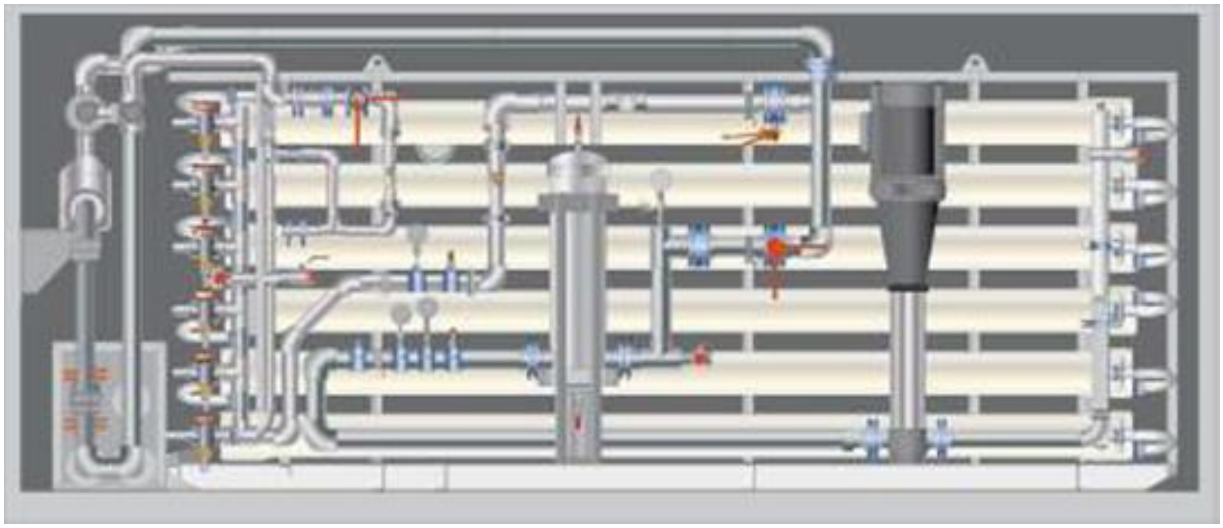
Appendix A

Examples Images of Various Reverse Osmosis Process Components (Purchase and Rent)

RO Container / Skid:



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Multi-Media Filter:

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Appendix B

Average Pit Water Characteristics – via 4Pillars

The following water profile was used as the basis for water treatment strategy developed, and the associated desktop and software modelling; note that some of the figures were altered slightly by Victory's licenced water treatment modelling software ('EnviroSuite: Prophet'), as the chemical profile did not balance ionically initially:

Analyte	Units	Value	Analyte	Units	Value
Total dissolved solids	mg/L	2205	Fluoride	mg/L	0
Total suspended solids	mg/L	-	Hydrogen Sulphide as S	mg/L	0
Turbidity	NTU	3.1	Hydroxide	mg/L	0
Conductivity	µS/cm	3848	Iodide	mg/L	0
pH		8.64	Iron	mg/L	0.09
Temperature	°C	20	Lead	mg/L	0.002
Dissolved organic carbon	mg/L	0	Lithium	mg/L	0
Total organic carbon	mg/L	0	Magnesium	mg/L	93.75
UV254	cm-1	0	Manganese	mg/L	0.1
True Colour	HU	0	Mercury	mg/L	0
Total Alkalinity	mg/L as CaCO3	331	Molybdenum	mg/L	0
Aluminium	ug/L	16.67	Nickel	mg/L	0.00167
Ammonia as N	mg/L	0.02	Nitrate as N	mg/L	1.42
Arsenic	mg/L	0.00133	Nitrite as N	mg/L	0
Barium	mg/L	0	Oxygen (dissolved)	mg/L	0
Bicarbonate as HCO3(-)	mg/L	0	Phosphorus as P	mg/L	0.017
Boron	mg/L	0	Potassium	mg/L	13.25
Bromide	mg/L	0	Selenium	mg/L	0.01
Cadmium	mg/L	0	Silica as SiO2	mg/L	0
Calcium	mg/L	0	Sodium	mg/L	663.75
Carbon dioxide as CO2	mg/L	0	Strontium	mg/L	0
Carbonate as CO3(2-)	mg/L	0	Sulphate as SO4(2-)	mg/L	0
Chloride (adjusted)	mg/L	1376.126	Uranium	mg/L	0
Chromium as CrO4(2-)	mg/L	0	Vanadium	mg/L	0
Cobalt	mg/L	0	Zinc	mg/L	0.0175
Copper	mg/L	0.00167			

Note that Sulphates were set to zero, as the provided water analyses did not test for Sulphates – however, this is very unlikely to be the case, and future chemical analyses should include the following as well, both Total and Dissolved:

- Manganese;
- Strontium;

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- Molybdenum;
- Reactive Silica;
- Sulphates;
- Fluorides;
- Boron;
- Oxidation-Reduction Potential (ORP).

