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

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This report has been prepared in accordance with the brief provided by the client and has relied upon the information collected at the time and under the conditions specified in the report. All findings, conclusions or recommendations contained in the report are based on the aforementioned circumstances. The report is for the use of the client and no responsibility will be taken for its use by other parties. The client may, at its discretion, use the report to inform regulators and the public.

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:

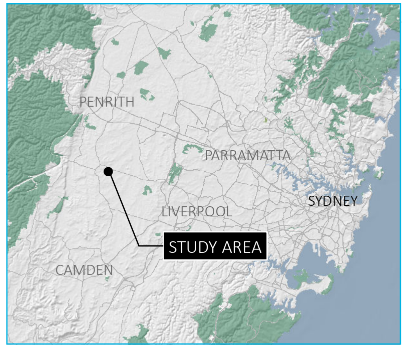
- describe and characterise the existing surface water environment;
- detail the surface water management system at the site;
- identify and assess impacts to surface water as a result of the proposed modification; and
- develop management and mitigation measures to reduce the impacts to surface water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

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Site locality

Luddenham Quarry - Modification 5
Surface Water Assessment
Figure 1.1

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

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GDA 1994 MGA Zone 56

N

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

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

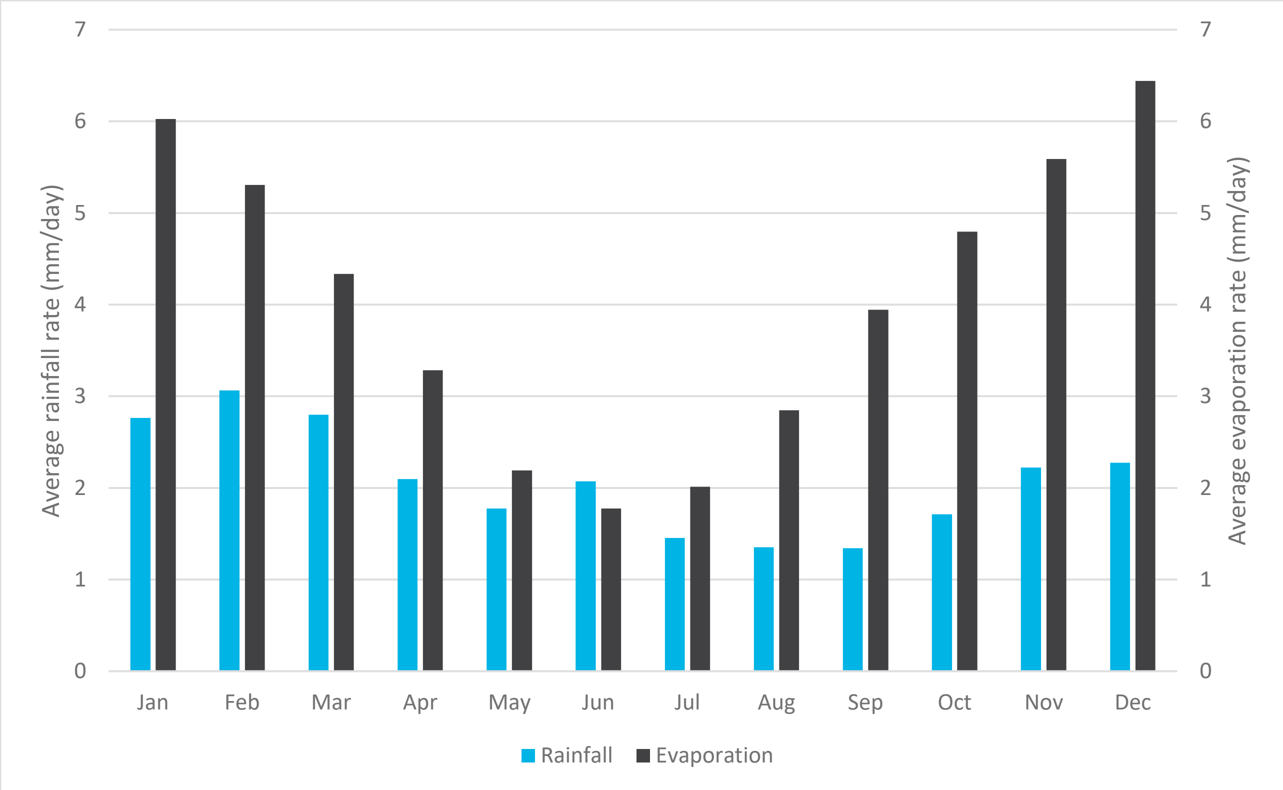

Figure 3.1 Average daily rainfall and evaporation rates

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.

