

VICKERY EXTENSION PROJECT

ENVIRONMENTAL IMPACT STATEMENT

APPENDIX N

AQUATIC ECOLOGY

ASSESSMENT



Vickery Extension Project - Aquatic Ecology Assessment

Prepared for
Whitehaven Coal Limited

April 2018



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Executive Summary

The former Vickery Coal Mine and the former Canyon Coal Mine are located approximately 25 kilometres (km) north of Gunnedah, in New South Wales (NSW). Open cut and underground mining activities were conducted at the former Vickery Coal Mine between 1986 and 1998. Open cut mining activities at the former Canyon Coal Mine ceased in 2009. The former Vickery and Canyon Coal Mines have been rehabilitated following closure.

The approved Vickery Coal Project (herein referred to as the Approved Mine) is an approved, but yet to be constructed, project involving the development of an open cut coal mine and associated infrastructure, and would facilitate a run-of-mine (ROM) coal production rate of up to approximately 4.5 million tonnes per annum (Mtpa) for a period of 30 years.

Whitehaven Coal Limited (Whitehaven) is seeking a new Development Consent for extension of open cut mining operations at the Approved Mine (herein referred to as the Vickery Extension Project [the Project]). This would include a physical extension to the Approved Mine footprint to gain access to additional ROM coal reserves, an increase in the footprint of waste rock emplacement areas, an increase in the approved ROM coal mining rate and construction and operation of a Project Coal Handling and Preparation Plant, train load-out facility and rail spur. This infrastructure would be used for the handling, processing and transport of coal from the Project, as well as other Whitehaven mines.

Eco Logical Australia (ELA) was commissioned by Whitehaven to prepare this aquatic ecology assessment for the Project. The study area for this assessment incorporates the watercourses proposed for crossing by the Project rail spur as well as watercourses downstream of the Project. The study area includes the Namoi River, which is a large, deeply incised floodplain river with flow regulated by releases from Keepit Dam. A series of small ephemeral creeks in the Project area drain into the Namoi River downstream of the Project. These include Driggle Draggles Creek, Deadmans Gully and Stratford Creek, which are mostly dry watercourses.

The assessment began with a desktop review of threatened species and their habitat as listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act) and/or the NSW *Fisheries Management Act, 1994* (FM Act), and was followed by field surveys. Four sites were surveyed along the Namoi River, and visual habitat assessments were undertaken at a further three sites on the Namoi River. Habitat assessments were undertaken at two sites on Driggle Draggles Creek (as this creek was dry).

Flow in the Namoi River was low when sampled in late February and early March 2016, with water restricted to standing pools. Sites along the Namoi River were in a condition typical of inland rivers that are in the drying phase of their hydrograph. Large woody debris was present at all of the Namoi River sites, providing plenty of structure for fish. Eel-tailed catfish (*Tandanus tandanus*), listed as an endangered population in the Murray-Darling Basin under the FM Act, were collected from two sites on the Namoi River (one upstream and the other downstream of the Project area), while Murray cod (*Maccullochella peelii peelii*), listed as vulnerable under the EPBC Act, was collected at a single location downstream of the Project area. Both of these species are likely to occur along the reach of the Namoi River that is subject to this study.

The two sites on Driggle Draggie Creek were dry during the field survey, but they were assessed for their potential to provide aquatic habitat. Neither site had areas that are likely to create deep pools when surface water flows through the site. Driggle Draggie Creek is not likely to provide habitat for any threatened fish species and potential impacts (if any) on aquatic ecology in this watercourse would be minimal.

Access to Deadmans Gully was not permitted during the survey, so two sites (DG1 and DG2) were assessed remotely using satellite imagery. This gully is mostly dry and does not constitute any significant fish habitat.

Ten bores, two of which are located in the Driggle Draggie Creek alluvium, as well as a selection from the Namoi River alluvium and deeper rock aquifers, were sampled for stygofauna. Four stygofauna taxa were collected from three bores in the Namoi River alluvial aquifer. The stygofauna collected during this survey are all widespread taxa and, consequently, have low conservation value. They are likely to occur throughout large sections of the Namoi River alluvial aquifer, so it is unlikely the Project would have a significant impact on the stygofauna community.

The Project would have negligible adverse impacts on water quality (Advisian 2018), given the proposed water management strategy. HydroSimulations (2018) concludes that groundwater drawdown associated with the Project would present negligible risk to the Namoi River. As such, the Project would not have a significant impact on aquatic ecology in or around the Project area.

The potential impacts of the Project on threatened species and communities listed under the EPBC Act and/or the FM Act were assessed in accordance with the *Threatened Species Assessment Guidelines - the Assessment of Significance* and the *Significant Impact Guidelines 1.1 - Matters of National Environmental Significance*. The Project would not have a significant impact on any threatened aquatic species, population or community known or likely to occur within the Project locality.

There are a number of existing mitigation measures implemented for the Approved Mine that would be continued for the Project, including the design and operating procedures for the approved pumping station, progressive rehabilitation of the Project area and implementation of a surface water monitoring program. In addition to the existing measures, the design and construction of the Project rail spur would be undertaken in accordance with the Department of Primary Industries (DPI) Fisheries *Policy and Guidelines for Fish Habitat Conservation and Management (Update 2013)*.

The Project would not require any biodiversity offset or compensatory measure for potential impacts to aquatic ecology in accordance with DPI Fisheries *Policy and Guidelines for Fish Habitat Conservation and Management (Update 2013)* or the *EPBC Act Environmental Offsets Policy*.

1 Introduction

The former Vickery Coal Mine and the former Canyon Coal Mine are located approximately 25 kilometres (km) north of Gunnedah, in New South Wales (NSW) (Figure 1). Open cut and underground mining activities were conducted at the former Vickery Coal Mine between 1986 and 1998. Open cut mining activities at the former Canyon Coal Mine ceased in 2009. The former Vickery and Canyon Coal Mines have been rehabilitated following closure.

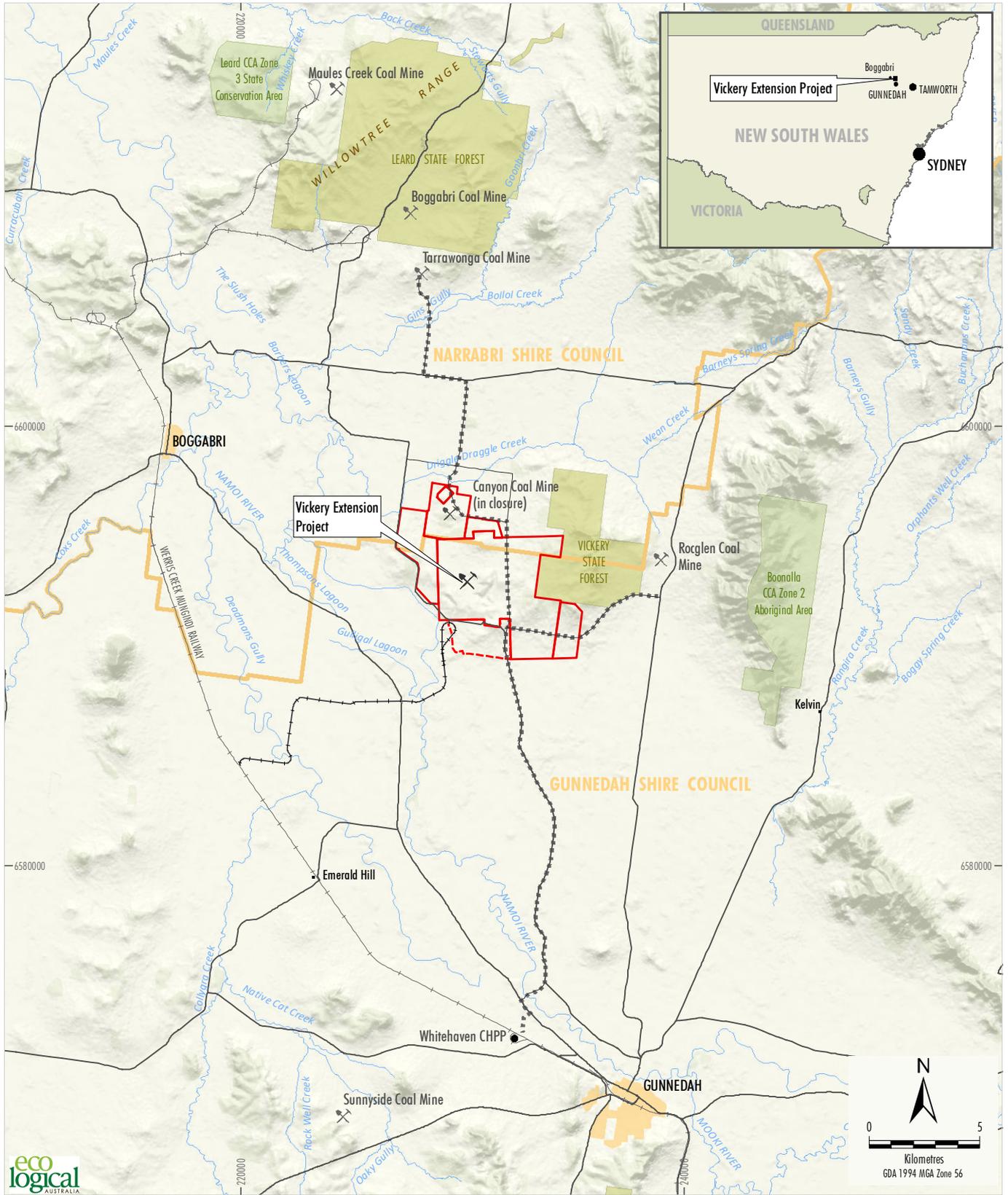
The approved Vickery Coal Project (herein referred to as the Approved Mine) is an approved, but yet to be constructed, project involving the development of an open cut coal mine and associated infrastructure, and would facilitate a run-of-mine (ROM) coal production rate of up to approximately 4.5 million tonnes per annum (Mtpa) for a period of 30 years.

Whitehaven Coal Limited (Whitehaven) is seeking a new Development Consent for an extension of open cut mining operations at the Approved Mine. This would include a physical extension to the Approved Mine footprint to gain access to additional ROM coal reserves, an increase in the footprint of waste rock emplacement areas, an increase in the approved ROM coal mining rate and construction and operation of a Project Coal Handling and Preparation Plant (CHPP), train load-out facility and rail spur (Figure 2). This infrastructure would be used for the handling, processing and transport of coal from the Project, as well as other Whitehaven mines.