Appendix C

Reverse Osmosis Report from Emerald Process Engineering

To:	Stewart Reeve (Victory Engineering)	**Date:**	28/10/2022
From:	Victoria Kippax (Emerald Process Engineering)		
cc:			
Subject:	**Luddenham Quarry Dewatering**		

Forward: Note that this Memorandum has been edited by Victory Engineering (on 31/10/22), to conveniently include specific details in a single communication.

Background

The Luddenham Quarry currently contains 170 ML of water that needs to be removed. In addition to the current 170 ML, there is an anticipated 30 ML/ year of ground and rain water runoff that would need to be removed on an ongoing basis (a total of ~200ML needing treatment for an 12-month campaign).

Based on the sampling conducted as part of the Discharge Characterisation and Water Pollution Impact Assessment (20220601KLF_DCWPIA, September 2022), the following Quarry Water Quality and Discharge Requirements were used to develop an initial water treatment concept.

Table 1: Luddenham Quarry Water Quality and Discharge Limits

Parameter	Units	Quarry	Discharge Requirement
pH		8.7	6.5 - 8.0
Conductivity	uS/cm	3,850	1,100
Turbidity	NTU	2 - 7	6 - 50
Hardness	mg/L $CaCO_3$	363	20 - 100
Aluminium Dissolved	ug/L	17	
Manganese Dissolved	ug/L	15	
Iron Dissolved	ug/L	90	
Alkalinity	mg/L $CaCO_3$	330	>20

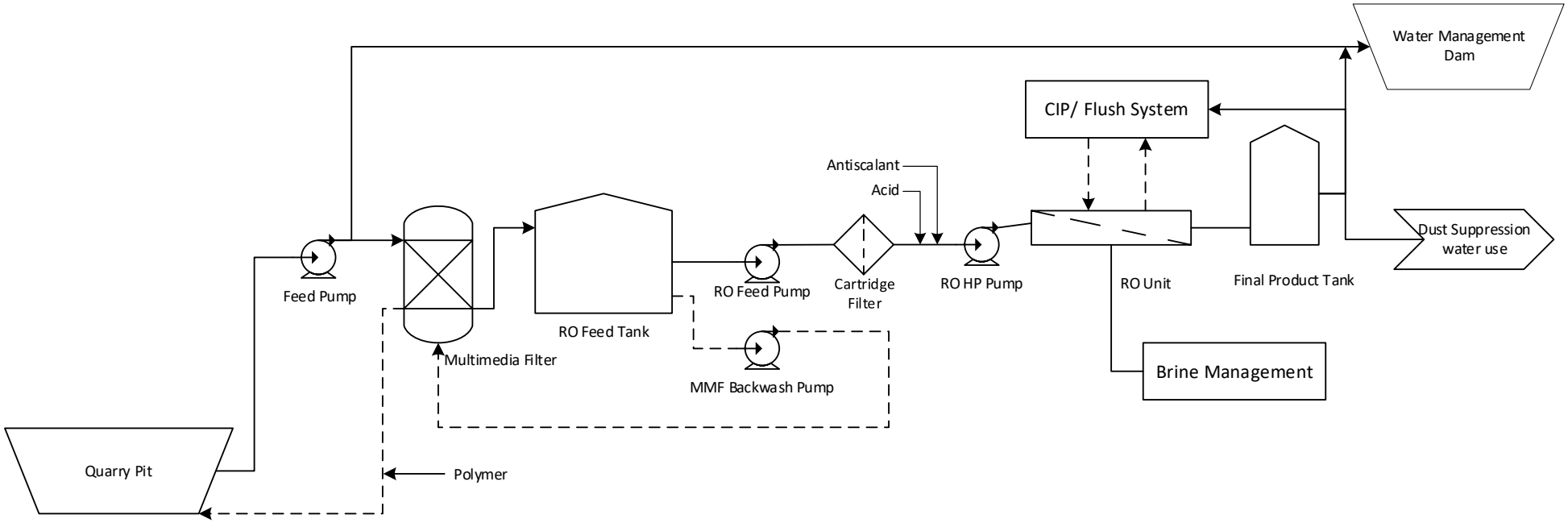
Note: *the average Quarry water quality was used as a basis, further sampling and development of the water envelope would be required to formalise the suggested water treatment concept.*