KEY

- Study area
- Western Sydney Airport
- Major road
- Minor road
- Vehicular track

Strahler stream order

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

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

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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.

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

0 100 200 m

GDA 1994 MGA Zone 56

N

KEY

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

Water quality monitoring locations

Luddenham Quarry - Modification 5
Surface Water Assessment
Figure 3.3

EMM
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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.

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

0 50 100 m
GDA 1994 MGA Zone 56
N

KEY
- Study area
- Cadastral boundary
- Watercourse
- Proposed transfer point
- Licensed discharge point

Proposed road alignment
- Sealed
- Unsealed

On-site drainage lines
- Clean water diversion
- Piped drainage
- Water management
- Water storages

Sub-catchments
- Clean water catchment
- Pit catchment
- Water Management Dam catchment

Proposed water management system layout

Luddenham Quarry - Modification 5
Surface Water Assessment
Figure 4.1

EMM creating opportunities

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 0.2 ML	6,431 m^3 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.

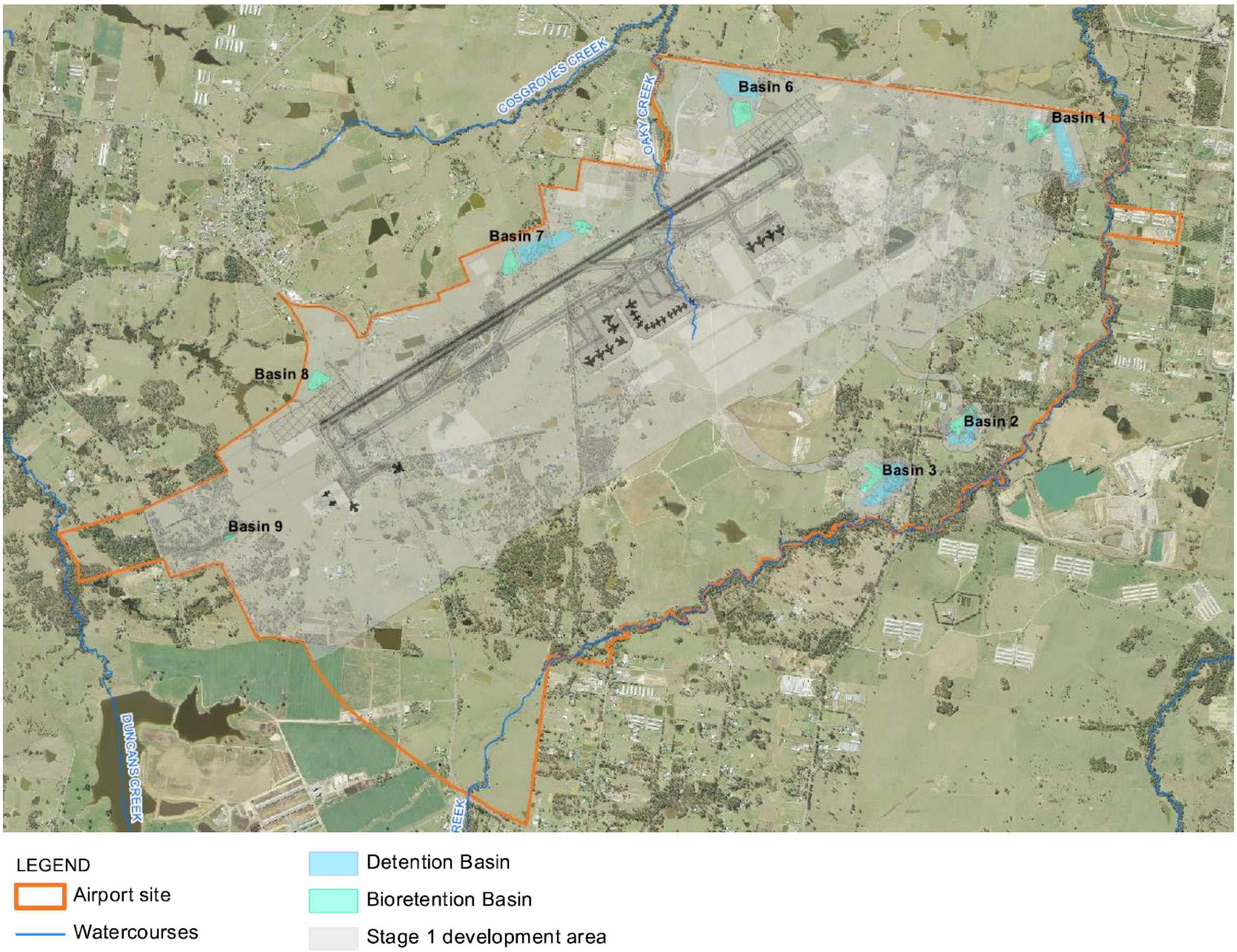


Figure 4.2 Western Sydney Airport - Stage 1 development (GHD 2016)

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.