The Project involves mining the coal reserves associated with the Approved Mine, as well as accessing additional coal reserves within the Project area. ROM coal would be mined by open cut methods at an average rate of 7.2 Mtpa over 25 years, with a peak production of up to approximately 10 Mtpa.

Figure 2 illustrates the general arrangement of the Project. A detailed description of the Project is provided in Section 2 in the Main Report of the Environmental Impact Statement (EIS).

This Aquatic Ecology Assessment forms part of an EIS, which has been prepared to accompany a Development Application made for the Project in accordance with Part 4 of the NSW *Environmental Planning and Assessment Act, 1979* (EP&A Act).



WHC15-39_Amp_AEA_2017



LEGEND

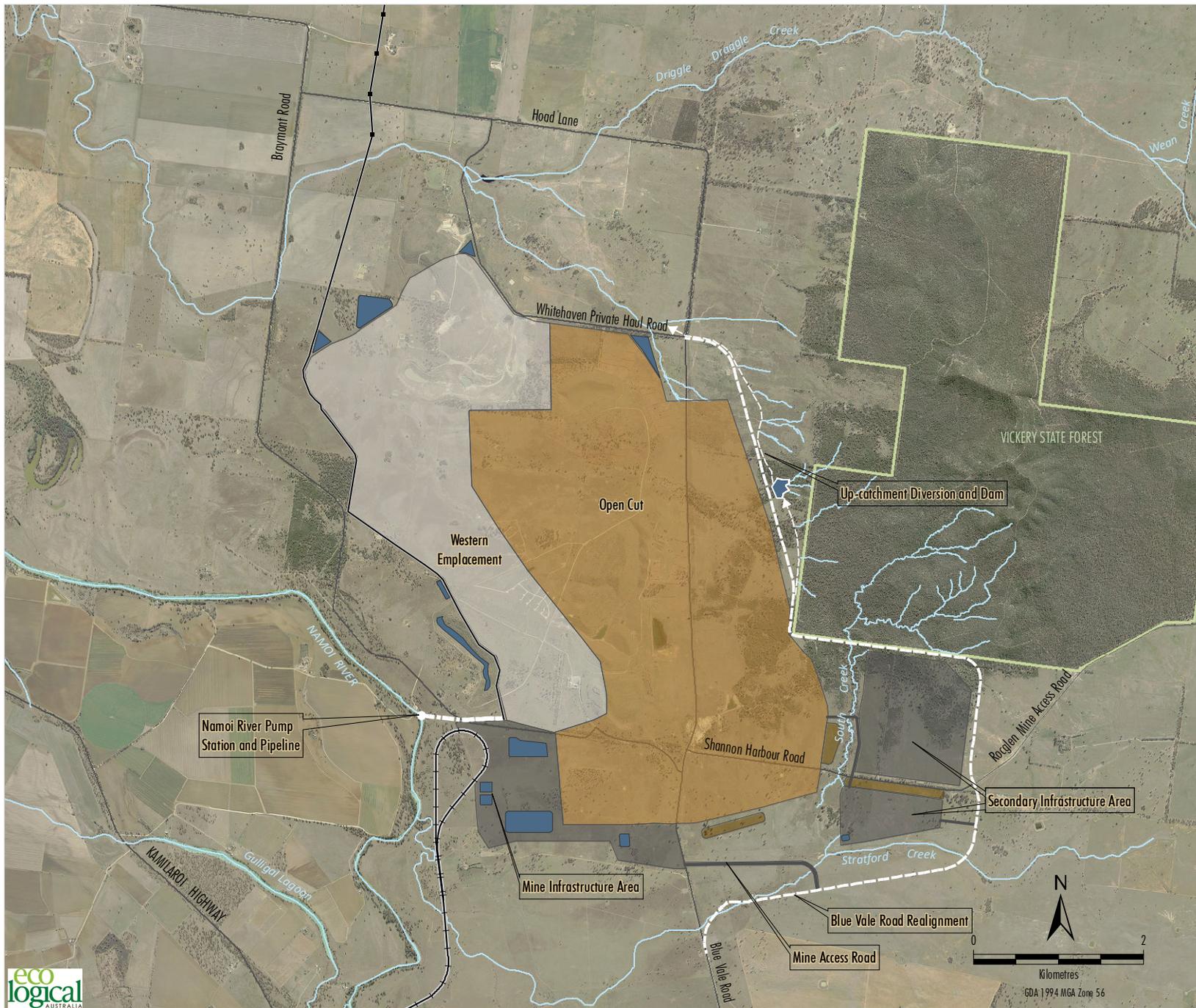
- Mining Tenement Boundary (ML and CL)
- Mining Lease Application (MLA)
- Local Government Boundary
- State Forest
- State Conservation Area, Aboriginal Area
- Major Roads
- Railway
- Approved Road Transport Route
- Indicative Project Rail Spur

Source: LPMA - Topographic Base (2010); NSW Department of Industry (2015)



VICKERY EXTENSION PROJECT
Project Location

Figure 1



- LEGEND**
- State Forest
 - Project Components**
 - Indicative Extent of Open Cut
 - Indicative Extent of Out of Pit Waste Rock Emplacement
 - Indicative Extent of Infrastructure Area
 - Indicative Extent of Soil Stockpile
 - Indicative Extent of Water Storage
 - Indicative Mine Access Road Alignment
 - Indicative Namoi River Pump Station and Pipeline
 - Indicative Road Realignment
 - Indicative Up-catchment Diversion and Dam Location
 - Indicative Rail Spur Alignment
 - Indicative Location of Groundwater Bores and Pipeline

Source: Orthophoto - Department of Land and Property Information, Aerial Photography (July 2011); Department of Industry (2015); Essential Energy (2015)



VICKERY EXTENSION PROJECT
Project General Arrangement -
Project Mining Area

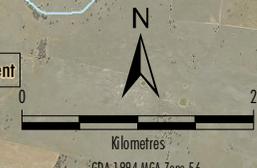


Figure 2

The Secretary's Environmental Assessment Requirements (SEARs) for the Project. Of relevance to this Aquatic Ecology Assessment, input into the SEARs from relevant government agencies included the following:

- assess potential waterway crossings in accordance with the Department of Primary Industries (DPI) Fisheries *Policy and Guidelines for Fish Habitat Conservation and Management (Update 2013)* (DPI Fisheries 2013);
- assess impacts to surface water ecosystems in the area;
- collect sufficient data to establish baseline condition of groundwater dependent ecosystems (GDEs) which, for our assessment, includes aquifer ecosystems;
- describe potential impacts to wetlands, rivers, and the species dependent on them;
- describe the nature and degree of impacts to stream bank stability and aquatic macroinvertebrate communities; and
- assess the impacts of expected hydrological changes to downstream and groundwater ecological communities and their natural processes and functions, including connectivity and access to spawning and refuge areas.

The Vickery Coal Project (EPBC 2012/6263) was previously referred under the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act) in January 2012 and was determined not to be a Controlled Action if implemented in a particular manner (EPBC 2012/6263). The decision stipulated measures to be undertaken to avoid significant impacts on the winged peppergrass (*Lepidium monophlooides*). This is a terrestrial plant species, rather than an aquatic one, and is listed as threatened.

On 12 February 2016, the Project was referred under the EPBC Act (2016/7649). The referred Action does not include the components and operations of the Vickery Coal Project (EPBC 2012/6263). On 14 April 2016, a delegate of the Commonwealth Minister for the Environment declared the action to be a 'controlled action' for the purpose of the EPBC Act due to potential adverse impacts on the following controlling provisions under Part 3 of the EPBC Act:

- sections 18 and 18A of the EPBC Act (listed threatened species and communities); and
- sections 24D and 24E of the EPBC Act (a water resource, in relation to coal seam gas development and large coal mining development).

In 2018, Whitehaven notified the Department of the Environment and Energy (DEE) of a variation to the Action, to reflect the final proposed approximate extent of the Vickery Extension Project (EPBC 2016/7649).

On 17 July 2018, the request to vary the referred action was accepted by the DEE.

The action is to be assessed under the assessment bilateral agreement with NSW. Accordingly, this document provides an assessment on the relevant EPBC Act-listed threatened aquatic species.

1.1 Scope of Works

The scope of works for the Project is designed to address the SEARs and relevant agency comments, and to determine the significance and condition of aquatic and aquifer ecosystems around the Project area. The tasks within the assessment included:

- describe aquatic habitats, including significant features such as substrate, stream type, water quality, and surrounding land use;
- describe aquatic plants and animals (including mammals, fish, reptiles and aquatic invertebrates) that are present during sampling, or likely to occur at any time during the year;
- identify and describe any aquatic species listed under the *Fisheries Management Act, 1994* (FM Act) and EPBC Act as threatened, that are likely to be present in the study area;
- consider State and Commonwealth guidelines associated with threatened species likely to occur in the study area (e.g. survey guidelines, referral guidelines, recovery plans and threat abatement plans);
- conduct a desktop review of available stygofauna literature and previous studies in and around the study area; and
- conduct a study using appropriate methods to identify stygofauna.

1.2 Assessment Areas

Project Area

The Project area (Figure 3) is referred to throughout this assessment and, for the purposes of this assessment, is defined as the development site construction and operational footprint. The Project area comprises the proposed open cut extension area and associated infrastructure areas outside the areas of the Approved Mine (Development Consent SSD-5000), such as the Project rail spur and borefield pipeline (Figure 4).

Watercourses relevant to the Project area include the Namoi River, Driggle Draggie Creek, Deadmans Gully and Stratford Creek.