Water Treatment Concept

The key parameters of focus for the water treatment concept are:

1. Removing dissolved solids to lower the conductivity to less than 1,100 uS/cm (ANZECC 2000)
2. Correcting pH to between 6.5 and 8.0 as required under ANZECC 2000 guidelines for lowland river in south-east Australia.
3. Maintain or lowering heavy metal contaminants.
4. Nutrient removal to both protect downstream process equipment and meet the lowland river discharge requirements.

With the removal of nutrients such as ammonia and nitrogen (necessary) in the Quarry pit with the use of diatom-based treatment tech for passive dam treatment, the initial water treatment concept is as follows:


Water Management Dam
CIP/ Flush System
Antiscalant
Acid
Dust Suppression water use
Feed Pump
RO Feed Pump
Cartridge Filter
RO HP Pump
RO Unit
Final Product Tank
RO Feed Tank
Multimedia Filter
MMF Backwash Pump
Brine Management
Quarry Pit
Polymer

The initial water treatment concept consists of the following:

Treated Water Flow: The concept has been developed to produce approximately 500 to 1,000 L/min of Reverse Osmosis permate (high-quality water).

Feed Pump: operates at a flow range of 30 to 60 m^3/hr (500 to 1000 L/min) that draws water from the Quarry, with 40 m3/hr flowing into the Multimedia Filter.

Multimedia Filtration: the feed water can be feed into the multimedia filter consisting of anthracite, river-sand and gravel layers. The filter is used to remove any solids including insoluble heavy metals that are in the quarry water. Periodically, approximately once every 24 hours, the Filter will automatically stop filtering for 40-60 minutes to automatically backwash the filter with air and filtered water to clean the filter media. This action will use approximately 15 – 20 m^3 of filtered water. Currently, the concept assumes that the backwash waste water can be returned to the quarry pit after the addition of a polymer to assist with binding the solids. Note: typically, ~1-3% of the total treated flow will be used as backwash water, depending on the turbidity of the raw water.

RO System: the RO system is used to remove salts, conductivity and hardness. The RO unit with low pressure feed pump, 2 micron cartridge filters, high pressure feed pump and a single pass 2-stage RO unit with a total of 6 RO vessels, dosing systems for antiscalant and acid as required, and manual CIP (membrane 'Clean In Place') rig would be housed in 2 x 40ft containers that could be shipped directly to site. An RO recovery of 80% has been selected to minimise the amount of on site operation time due to issues with RO scaling. Periodic cleaning of the RO membranes with caustic and acid would occur on a 3-4 monthly basis depending on the amount of membrane scaling. A higher %-recovery RO system could be selected to reduce the volume of waste brine concentrate – however, this comes with the increased risk of membrane fouling, damage, downtime, and the potentially-expensive prospect of membrane replacement (Note: RO system selection is a balance of capital cost, operational cost, membrane risk, recovery efficiency, and brine volumes).

RO Permeate: the permeate exiting the RO system would have a conductivity of 200 to 400 uS/cm depending of the final RO membrane selection, a pH of between 7.2 and 7.8, with minimal dissolved heavy metal residue and little hardness.

Flow Split: Due to the quality of the RO permeate, there is an opportunity to divert a small potion of the Quarry water directly to the Water Management Dam where it could mix with the RO permeate to produce the water quality required for discharge. On a preliminary basis, it is anticipated that this would be a blend 2/3 RO permeate to 1/3 raw Quarry water (Note: all waters pre-treated for nutrients). This would allow the treatment of up to 45m^3/hr (750 L/min). It would also provide some flexibility for the operation of the facility dependent on the water quality.

Control and Communications: The system would include standalone PLC (Programmable Logic Controller), MCC (Main Control Cabinet), and control system with remote telemetry.

Timeframes: Based on the above design parameters, and assuming a total treatment of ~200ML (including 30ML/yr extra water inflows): if operated at the maximum discharge flow of 1000 L/min, the initial campaign would be completed in a 6 - 8 month time frame, taking into account downtime for maintenance and cleaning.