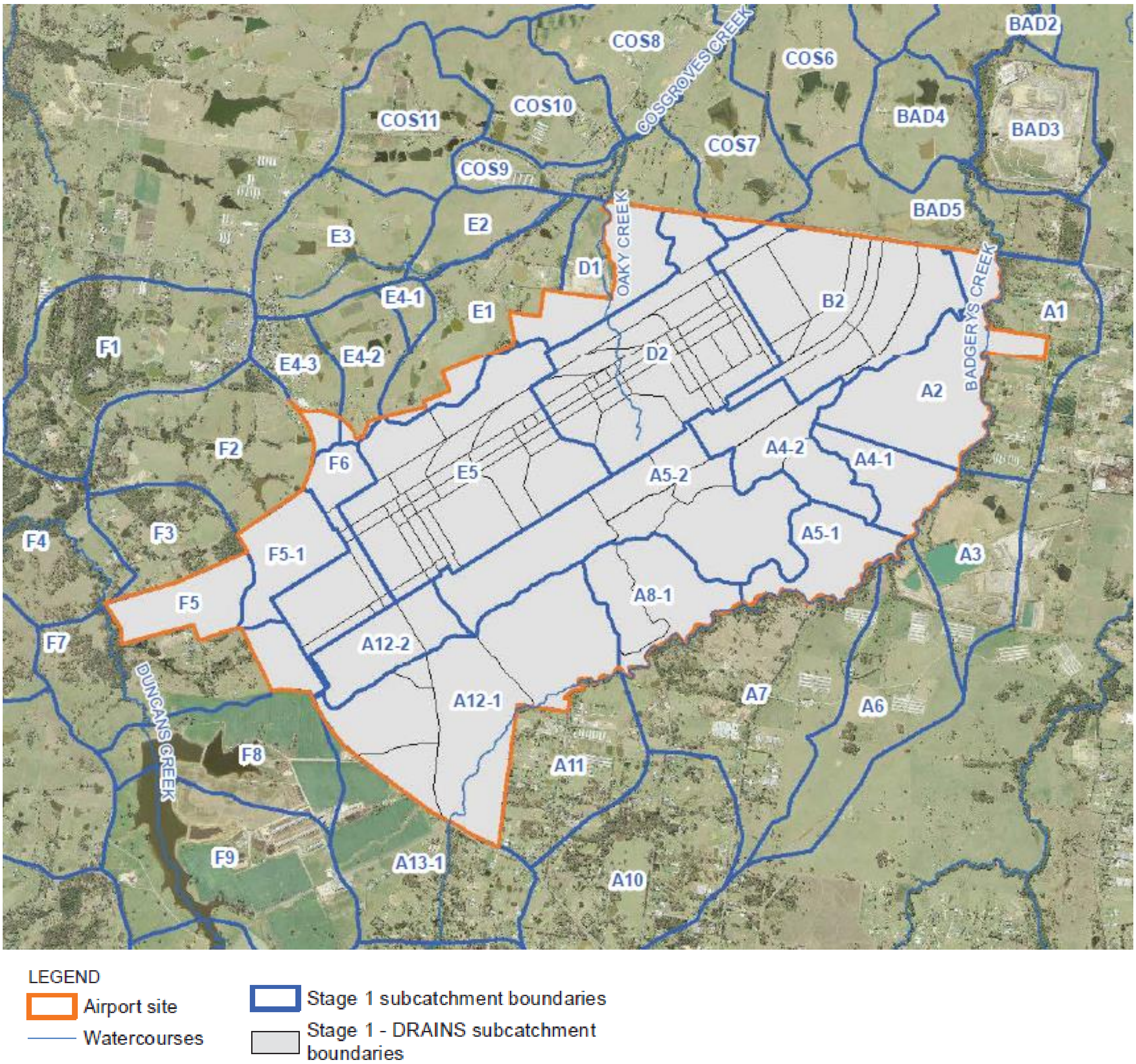


Figure 4.3 Western Sydney Airport - Stage 1 catchment boundaries (GHD 2016)

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.