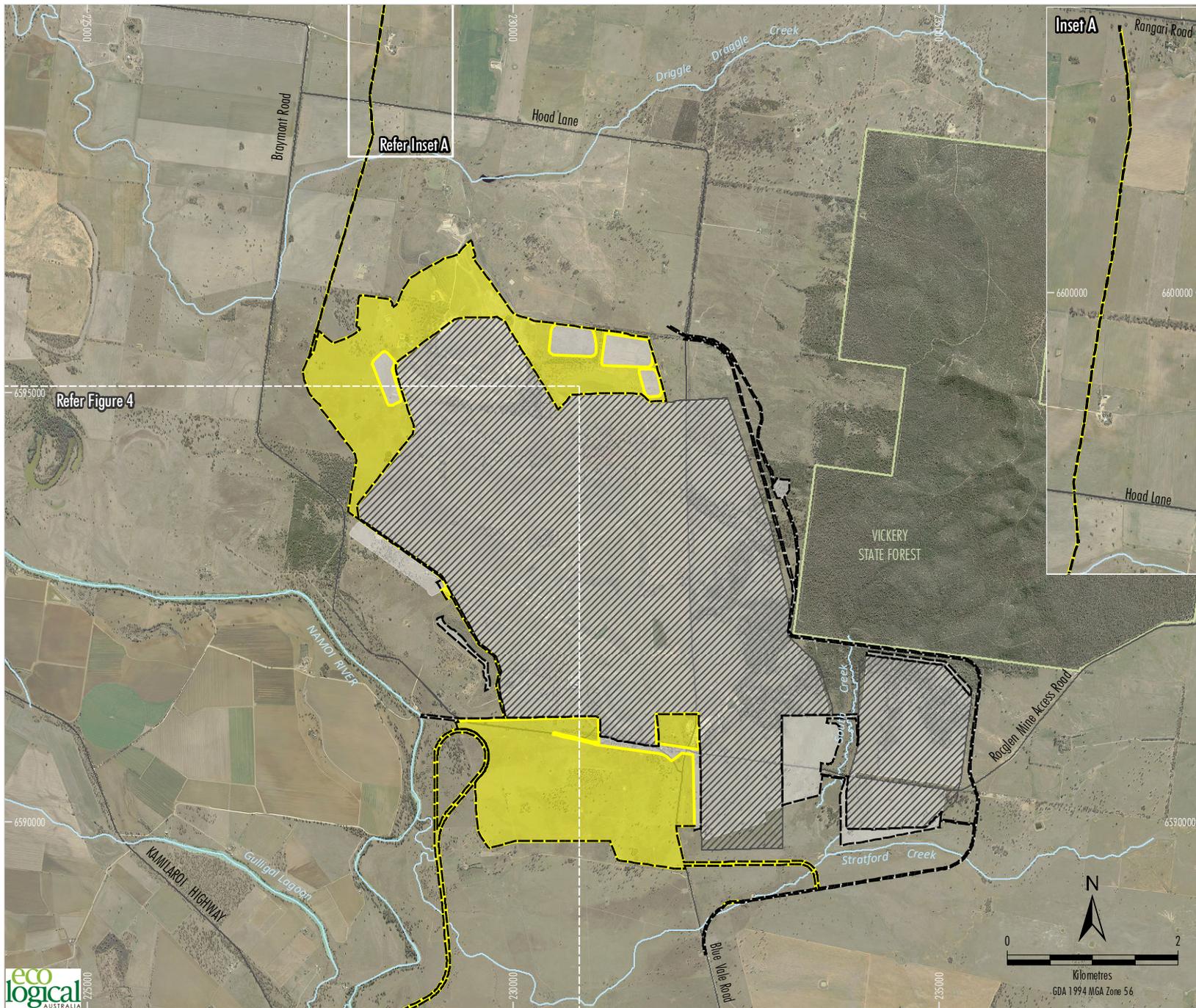
Sampling and Assessment Sites

Detailed sampling was undertaken at four sites along the Namoi River (VIC03 to VIC06) and a further seven sites were assessed for aquatic habitat values. These additional seven sites included two sites along Driggle Draggie Creek (VIC01 and VIC02), three sites along the Namoi River (VIC07 to VIC09) and two sites on Deadmans Gully (DG1 and DG2). Due to constraints regarding access to private property, aquatic surveys of Deadmans Gully were assessed remotely using satellite imagery.

Vickery Extension Project (EPBC 2016/7649) Footprint

The referred Project does not include the components and operations of the Vickery Coal Project (EPBC 2012/6263) (Figure 3). The Vickery Extension Project (EPBC 2016/7649) Footprint includes the extent of the Project area (defined above) in addition to some soil stockpiles, a road realignment and the most south-eastern extent of the Vickery Open Cut (Figure 3).

Watercourses relevant to the Vickery Extension Project (EPBC 2016/7649) Footprint include all those relevant to the Project area as well as South Creek, North Creek and Stratford Creek, all of which are ephemeral drainage lines located to the south of the Vickery State Forest (Figure 3).



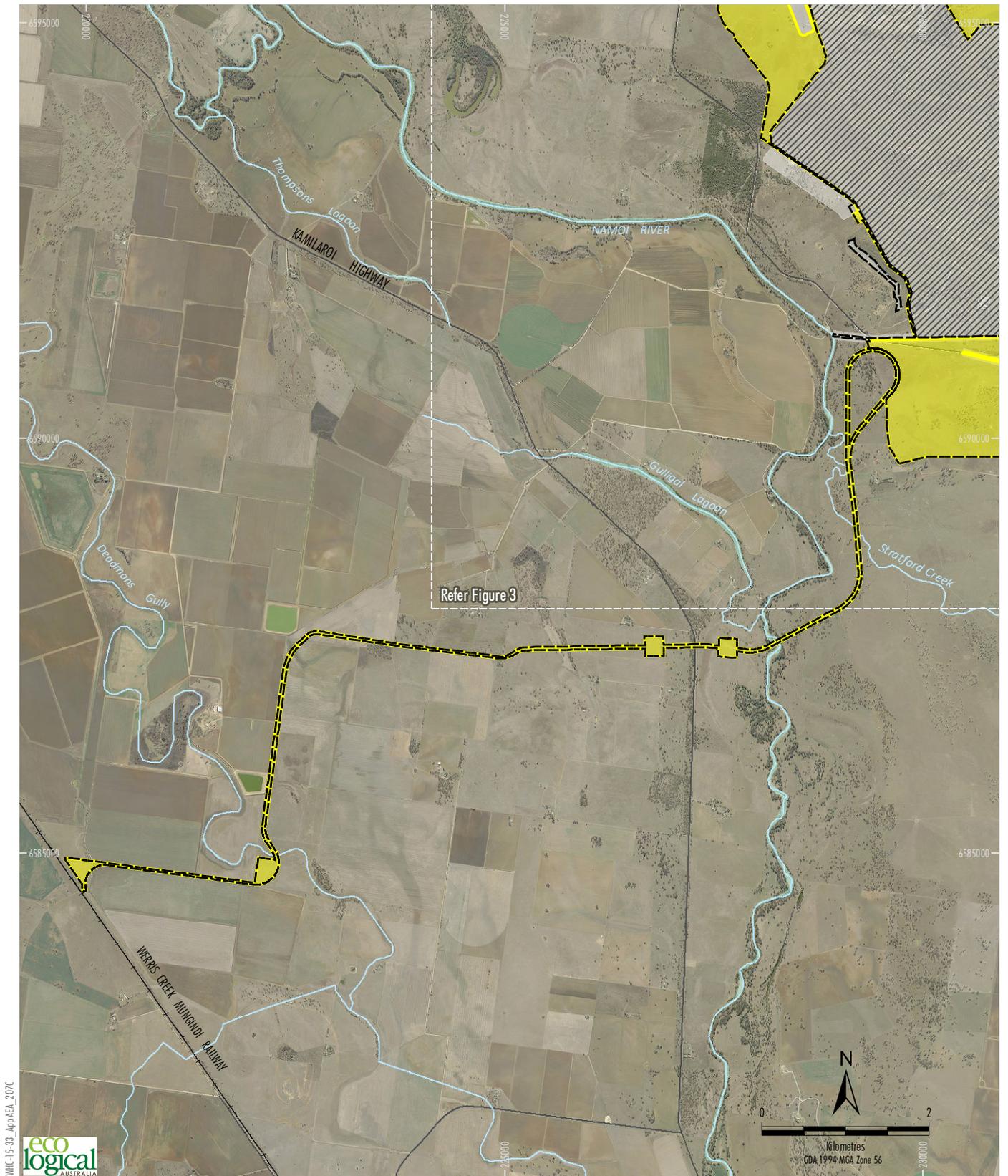
- LEGEND**
- State Forest
 - Approximate Extent of Approved Mine
 - Vickers Coal Project (EPBC 2012/6263) Footprint - Not a Controlled Action - Particular Manner
 - Approximate Extent of Vickers Extension Project (EPBC 2016/7649) Footprint
 - Project Area

Source: Orthophoto - Department of Land and Property Information, Aerial Photography (July 2011)



VICKERY EXTENSION PROJECT
Assessment Area - Project Mining Area

Figure 3



WMC-15-33_App.AEA_201C



Source: Orthophoto - Department of Land and Property Information, Aerial Photography (July 2011)

- LEGEND**
- Approximate Extent of Approved Mine
 - Vickers Coal Project (EPBC 2012/6263) Footprint - Not a Controlled Action - Particular Manner
 - Approximate Extent of Vickers Extension Project (EPBC 2016/7649) Footprint
 - Project Area



VICKERY EXTENSION PROJECT
Assessment Area -
Project Rail Spur

Figure 4

2 Site Description

2.1 Regional Setting

The Project is located within the following regions:

- North-west Local Land Service area (formerly the Namoi Catchment Management Authority [CMA], Liverpool Plains [Part B] CMA sub-region);
- the Brigalow Belt South Region Interim Biogeographic Regionalisation for Australia (IBRA) Bioregion and Liverpool Plains IBRA sub-region; and
- the Narrabri and Gunnedah Local Government Areas.