Based on the above design parameters, and assuming a total treatment of ~200ML (including 30ML/yr extra water inflows): if a discharge flow of 500 L/min was utilised (just using RO) without blending, the initial campaign would be completed in a 12 – 14 month time frame taking into account downtime for maintenance and cleaning.

Note: assumed operational times:

- 20 hours per day operation;
- 3 week window for maintenance and cleaning.

Other Important Design and Operational Considerations

Brine Management

As with all RO systems, brine waste must be managed.

For this system, the RO concentrate is produced at a rate of 7.5 m^3/hr, over the initial dewatering campaign of 170 ML, this would equate to 25 ML (on a 200ML / 12-month total water basis).

There are several options for brine management which could be utilised depending on the specific constraints on the site, they include:

Brine Management	PRO	CON
Brine Crystalliser	Minimal Footprint Produces a salt that can be landfilled directly	High Capital Cost ($15-20 M) No option to rent High Energy Consumption
Evaporation Pond	Low Capital Investment Low OPEX cost	Large Footprint Environmental regulations regarding pond liners and disposal
Rotating Vacuum Drum Concentrator followed by Evaporation Pond	Small Footprint due to decreased size of evaporation pond	High OPEX cost due to energy consumption
Rotating Vacuum Drum Concentrator followed by Centrifuge	Small Footprint Produces a salt that can be landfilled directly	Capital Cost (still significant lower than Crystalliser) Higher Energy Consumption

Note: some further investigation of the client drivers and constraints would be required to provide additional detail to the brine management solutions.

Redundancy

To minimise the initial capital cost, the initial concept includes little process redundancy (such as item backups). Therefore, if the RO system should have a fault such as an RO Pump failure, a scaling issue with the RO unit then production would stop until rectified. This would have an impact on the overall schedule for dewatering.

There are multiple options to provide some redundancy, however, this would increase the

capital/rental cost.

Changes in Quarry Water Quality

As the Quarry is dewatered, it is anticipated that there will be some changes in the water characteristics. This may be particularly relevance after the initial dewatering campaign.

There are several areas of concerns regarding the Quarry Water quality and its impact on the water treatment system:

1. Turbidity/ Solids: If the turbidity rose above 30- 50 NTU then additional pre-treatment may be required. This may include utilising the new Water Management Dam as a settling pond by addition of coagulant and polymer to remove solids prior to pump to the water treatment system.
2. Salinity: The current design utilises brackish water RO membranes which operate up to 15-20,000 mg/L TDS, if the salinity was consistently above that level then the system would need to be reconfigured for seawater RO membranes with higher operating pressures.
3. Dissolved metals: currently the dissolved metal concentrations are low and do not require addition pre-treatment prior to the RO. However if dissolved manganese is above 0.1 mg/L, dissolved iron or aluminimum is above 0.5 mg/L then it may be necessary to pre-treatment the water by oxidising these metals and removing them through the filtration prior to the RO.
4. Reactive Silica: Dissolved silica can significantly influence the formation of stubborn metal-silicate scales, which are destructive for RO membranes. The average water profile provided did not measure for silica, and this (in addition to other additional analytes) ought to be done prior to proper RO system specificiation.

Proper System Specification

The above evaluations are indicative only, based on a number of assumptions, and a limited average water profile.

To assist with the possible future design of the water treatment system, it is highly recommended that additional sampling of the quarry at various depths is conducted with a full suite of cation and anion analysis as well as the metals listed in the previous sampling regime, with the addition of:

- Manganese;
- Strontium;
- Molybdenum;
- Reactive Silica;
- Sulphates;
- Fluorides;
- Oxidation-Reduction Potential (ORP).

Note: it is possible that de-stratification of the pit water body during the initial nutrient polishing treatment will significantly improve the homogeneity of the water body, potentially making further water sampling easier and more representative. Periodic sampling of the water body during the nutrient treatment stage is recommended, so that any RO (or other) design can be adjusted accordingly.

Costing

All values given below are indicative only, on a +/- 50% basis, and are based on the preliminary information available and the above water treatment concept excluding brine management.

Rental Cost : $145,000 per month + one off mobilisation and demoblisation costs of $132,000

CAPEX : $8,000,000 (+/- 50%) (all inclusive cost)

OPEX : $ 480 per ML (chemical + power + cartridge filter consumables)

Operating Contact (Labour): $15,000 per month, this would include monitoring of the site, preventive maintenance, conducting cleaning as needed, changing of cartridge filters and replenishing chemicals.