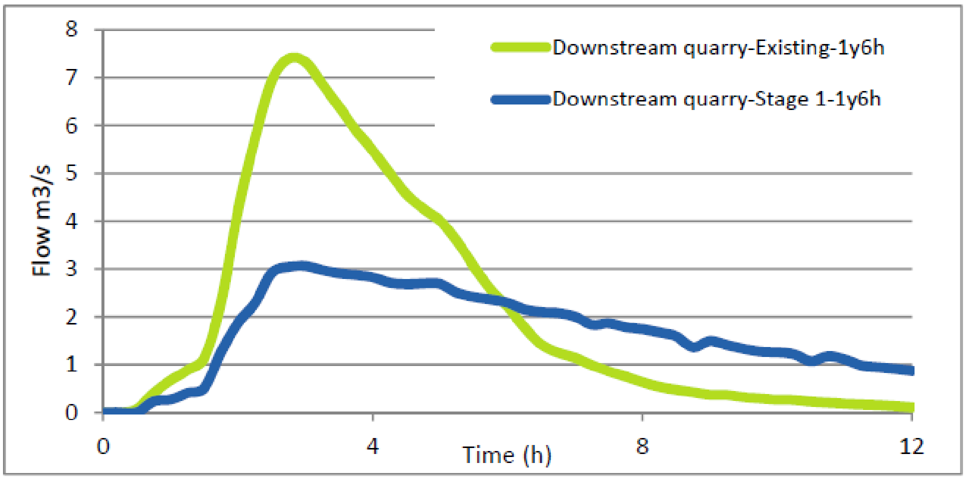


Figure 4.4 Comparison of existing and Stage 1 flows for Oaky Creek (one-year average recurrence interval event) (GHD 2016)