2.2 Landform and Hydrology

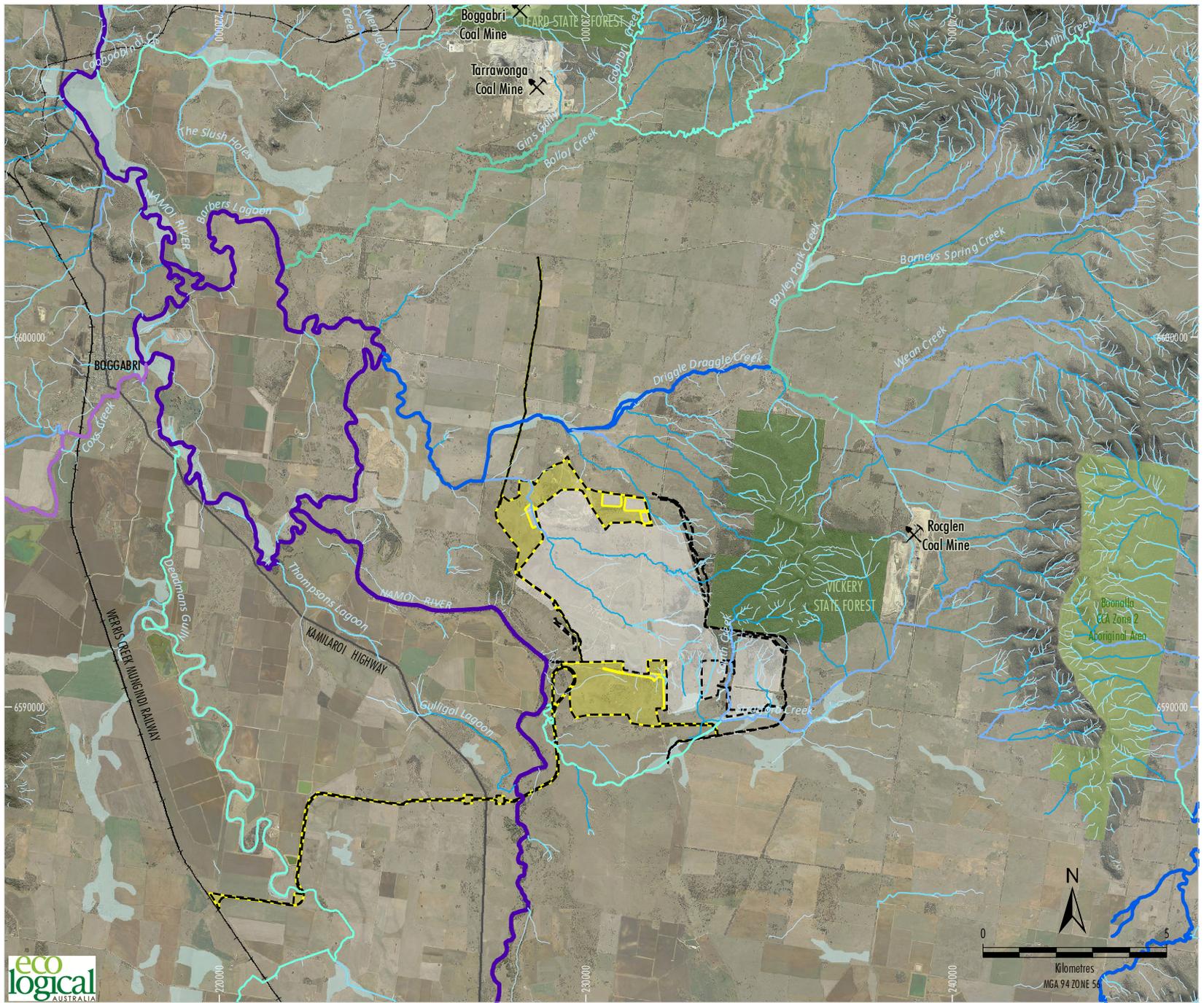
The topography of the central part of the Project area comprises rolling hills (partly due to the landform associated with previous mining at the Canyon Coal Mine), with flatter areas to the north and south.

The Project area is situated in the Namoi River Catchment and part of the Murray-Darling Basin. The Namoi River flows to the south-west of the Project mining area (Figure 5) and flows in a generally north-westerly direction from its headwaters in the Great Dividing Range. The Project rail spur would cross the Namoi River south-west of the Project mining area.

Driggle Draggie Creek, an ephemeral drainage line to the north of the mining area would also be traversed by the Project borefield pipeline (Figure 5). The headwaters of Driggle Draggie Creek and a number of other unnamed ephemeral streams originate in the slopes of the Vickery State Forest and flow through the north of the Project area (Figure 5). As they descend onto the flatter areas they become less well-defined drainage paths which broaden into expansive, ponded, overland flow areas during and following heavy rainfall. These flows slowly move down gradient and merge with the Namoi River.

The Project rail spur crosses Stratford Creek north-east of the Namoi River. Stratford Creek is an ephemeral watercourse that runs in a westerly direction before turning northwards to join the Namoi River.

The Project rail spur also crosses Deadmans Gully south-west of the Namoi River crossing. Deadmans Gully is formed by the joining of several shallow depressions that rise in an otherwise flat landscape east of Emerald Hill. The creek is often not much more than a shallow depression itself, and is mostly dry. During wet periods, it meanders northwards to join the Namoi soon after passing beneath the Kamilaroi Highway, 3 km south of Boggabri.



LEGEND

- NSW State Forest
- State Conservation Area, Aboriginal Area
- Approximate Extent of Approved Mine
- Project Area
- Approximate Extent of Vickers Extension Project (EPBC 2016/7649) Footprint
- Land Subject to Inundation

Strahler Stream Order

- 1st Order
- 2nd Order
- 3rd Order
- 4th Order
- 5th Order
- 6th Order
- 7th Order
- 8th Order
- 9th Order

Source: Office of Environment and Heritage NSW (2016);
 Orthophoto - Department of Land and Property Information,
 Aerial Photography (July 2011); Department of Primary
 Industries Water (2017)


WHITEHAVEN COAL
VICKERY EXTENSION PROJECT
 Watercourses in the Project Locality

Figure 5

The Namoi River is considered to be a GDE¹ because riparian vegetation and baseflows in the main channel are partially sustained by inputs from alluvial groundwater. Interaction between the Namoi River and the underlying alluvium varies with rainfall conditions (HydroSimulations 2018). However, in accordance with the GDE guideline (NSW Office of Water [NOW] 2012), the Namoi River is not considered to be a high value GDE given that (HydroSimulations 2018):

- it is not reserved as a National Estate, listed wetland or State Environment Planning Policy (SEPP) 26 (Littoral Rainforests);
- several exotic species occur in large populations;
- major changes in physical structure and species composition have occurred as a result of historical agriculture and irrigation practices; and
- flow regime in the main channel is largely determined by releases from Keepit Dam.

There are two groundwater systems in the Project area (HydroSimulations 2018):

- a porous rock groundwater system; and
- an alluvial groundwater system.

The Project coal resource is located in the Maules Creek sub-basin of the Early Bellata Group, which is within the porous rock (i.e. sedimentary rock) groundwater systems of the Gunnedah Basin and within the boundary defined in the *Water Sharing Plan for the NSW Murray-Darling Basin Porous Rock Groundwater Sources 2011* (HydroSimulations 2018).

Alluvial sediments associated with the Namoi River and its tributaries are located to the north, south and west of the Project. These alluvial sediments are part of the Upper Namoi Alluvium within Upper Namoi Zone 4, Namoi Valley (Keepit Dam to Gin's Leap) Groundwater Source of the *Water Sharing Plan for the Upper and Lower Namoi Groundwater Source 2003*. The open cut would not extend into the Upper Namoi Alluvium (HydroSimulations 2018).

2.3 Land Use

Most of the study area is located in previously cleared agricultural areas. Dryland cropping and cattle grazing occurs to the north, west and south of the Project area on the flatter lands near the Namoi River and its tributaries. West of the Namoi River, the Project rail spur crosses cropping/grazing land and Deadmans Gully before joining the Werris Creek Mungindi Railway.

The Vickery State Forest is located to the east of the Project area.

Open cut and underground mining activities were previously conducted in the Project area. Three areas associated with former open cuts and associated waste rock emplacements (the Red Hill Pit, Greenwood/Shannon Hill Pit and Blue Vale Open Cut) are located within CL 316 (Figure 2). In addition, part of the final void associated with the former Canyon Coal Mine (mining ceased in 2009) occurs in the north-west portion of the Project area (Figure 2).

¹ *Ecosystems which have their species compositions and their natural ecological processes determined by groundwater.*

Further, Whitehaven has approval to mine a large portion of the Project area for the Approved Mine (Figure 2). However, construction and operation of the Approved Mine has not yet commenced.

2.4 Previous Surveys

An aquatic ecology assessment for the Approved Mine was conducted by Coast Ecology (2012). The assessment included sites on two ephemeral creeks (unnamed, but referred to as North Creek and South Creek). Both creeks had shallow, poorly defined channels without significant habitat features. The creeks are dry in periods of no rain but, after rainfall, both flow west into the Namoi River. Water persists in deeper pools, but these are not substantial enough to remain permanently.

Invertebrate communities in the two creeks were dominated by disturbance-tolerant taxa, and the only fish collected were exotic mosquitofish (*Gambusia holbrooki*). Physico-chemistry of North and South Creeks was generally outside the recommended Australian and New Zealand Environment and Conservation Council (ANZECC) guidelines (ANZECC 2000; Coast Ecology 2012).

No threatened species or communities were recorded in North or South Creeks (Coast Ecology 2012). The ephemeral nature of North and South Creeks, the low level of habitat complexity, the lack of native fish and sensitive macroinvertebrate taxa, and water that is outside of the ANZECC Guidelines (ANZECC 2000), indicate that they have little potential to be significant aquatic habitat (Coast Ecology 2012).

3 Methods

3.1 Overview of Sampling Program

The field survey was conducted between 29 February 2016 and 2 March 2016 by Eco Logical Australia (ELA) Aquatic Ecologists Dr Peter Hancock and Ben Martin, with surveys occurring at six sites (Figure 6). Four sites were located along the Namoi River (VIC03 to VIC06), with an additional two sites on Driggle Draggles Creek (VIC01 and VIC02). The two sites along Driggle Draggles Creek were dry, so could not be sampled for fish; however, habitat assessments were still conducted to assess the potential for these sites to have aquatic habitat during times of flow.

An additional site inspection occurred on 21 December 2016 at a further three sites (VIC07 to VIC09) on the Namoi River and two sites on Deadmans Gully (DG1 and DG2). This consisted of habitat assessments of these water bodies. No fish or macroinvertebrate samples were collected during this visit, as those collected earlier provided a sufficient understanding of the aquatic community. This inspection was undertaken by Dr Peter Hancock.

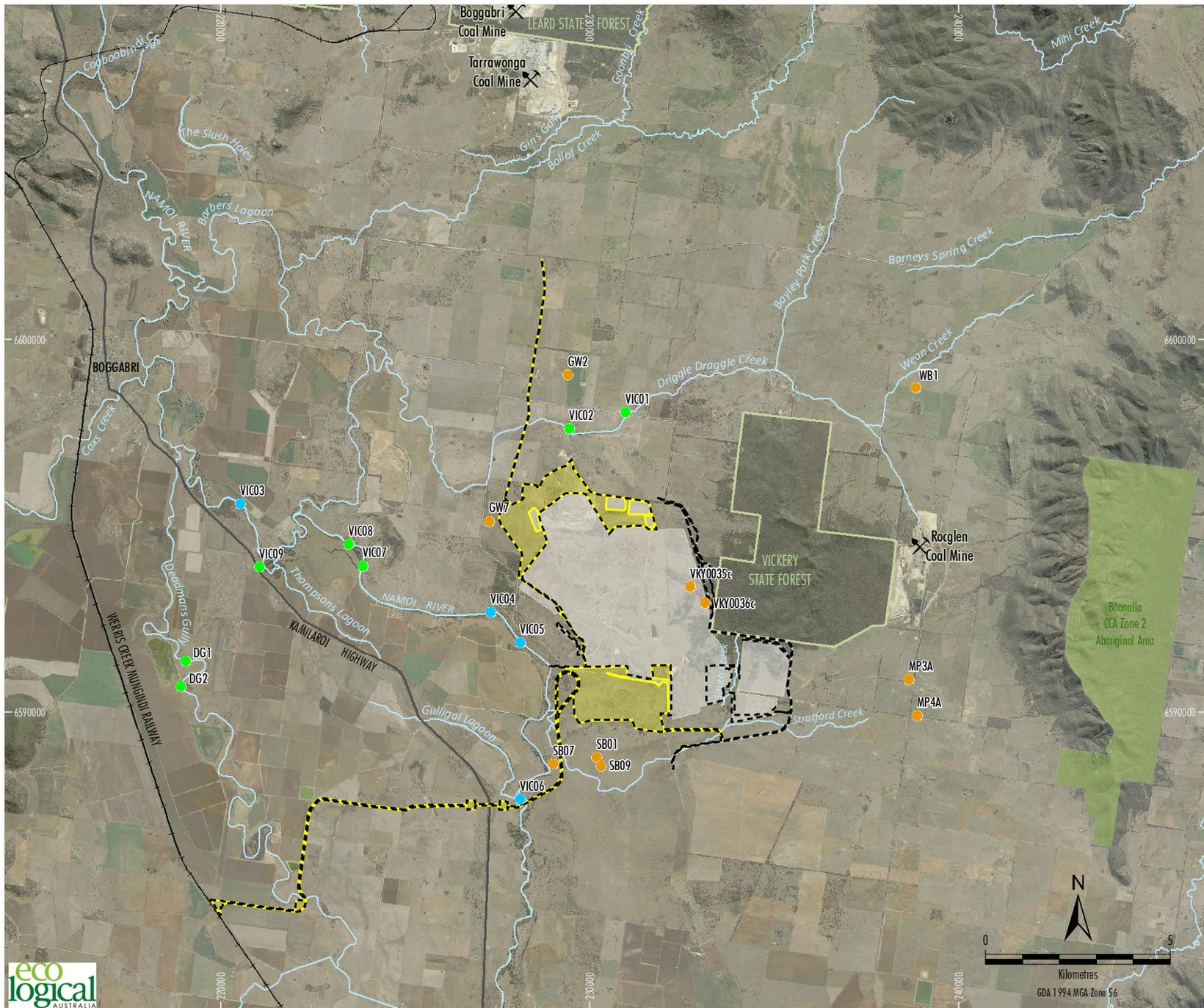
During the February/March 2016 survey, the weather was warm and dry, with temperatures up to 35.4 degrees Celsius (°C) (Table 1). These temperatures, although high, are not out of the ordinary for this time of year (Bureau of Meteorology [BOM], 2016) and are not expected to detract from the validity of this assessment. There was very little rain in the weeks prior to the survey date, and flow in the Namoi River had ceased, with water restricted to a series of disconnected pools. The largest of the sampled pools was more than 3 km long, linking sites VIC04 and VIC05. In January a pulse moved through the system, with flow peaking at 1.12 m (Figure 7). Flow persisted for three weeks before falling rapidly in late January. Flow continued to recede steadily from early February, and maintained low levels until 21 March.

Table 1: Weather data for the survey period (29/2/2016 to 4/3/2016)

Date	Minimum Temperature (°C)	Maximum Temperature (°C)	Rainfall (mm)
29/02/2016	17.9	33.7	0
1/03/2016	18.2	35.0	0
2/03/2016	19.9	35.2	0
3/03/2016	21.2	35.4	0
4/03/2016	20.7	34.3	0

Source: Whitehaven.

In December 2016, during the additional assessment, the temperature was between 20.2 °C and 37.9 °C (BOM, Narrabri AWS 054038 [BOM 2016]). Following the assessment, approximately 5 millimetres (mm) of rain fell. Flow in the Namoi River was higher in December 2016 than in February/March 2016, and rose steadily from 0.33 m on 4 December to 1.30 m at the time of the site visit on 21 December. Much of this water originated as releases from Keepit Dam. The largest peak in the Namoi River between the February/March 2016 survey and December 2016 inspection was 6.82 m, on 18 September 2016.



- LEGEND**
- NSW State Forest
 - State Conservation Area, Aboriginal Area
 - Approximate Extent of Approved Mine
 - Project Area
 - Approximate Extent of Vickers Extension Project (EPBC 2016/7649) Footprint
 - Aquatic Ecology Sampling Site
 - Stygofauna Sampling Bore
 - Inspection and Habitat Assessment Site

Source: Orthophoto - Department of Land and Property Information, Aerial Photography (July 2011); Department of Industry (2015)

WHITEHAVEN COAL
VICKERY EXTENSION PROJECT
Sampling Locations

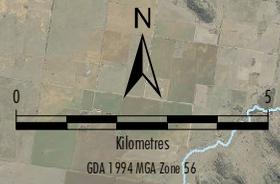


Figure 6

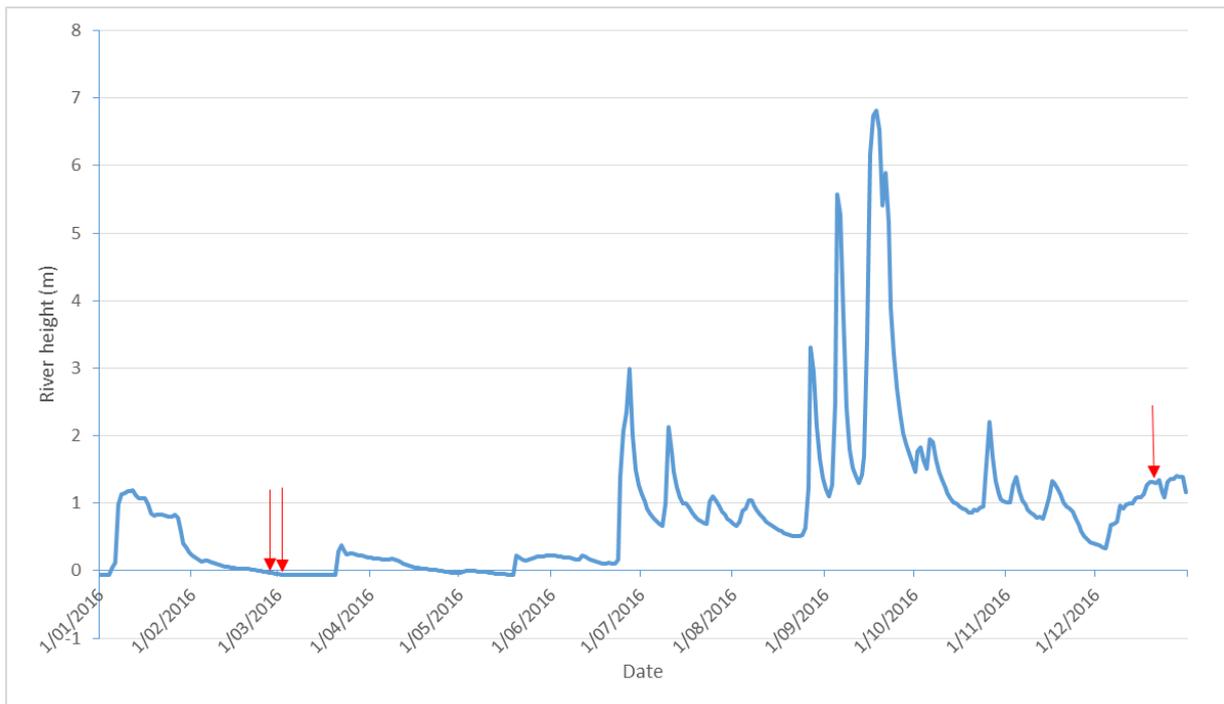


Figure 7: River Flow at NSW Office of Water Gauging Station at Boggabri (419012) (NoW 2016) from 1 January 2016 to 31 December 2016. Arrows indicate dates of site inspection.

3.2 Aquatic Habitat Assessment

Aquatic habitat assessments were based on the *Policy and Guidelines for Fish Habitat Conservation and Management* (DPI Fisheries 2013), which outlines the features important for fish habitat in freshwater, estuarine and marine areas. The guidelines recognise the importance of links between upstream and downstream reaches, and the potential impact of riparian management and in-stream barriers to the ongoing health of fish and aquatic communities. Habitat assessments allow the significance of river reaches to be determined, regardless of whether target fish species are present permanently, or for brief periods of time.

Aquatic habitat variables (environmental data) were noted for each site during surveys, with observations made from the bank on the following characteristics:

- General signs of disturbance;
- Habitat type;
- Channel topography;
- Current water level;
- Bank and bed slope;
- Degree of river shading;
- Amount of detritus;
- Macrophyte type and extent;
- Riparian zone width;
- Snags and large woody debris coverage;
- Stream width and depth;

- Surrounding land use;
- Description of the natural substrate;
- Extent of bank overhang; and
- Amount of trailing bank vegetation.

Riparian condition was assessed using a modified version of the Riparian, Channel and Environmental (RCE) inventory (Peterson 1992), which was modified for Australian conditions (Chessman *et al.* 1997). The modified RCE has 13 descriptors, each with a score from 1 to 4.

Descriptors included width and condition of the riparian zone, surrounding land use, extent bank erosion, stream width, water depth, occurrence of pools, riffles and runs, sub-stratum type, presence of snags and woody debris, in-stream and emergent macrophytes, algae and barriers to fish passage. The total score for each site was derived by summing the score for each descriptor and calculating the result as a percentage of the highest possible score (up to 52).

Deadmans Gully was assessed remotely using satellite imagery as it was inaccessible due to property ownership boundaries. For each site along this waterbody, images from several time periods were analysed using the historical imagery viewer in Google Earth.

Sites with a high RCE score indicate that the riparian zone is unmodified by human activity, while those with a low score have undergone substantial modification. Based on the original classification established by Peterson (1992), site condition was rated as:

- Poor for RCE scores of 0–24%.
- Fair for RCE scores of 25–43%.
- Good for RCE scores of 44–62%.
- Very good for RCE scores of 63–81%.
- Excellent for RCE scores of 82–100%.