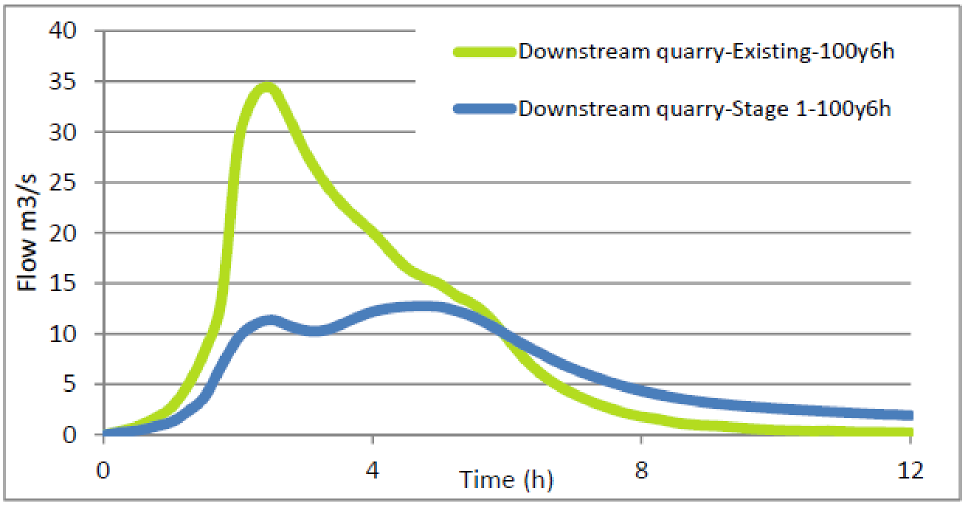
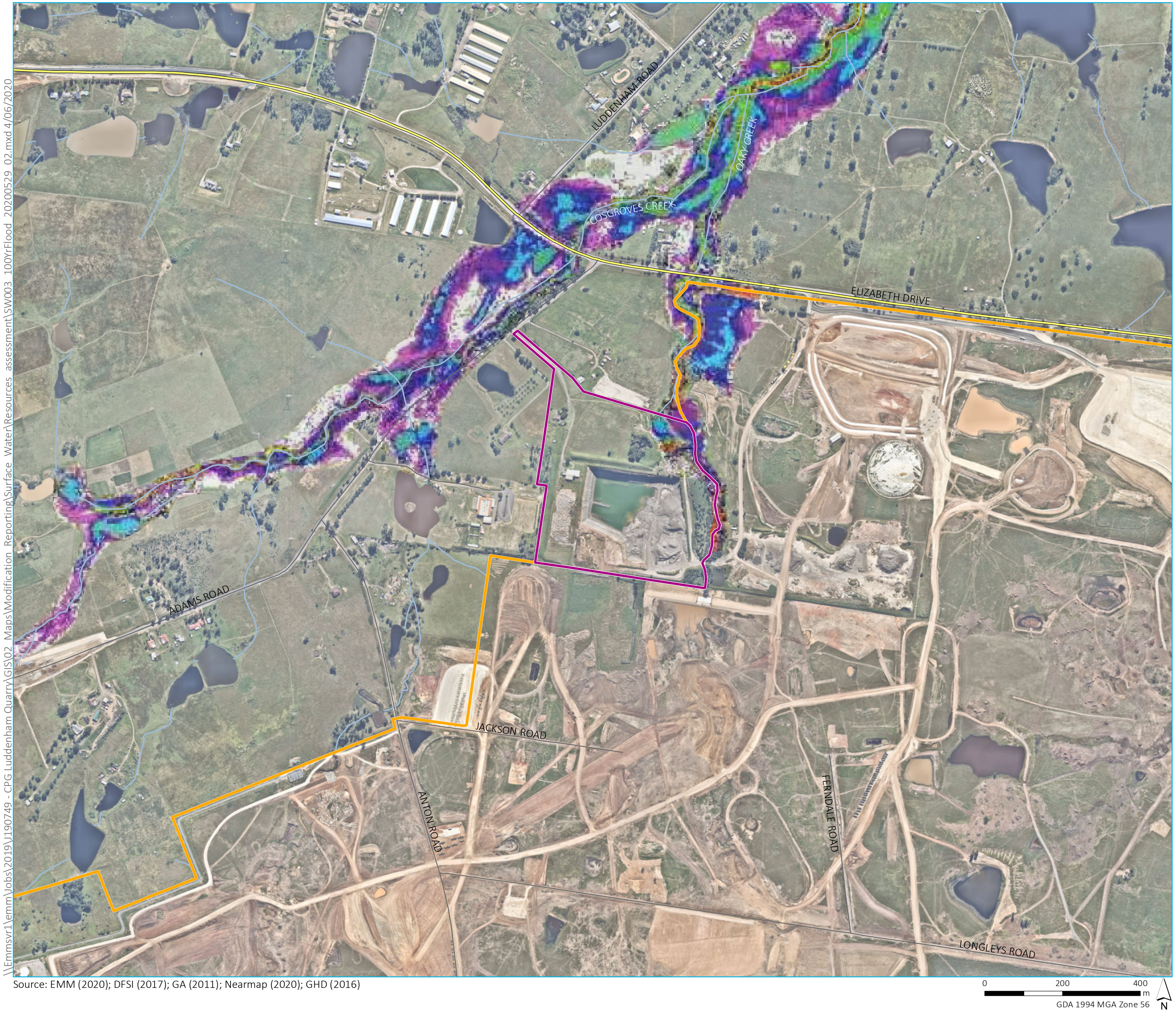