3.3 Physico-chemistry

To complement biological data, physico-chemical parameters were measured at each site. Temperature, dissolved oxygen (DO), electrical conductivity (EC) and pH were measured with a YSI-556 meter, which was calibrated in the laboratory prior to the field survey. The DO probe was calibrated at the start of each survey day. Turbidity was measured with a Hach 2100Q Turbidimeter and alkalinity was measured with a Hanna HI755 Freshwater Alkalinity Checker.

3.4 Macroinvertebrate Community

Macroinvertebrate samples were collected using AUSRIVAS protocols, with a standard 250 micrometre (μm)-mesh sweep net (Turak *et al.* 2004) to assess the ecological condition of each site. At each site, macroinvertebrates were collected from edge habitats. Edge habitats were defined as the creek bank in areas of little or no flow, including alcoves and backwaters, with abundant leaf litter, fine sediment deposits, macrophyte beds and overhanging bank vegetation (Turak *et al.* 2004). Edge samples were collected from 10 metres of representative edge habitats using a standard AUSRIVAS kick net with 250 μm mesh. The net was bounced along the bottom to disturb resting invertebrates, and then rapidly passed again through the water column to collect them.

Macroinvertebrate samples were live-sorted in the field for a minimum of 40 minutes. If new taxa were collected in the period from 30 to 40 minutes, picking continued for 10 minutes. If no new taxa were found after the additional 10 minutes, sorting stopped. If new taxa were found, picking continued for a further 10 minutes. The maximum sorting time was 60 minutes. All picked animals were preserved in 70 per cent (%) ethanol solution, and were then transferred to the laboratory for identification. Specific care was taken to ensure cryptic, fast-moving or microcrustacean taxa were represented.

Macroinvertebrates were identified to the family level, except for Chironomidae which was identified to subfamily as required by the AUSRIVAS model, and Oligochaeta and Acarina, which were identified to order.

SIGNAL is a biotic index that allocates a value to each macroinvertebrate family based upon their sensitivity to pollution. A macroinvertebrate family with a value of 10 indicates high sensitivity, while a value of 1 indicates low sensitivity (i.e. high pollution tolerance) (Chessman 1995). The SIGNAL score for the entire site is calculated by summing the SIGNAL grades for each family collected at that site and then dividing by the total number of families collected. SIGNAL scores are used to grade water quality into the following categories:

- Signal Score > 6: Healthy Habitat.
- Signal Score 5–6: Mild Pollution.
- Signal Score 4–5: Moderate Pollution.
- Signal Score < 4: Severe Pollution.

3.5 Fish Community

The fish community was sampled using fyke nets, seine nets, and a sweep net. Two fyke nets were set at each site, except for VIC03, at which only one was used. It was not possible to set a second fyke net at VIC03 as the bed and bank had too much bedrock. A seine net was used at all sites except VIC03, which was too deep.

Surveys give an indication of which species are present in the community, and their numbers. Some species may still use the reach of river surveyed, but not be collected during sampling.

3.6 Stygofauna Sampling

The stygofauna study followed methods outlined in the Environmental Protection Authority (EPA) *Guidance for the Assessment of Environmental Factors No. 54* (EPA 2003), *Sampling methods and survey considerations for subterranean fauna in Western Australia No. 54a* (EPA 2007) and the *Environmental Assessment Guideline for Considering Subterranean Fauna in Environmental Impact Assessment in Western Australia* (EPA 2013).

Stygofauna have previously been collected from the Namoi River alluvial aquifer and its tributaries (Korbel 2013, Watts et al. 2008), so this survey aimed to determine which taxa are currently present, and whether they would potentially be impacted by the Project. The survey included bores in the Driggle Draggie Creek alluvium, as well as a selection from the Namoi River alluvium and deeper rock aquifers (Figure 6).

Stygofauna samples were collected from bores using a specifically designed net that was lowered to the bottom, bounced a number of times to dislodge resting stygofauna, and slowly retrieved. Net contents were emptied at the top of each haul until six hauls had been completed. Prior to sampling for stygofauna, water samples were collected using a disposable bailer to measure temperature, DO, electrical conductivity and pH.

3.7 Threatened Aquatic Fauna

The following databases were searched for threatened aquatic fauna likely to occur in the study area:

- Protected Matters Search Tool (Department of the Environment and Energy [DEE] 2018) to generate a report for EPBC-listed species;
- DPI Threatened Protected Species Records Viewer (DPI Fisheries 2016) to generate a report for FM Act-listed species; and
- Fisheries Spatial Data Portal (DPI Fisheries 2018).

On the basis of these searches, regional records, the literature review (Cenwest Environmental Services 2011; Coast Ecology 2012; Parsons Brinkerhoff 2010) and the presence of suitable habitat, three threatened animal species are known, or predicted to occur, in the Namoi River: namely, eel-tailed catfish (*Tandanus tandanus*), silver perch (*Bidyanus bidyanus*) and Murray cod (*Maccullochella peelii peelii*) (Table 2). The predicted presence is based on the known geographical distribution, preferred habitats for each species and the corresponding habitats in the Namoi River.

Targeted surveys for all potentially occurring threatened species identified in Table 2 were conducted in consideration of the *Survey Guidelines for Australia's Threatened Fish* (Department of Sustainability, Environment, Water, Population and Communities [SEWPaC] 2011); however, species-specific survey guidelines do not exist for the eel-tailed catfish or the silver perch. As such, the 'survey steps' described in the Commonwealth *Survey Guidelines for Australia's Threatened Fish* (SEWPaC 2011) were followed and the methods (and timing) applied are considered to be appropriate for these species, and all other species listed in Table 2 (were they to occur).

Sampling occurred in early March to maximise the chance of catching Murray cod, in accordance with the Commonwealth *Survey Guidelines for Australia's Threatened Fish* (SEWPaC 2011).

Table 2: Threatened aquatic animals in the Namoi River catchment with potential to occur in the study area

Common Name	Scientific Name	Status		Habitat Description	Likelihood Of Occurring In The Study Area
		EPBC Act ¹	FIM Act ²		
INVERTEBRATES					
River snail	<i>Notopala sublineata</i>	-	CE	Flowing rivers, found attached to logs and rocks, or crawling in the mud (NSW DPI 2007). The River Snail was once common and widespread in the Murray–Darling river system, but has undergone a rapid decline, such that it is now considered virtually extinct in its natural range (NSW DPI 2007). Remaining populations appear restricted to artificial habitats (e.g. irrigation pipelines) in the Murray and Darling systems.	Unlikely – the nearest records for this species are near Mollee Weir. <i>Last record 2007 or earlier.</i>
FISHES					
Murray-Darling Basin population of eel-tailed catfish	<i>Tandanus tandanus</i>	-	EP	A relatively sedentary species of slow-flowing streams and lake habitats. Widespread throughout the Murray-Darling Basin, but generally in the lower, slow-flowing rivers (Lintermans 2007).	Likely - Known to occur in the Namoi River downstream of Narrabri.
Silver perch	<i>Bidyanus bidyanus</i>	CE	V	Fast-flowing, open waters in lowland, turbid and slow-flowing rivers (Lintermans 2007). Originally present throughout most of the Murray-Darling drainage system, except the upper reaches; they have now declined to low numbers or disappeared from most of their former range (NSW DPI 2005).	Potential - Known to occur in the Namoi River, and is often stocked. In late February 2016, 50,000 juvenile silver perch were released near Narrabri, Boggabri, and Gunnedah (Namoi Valley Independent, 1 March 2016).
Murray cod	<i>Maccullochella peelii peelii</i>	V	-	A wide range of warm water habitats, ranging from clear, rocky streams to slow-flowing turbid rivers and billabongs in the Murray-Darling Basin (Department of the Environment [DotE] 2013b). Favours deeper water around boulders, logs, undercut banks and overhanging vegetation (DotE 2013b).	Potential - Known to occur in the Namoi River and is often stocked for recreational fishing.

Table 2: Threatened aquatic animals in the Namoi River catchment with potential to occur in the study area (continued)

Common Name	Scientific Name	Status		Habitat Description	Likelihood Of Occurring In The Study Area
		EPBC Act ¹	FM Act ²		
Murray hardyhead	<i>Craterocephalus fluviatilis</i>	E	CE	The Murray Hardyhead occurs in still and slow-flowing waters including billabongs, lakes, and margins and backwaters of lowland rivers (Backhouse, et al 2008).	Unlikely – There are no records of this species in the Namoi River.
Olive perchlet	<i>Ambassis agassizii</i>	-	EP	The Olive Perchlet is found in rivers, creeks, ponds, or swamps. They are found in slow-moving to still waters, usually in sheltered areas such as under overhanging vegetation and aquatic macrophyte beds (Fisheries Determination Committee 2009).	Unlikely – This species has not previously been recorded in the Namoi CMA.
Purple spotted gudgeon	<i>Mogurnda adspersa</i>	-	E	This species is found in slow-moving or still waters of creeks, rivers, wetlands and billabongs, and prefers slower-flowing, deeper habitats (Fisheries Determination Committee 2008).	Unlikely – This species has not previously been recorded in the Namoi CMA.

¹ Threatened species status under the EPBC Act (current as at May 2016).

² Threatened species status under the FM Act (current as at May 2016).

CE = Critically Endangered

E = Endangered

V = Vulnerable

EP = Endangered Population

4 Results

4.1 River Sites

4.1.1 Habitat Assessment

Descriptions of the habitat present at each aquatic ecology sampling site are given below. Additional site photos are included in Appendix C.

The location of the sampling sites in relation to the Project area is shown on Figure 6.

VIC01 and VIC02 Driggle Draggie Creek

VIC01 and VIC02 are both located along Driggle Draggie Creek, upstream of the Project borefield pipeline crossing (Figure 6). Driggle Draggie Creek is a shallow ephemeral creek in a broad, low-gradient valley. Advisian (2018) has mapped Driggle Draggie Creek as a 7th order stream (according to the Strahler Stream order); however, at the time of sampling the creek was dry, so while it was not possible to sample for fish, the potential for the sites to have aquatic habitat during times of flow was assessed.

Creek beds at both sites consisted of dry or drying mud, with a relatively flat bed topography (Plates 1 and 2). It is unlikely that Driggle Draggie Creek gets deeper at these sites for long periods of time; flow occurs only after extensive rainfall events and is unlikely to persist for long periods. Small agricultural dams occur 200 m upstream of VIC02 and 550 m upstream of VIC01. These may act as potential sources of colonisation during times of flow, from which fish and macroinvertebrates can disperse; however, Driggle Draggie Creek contains only poor aquatic habitat at these sites. Neither site would provide habitat that would be suitable for Murray cod, eel-tailed catfish, or silver perch.

The surrounding land is used for cattle grazing and is highly modified from the natural environment. Roads cross the creek immediately downstream of both sites. Fringing vegetation consists of sedges and grasses, with no woody vegetation growing over the main channel. As a result of this, there is little shading, and debris is scarce.



Plate 1: Driggle Draggie Creek at Blue Vale Road (VIC02) looking upstream



Plate 2: Driggle Draggie Creek at VIC01 looking upstream

VIC03-Namoi River downstream of the Project

VIC03 is located in the Namoi River, approximately 6.5 km west of the Project area (Figure 6). Reaches of the river at VIC03 were dry during the sampling period, and the sand and gravel bed showed evidence of 4WD traffic. The pool containing Site VIC03 was approximately 500 m long, 23 m wide, and 2 m deep (Figure 6). Large woody debris was abundant throughout the pool, and other smaller debris covered large sections of the bed, especially in deeper parts (Plate 3). The site has a high level of habitat complexity, with firm and soft substrate, large woody debris, and a range of depths and bed grades. While there are few in-stream macrophytes or trailing vegetation, tree roots along the western bank, which is steep in parts, create complex edge habitat. Site habitat complexity is increased by the gently sloping sand and gravel shoreline and extensive lateral gravel bar on the eastern shore.

Riparian vegetation on the western bank consisted of scattered mixed eucalyptus woodland that extends away from the river.



Plate 3: Namoi River at VIC03 looking upstream

The site is shaded during the afternoon because of the steep and vegetated western bank, but receives little shading before midday. The eastern bank slopes gently up to a thin band of riparian woodland vegetation, beyond which is cropped agricultural land.

VIC04- Namoi River off Johnston Road

VIC04 is located in the Namoi River, approximately 2.5 km west of the centre of the Vickery Open Cut (Figure 6). The northern bank consists of exposed bedrock that falls almost vertically to the water in places, creating a deep edge (Plate 4). The river was approximately 2.5 m deep when sampled, and 34 m wide. A sand and gravel bar rose at a gentle gradient from the water on the southern edge of the river. This bar was only narrow and was backed by a steep bank that rose a further 6 m above the current water level. Snags and large woody debris were scattered sparsely through the river at this site, and were mostly pushed up against the bank. Riparian vegetation was dominated by native eucalypt species, containing occasional weeping willow (*Salix babylonica*). On the northern bank, riparian vegetation was contiguous with a sparse to moderately vegetated native woodland. The riparian zone on the southern bank was approximately 70 m wide, after which the landscape was cleared for cultivated agriculture.



Plate 4: Namoi River at VIC04 looking upstream

VIC05- Namoi River

VIC05 is located in the Namoi River, approximately 2.5 km west of the centre of the Vickery Open Cut (Figure 6). The Namoi River at VIC05 is steeply banked on both sides (Plate 5). The river is approximately 2 m deep and 30 m wide. The north-eastern edge is lined with common reed (*Phragmites australis*), and the substrate is dense grey mud at least 1 m deep. Further from the shore, the layer of mud thins and the bed becomes firm sand and gravel. Submerged and emergent logs and other debris are encountered only occasionally at this site. Riparian vegetation is dominated by sparsely scattered river red gum and extends along both banks.

During the surveys this site was part of a pool approximately 3 km long that also contained VIC04. This site was part of a deep pool that stretched for several kilometres and had submerged snags and deep, still sections.



Plate 5: Namoi River at VIC05 looking upstream

VIC06- Namoi River

VIC06 is located in the Namoi River, approximately 200 m downstream of the Project rail spur (Figure 6). This site was in a pool that had a maximum depth of 1.2 m, and is mostly shallower than 0.6 m. The pool is approximately 160 m long and 20 m wide, and has a bed consisting of coarse sand and gravel that slopes upwards to a shallow-gradient gravel bar (Plate 6). Large woody debris is common at this site and several large logs have accumulated at the upstream end. Weeping willow trees provide overhanging and trailing vegetation on the western shoreline. Beyond the thin riparian zone, which is dominated by river red gums, the surrounding land is grazed by cattle. Cattle access the river, and were seen standing in the water upstream of the sampling site. Due to the complexity of woody debris, this site has moderate habitat value, which is limited by the shallow depth.



Plate 6: Namoi River at VIC06 looking upstream

VIC07- Namoi River Downstream from the Project

This site was visited on 21 December 2016. This sampling site of the Namoi River occurs approximately midway between VIC03 and VIC04 (Figure 6). The top of the bank is approximately 8 m above the water, and the river is 40 m wide. Mature river red gums line the banks on both sides of the river, and juveniles grow on a low gravel bar extending along the western bank (Plate 7). This was partly inundated during the December visit so that the juvenile river red gums were partially underwater. There is a large pool upstream of the gravel bar, and large woody debris formed by river red gum snags emerged from the water at several locations at this site (Plate 8).



Plate 7: Namoi River at VIC07 looking at western bank.



Plate 8: Namoi River at VIC07 looking downstream from eastern bank.

VIC08- Namoi River

This site was viewed from the northern bank on 21 December 2016. The riparian zone on both sides of the river consists of mature river red gums.

The river here is approximately 40 m wide and appeared to be shallow. The southern bank stands approximately 5 m above the water level, though it is of a gentler grade than the western bank (Plate 9). Large woody debris is moderately common in the river, and bars of sand and gravel occur along the channel margins during low flow.



Plate 9: VIC08 looking across to the southern bank of the Namoi River.

VIC09- Downstream from Thompsons Lagoon on the Namoi River

This site is located downstream from where Thompsons Lagoon flows into the Namoi River (Figure 6). At this location the river is 20 m wide and has sand and gravel bars on either side. Logs are common in the water, creating fish habitat.

DG1 and DG2- Deadmans Gully crossing

The Project rail spur crosses Deadmans Gully south-west of the Project (Figure 6). Access to both sites on Deadmans Gully (*DG1* and *DG1*) was not possible in December 2016, so this assessment is based on satellite imagery and current information on similar creeks in the area. Deadmans Gully is mapped as Key Fish Habitat by DPI Fisheries (2013); however, there is unlikely to be significant aquatic habitat at these sites, and neither has significant riparian tree communities.

Satellite imagery taken in 2012, 2014 and 2016 shows both sites as dry, shallow depressions without clearly defined, incised channels. There are no gravel beds or snags in the channel, so the creek is not TYPE 1 (highly sensitive) habitat. The bed appears covered in herbaceous vegetation or bare ground and, as the channel appears dry most of the time, the dominant vegetation is unlikely to be made of wetland-dependent species, so could be classified as TYPE 3 (minimally sensitive) habitat.

Habitat class factors in the functionality of a waterway as fish habitat. As Deadmans Gully flows only after rainfall events, and has no clearly defined drainage channel without any free-standing pools after rain events, it is likely to be a CLASS 4 (unlikely) key fish habitat.

4.2 River Channel Environment

RCE scores for the Namoi River indicate that the riparian and channel conditions at three sites (VIC04, VIC05, VIC06) were very good, and excellent at the fourth sampling site (VIC03) (Table 3). The immediate riparian zones along the Namoi River were dominated by native vegetation consisting of mature river red gum, and had only minor impacts from human activities. Consequently, there was sufficient in-stream structure provided by snags and large woody debris.

The stream bed generally consisted of sand, gravel or bedrock. Lateral bars occur regularly along the river, though were not present at all sites. Pools were common at most sites, and undercut banks and tree roots often made steep edges along the river during high flow.

Turbid water means that submerged aquatic macrophytes rarely form large beds in the Namoi River, although emergent species such as *Schoenoplectus* spp., *Eleocharis* spp. *Cyperus* spp. and *Phragmites australis* do occur along shallow edges and gravel bars.

Table 3: RCE scores for Namoi River sites. Each parameter is scored between 1 (poor condition) and 4 (good condition).

Parameter	VIC03	VIC04	VIC05	VIC06
Land use beyond riparian zone	3	2	2	2
Width of riparian strip	4	3	3	3
Completeness of riparian strip	4	2	3	3
Vegetation within 10 m of channel	4	4	4	3
Stream bank structure	4	4	4	4
Bank undercutting	4	4	4	4
Channel form	2	3	3	2
Riffle/pool sequence	2	2	2	2
In-stream retention devices	4	3	3	4
Channel sediment accumulation	2	2	2	3
Stream bottom	3	2	1	3
Stream detritus	4	3	2	4
Aquatic vegetation	4	4	4	3
Total	44	38	37	40
RCE (%)	84.62	73.08	71.15	76.92

4.2.1 Water Quality

VIC03 to VIC06, February-March 2016 (low flow)

Water temperatures within the Namoi River ranged from 26.19°C to 32.1°C (Table 4). Electrical conductivity within the Namoi River was between 425 microSiemens per centimetre ($\mu\text{S}/\text{cm}$) and 508 $\mu\text{S}/\text{cm}$, and at all sites exceeded the recommended ANZECC range (Table 4). Dissolved oxygen concentration within the Namoi River varied across sites because of diel fluctuations driven by algal photosynthesis, water temperature, and wind. The highest concentration was 136.4% saturation (VIC06) and the lowest was 56.2% saturation (VIC04). Only one site (VIC03) was within the range recommended by ANZECC. All Namoi River sites excluding VIC07, had pH higher than the upper ANZECC limit of 8 (Table 4). Turbidity within the Namoi River was within the recommended ANZECC range for all sites. Alkalinity ranged from 105 to 160 milligrams per litre (mg/L).

VIC07 (high flow)

During high flows, all physico-chemical parameters measured at VIC07 were within the recommended ANZECC range (Table 4). Turbidity was not measured, but the water was opaque and turbidity high because of increased flow. Conductivity, pH, dissolved oxygen concentration and temperature were all lower in December than in February/March. Again, this is because flow was higher in December than February.

Table 4: Water quality data from Namoi River sites. *VIC07 was visited in December 2016; other sites in February/March 2016.