Figure 4.5 Comparison of existing and Stage 1 flows for Oaky Creek (100-year average recurrence interval event) (GHD 2016)

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.



Source: EMM (2020); DFSI (2017); GA (2011); Nearmap (2020); GHD (2016)

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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.

100-year average recurrence interval flood depth

Luddenham Quarry - Modification 5
Surface Water Assessment
Figure 4.6

EMM
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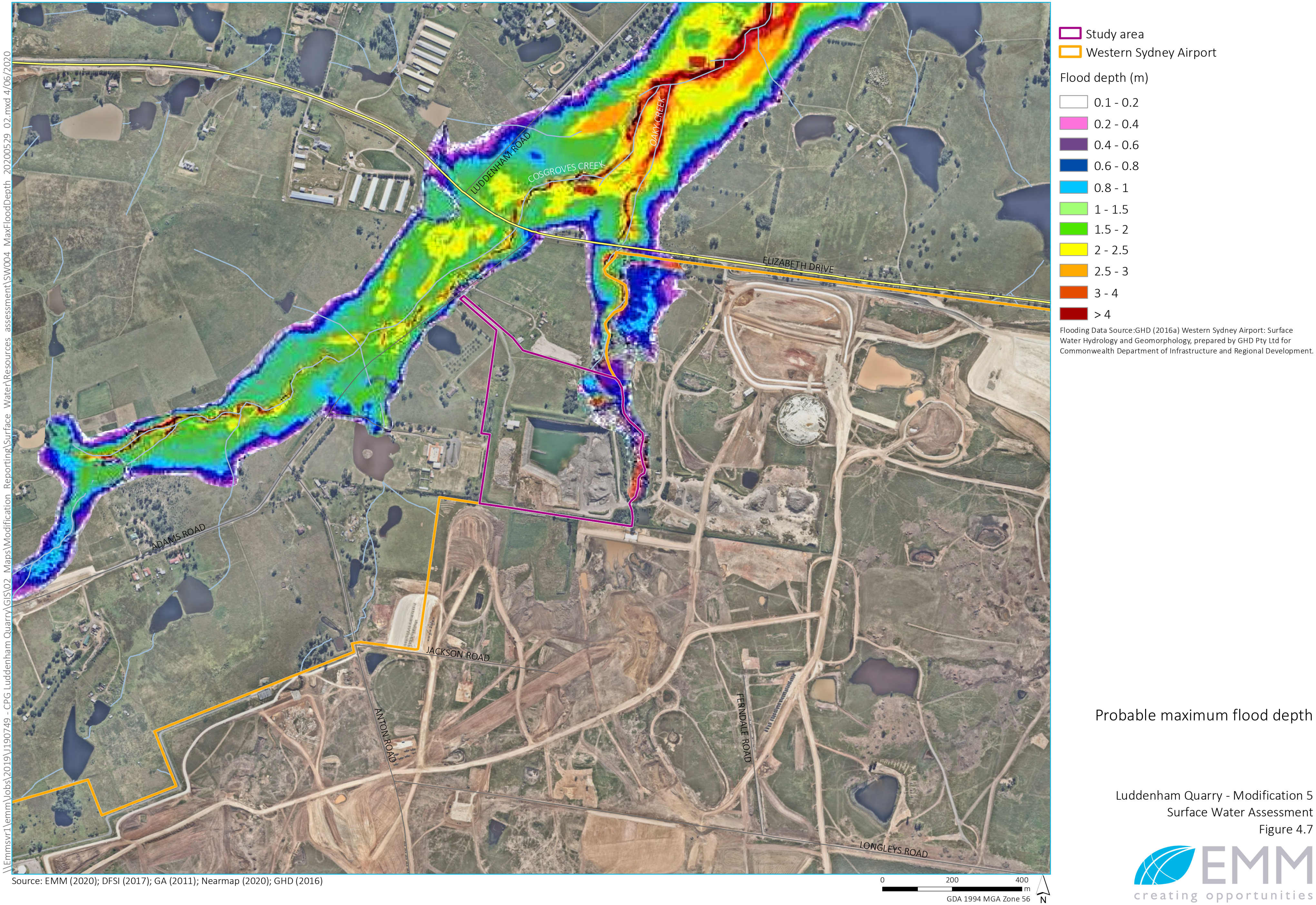

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Source: EMM (2020); DFSI (2017); GA (2011); Nearmap (2020); GHD (2016)

Probable maximum flood depth

Luddenham Quarry - Modification 5
Surface Water Assessment
Figure 4.7

creating opportunities

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.

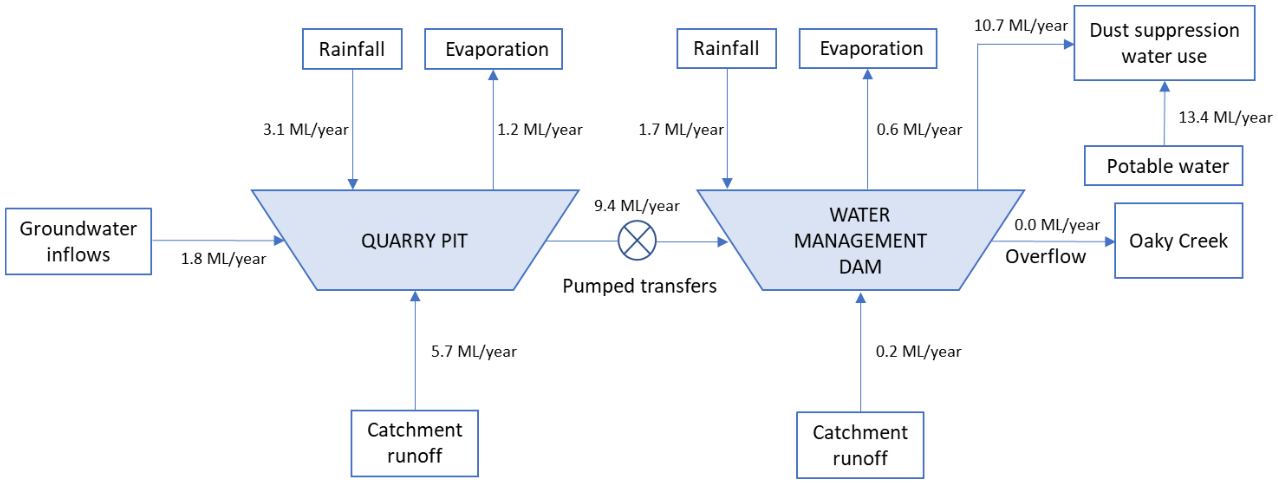

Figure 5.1 **Water balance results – typical dry rainfall year**

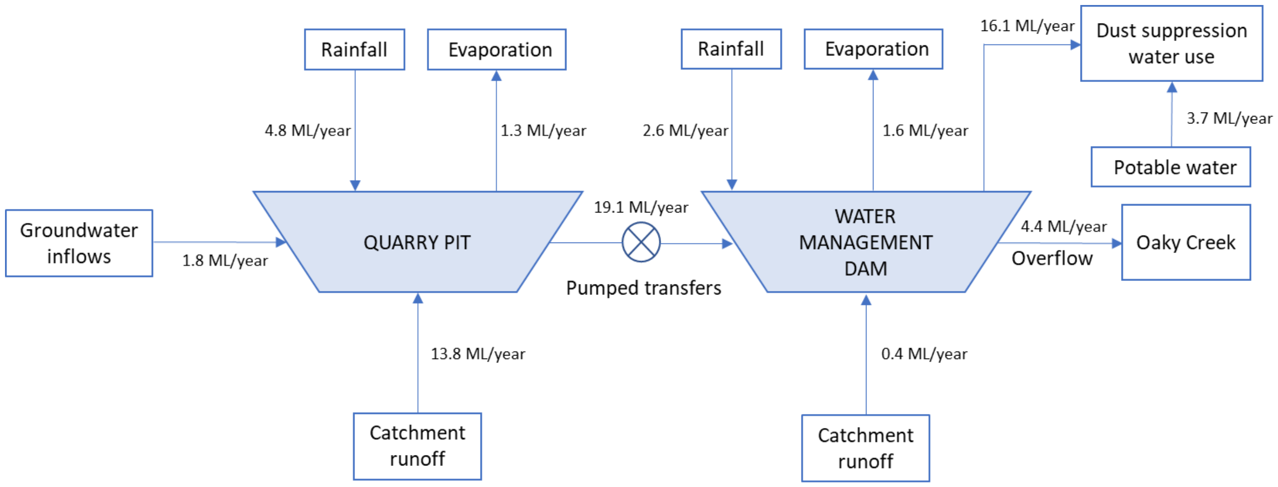

Figure 5.2 **Water balance results – typical median rainfall year**

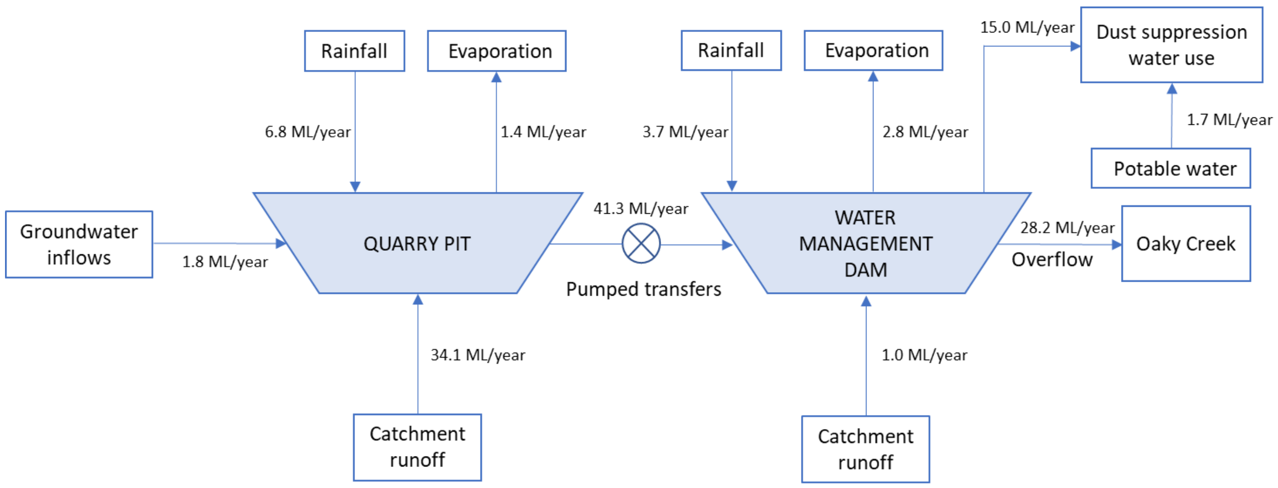

Figure 5.3 **Water balance results – typical wet rainfall year**

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 Primary contact recreation	Maintaining or improving water quality for activities such as boating or wading, where there is a low probability of water being swallowed. Maintaining or improving water quality for activities such as swimming in which there is a high 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.
Livestock water supply Irrigation water supply	Protecting water quality to maximise the production of healthy livestock. Protecting the quality of waters applied to crops or pasture.	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.
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 Drinking water at point of supply – clarification and disinfection Drinking water at point of supply – groundwater	These objectives apply to all current and future licensed offtake points for town water supply and to specific sections of rivers that contribute to drinking water storages or immediately upstream of town water supply offtake points. The 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.
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






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