Parameter	Default ANZECC Trigger Values*	Site				
		VIC03	VIC04	VIC05	VIC06	VIC07*
Temperature (°C)	N/A	32.1	26.19	28.96	28.74	23.34
Conductivity ($\mu\text{S}/\text{cm}$)	30 - 350 $\mu\text{S}/\text{cm}$	466	425	433	508	242
Dissolved Oxygen (% saturation)	90 - 110%	97	56.2	125.1	136.4	92.3
Dissolved Oxygen (mg/L)	N/A	7.06	5.54	9.65	10.48	7.89
pH	6.5 - 8.0	8.57	8.21	8.42	8.22	7.52
Turbidity (NTU)	2 - 25 NTU	19.2	13.4	24.4	21.7	N/A
Alkalinity	N/A	160	157	105	143	N/A

* ANZECC (2000)

Note: there are no ANZECC guidelines for temperature, dissolved oxygen (mg/L) and alkalinity. Cells shaded green fall within ANZECC range, while those in pink fall outside the range.

Note: $\mu\text{S}/\text{cm}$ =microSiemens per centimetre

4.2.2 Macroinvertebrate Assessment

Seven orders, consisting of 11 families and three subfamilies, were collected from the Namoi River sites (Table 5). Most of the individuals collected were crustaceans of the Atyidae family. The number of species collected was low at all sites, with 5 taxa or fewer at three of the sites. Taxa richness at the Namoi River sites was highest at VIC06, but this still comprised only eight families. VIC06 had a moderate number of in-stream detention devices such as fallen logs and detritus. The pool at this site was small and shallow, and had a higher level of complexity than other sites.

Average SIGNAL2 scores for the Namoi River sites were less than four at all sites, indicating that all sites were severely polluted. All of the taxa present in the Namoi River had SIGNAL2 scores of 4 or less, indicating that they were tolerant of moderate pollution. Baetidae, with a SIGNAL2 score of 5, and Leptoceridae, with a score of 6, were the most pollution-sensitive taxa, and were present only at VIC05 and VIC06 (Table 5).

The Namoi River has a long history of flow regulation, and this has potentially contributed to the long-term decline in macroinvertebrate diversity. The additional stressor of drought and the scarcity of natural, rain-generated flow events are also likely to further reduce the macroinvertebrate community diversity.

Table 5: Macroinvertebrate families identified at Namoi River sites

Order	Family	Subfamily	Site			
			VIC03	VIC04	VIC05	VIC06
Decapoda	Atyidae		-	1	36	2
Isopoda	Corallanidae		-	2	4	1
Trichoptera	Leptoceridae		-	-	1	3
Ephemeroptera	Baetidae		-	-	1	4
Ephemeroptera	Caenidae		-	-	-	3
Hemiptera	Micronectidae		1	-	1	7
Hemiptera	Notonectidae		-	2	-	-
Hemiptera	Ochteridae		2	-	-	-
Odonata	Lestidae		-	2	-	-
Diptera	Ceratopogonidae		-	-	-	1
Diptera	Chironomidae	Chironominae	-	-	-	1
Diptera	Chironomidae	Tanypodinae	-	-	-	1
Diptera	Chironomidae	Orthoclaadiinae	-	-	-	1
Total individuals			3	7	43	24
Total families			2	4	5	8
Average SIGNAL2 Score			2	1.75	3.6	3.7

4.2.3 Fish Community

Ten fish species were collected at the Namoi River sites (Table 6). Fish diversity and abundance was greatest at VIC03. This site had abundant in-stream woody debris and detritus, providing suitable habitat for fish. Of the species collected, two were exotic; *Gambusia holbrooki* (mosquitofish) and *Cyprinus carpio* (common carp). At VIC03, mosquitofish accounted for nearly half of the total specimens at the site.

Table 6: Fish species caught at Namoi River sites

Species Name	Common Name	Conservation Status		VIC03 ³	VIC04 ³	VIC05 ³	VIC06 ⁴
		EPBC Act ¹	FM Act ²				
<i>Craterocephalus stercusmuscarum</i>	fly-speckled hardhead	-	-	12	22	27	2
<i>Cyprinus carpio</i> *	common carp	-	-	2	-	2	4
<i>Gambusia holbrooki</i> *	mosquitofish	-	-	72	-	-	-
<i>Hypseleotris klunzingeri</i>	western carp gudgeon	-	-	-	6		7
<i>Maccullochella peelii peelii</i>	Murray cod	V	-	-	-	1	-
<i>Macquaria ambigua</i>	golden perch	-	-	1	-	-	-
<i>Melanotaenia duboulayi</i>	crimson-spotted rainbowfish	-	-	37	6	1	2
<i>Nematalosa erebi</i>	bony bream	-	-	26	-	-	-
<i>Philypnodon grandiceps</i>	flathead gudgeon	-	-	17	-	-	-
<i>Tandanus tandanus</i>	catfish	-	EP	-	1	-	3
Total individuals				167	35	31	18
Total species				7	4	4	5

¹ Threatened species status under the EPBC Act (current as at May 2016).

² Threatened species status under the FM Act (current as at May 2016).

³ Downstream of the Project area.

⁴ Upstream of the Project area.

V= Vulnerable

EP = Endangered Population

* denotes exotic species.

4.3 Stygofauna Sampling Sites

4.3.1 Water Chemistry

The water table was too deep to collect water samples at VKY0036c (Figure 6). Groundwater temperatures averaged 23.38°C across the nine bores sampled for water quality, with a minimum of 22.33°C and a maximum of 25.18°C (Table 7). Groundwater pH averaged 7.4 across all bores. Electrical conductivity averaged 2010 µS/cm across all bores, and ranged from 914 µS/cm (SB07) to 3,975 µS/cm (MP4A). The average DO for all sites was 2.56 mg/L, with concentrations ranging from 1.46 mg/L to 4.5 mg/L.

Table 7: Groundwater quality at all sampled bores

Site	Date Sampled	Water Temperature (°C)	pH	Conductivity (µS/cm)	Dissolved Oxygen (% saturation)	Dissolved Oxygen (mg/L)
GW02	1/03/2016	23.4	6.66	1171	53.2	4.5
GW07	1/03/2016	23.89	8.19	3833	25.1	2.07
MP3A	2/03/2016	23.74	7.65	1300	28.9	2.4
MP4A	2/03/2016	22.5	7.3	3975	n/a	3
SB01	1/03/2016	25.18	7.45	1626	30.2	2.44
SB07	1/03/2016	22.33	7.22	914	22.9	1.95
SB09	1/03/2016	24.21	7.04	1062	43.2	3.62
VKY0035c	2/03/2016	22.88	6.99	3112	19.7	1.64
VKY0036c	2/03/2016	Water level too deep for sampling.				
WB01	1/03/2016	22.33	7.76	1098	17.2	1.46

Note: The location of sampling bores is shown on Figure 6.

4.3.2 Stygofauna

Preferred water conditions for stygofauna are characterised by an EC of less than 5,000 µS/cm, moderate concentrations of DO and a pH between 6.2 and 7.2 (Hancock and Boulton 2008). The bores from which definite and potential stygofauna were collected generally met these conditions, making them suitable for stygofauna if other unmeasured conditions, such as hydraulic conductivity and organic matter concentration, were also suitable.

Alluvial aquifers often provide favourable conditions, including a shallow water table and hydrological connectivity with surface water. The Groundwater Assessment (HydroSimulations 2018) describes the Namoi River in the vicinity of the Project as a 'losing stream' (i.e. some surface water is lost to the surrounding alluvium). As such, the aquifers would be recharged of organic matter and oxygen from surface flows entering the alluvium.

The Namoi alluvium also receives recharge from rainfall. Rainfall is also high in dissolved oxygen, but as it infiltrates and travels through the unsaturated zone, oxygen is consumed and the concentration declines. This means that alluvial aquifers with deeper water tables often have fewer stygofauna than those with shallow water tables.

Analysis of field samples revealed the presence of definite stygofauna taxa in three of the 10 bores sampled (Table 8). An additional three bores contain taxa that are likely/possibly stygofauna. The obligate groundwater community is characterised by Copepoda and Syncarida (Crustacea). GW02 had the highest diversity and abundance of stygofauna and was representative of the obligate groundwater community.

Without identifying samples to species it was not possible to confidently determine whether some orders and families were indeed stygofauna, as it is possible these are part of the soil invertebrate community. Even with species-level identifications, there is insufficient knowledge of stygofauna ecology in NSW to conclusively attribute members of the copepod and ostracoda as being stygofauna. However, there is less ambiguity with the Syncarida, which are almost exclusively dependent on groundwater.

Stygofauna were collected from the Namoi alluvium to the south and north of the Project. Two taxa, Cyclopoida and Notobathynellidae, occurred in both the northern and southern bores, indicating that the groundwater invertebrate community extends between these bores and probably along the alluvium beyond.

The stygofauna collected during this survey are all widespread taxa and consequently have low conservation value. They are likely to occur throughout large sections of the Namoi River alluvial aquifer.

Table 8: Stygofauna collected during the survey period

Order	Family	Stygofauna	Site										
			GW02	GW07	MP3A	MP4A	SB01	SB07	SB09	VKY0035C	VKY0036C	WB01	
Oligochaeta		Possible	6	-	-	-	-	-	-	-	-	-	7
Copepoda	Cyclopoida	Likely	8	-	-	-	-	-	4	-	-	-	38
Copepoda	Harpacticoida	Likely	18	-	-	-	-	-	-	-	-	-	-
Syncarida	Parabathynellidae	Yes	-	-	-	-	-	-	4	-	-	-	-
Syncarida	Notobathynellidae	Yes	1	-	-	-	-	5	-	-	-	-	-
Ostracoda		Possible	21	-	-	-	-	-	-	-	-	-	-
Nematoda		Possible	3	-	-	-	-	-	-	-	-	-	-
Total individuals			57	0	0	0	0	5	8	0	0	45	

Note: The location of sampling bores is shown on Figure 6.

4.4 Threatened Aquatic Fauna

Four eel-tailed catfish (listed under the FM Act as an endangered population in the Murray-Darling Basin) were collected in the Namoi River; three at VIC06, and one at VIC04 (Figure 6). Catfish are likely to occur at other sites along the Namoi River upstream of Boggabri, as there is plenty of suitable habitat (slow-flowing water, sand or gravel bed) present.

A single Murray cod (listed as vulnerable under the EPBC Act) was collected from the Namoi River at VIC05, adjacent to a steep bank. This site was part of a deep pool that stretched for several kilometres and had abundant cod habitat with submerged snags and deep, still sections. As with the catfish, it is likely that Murray cod occur along the reach of river adjacent to the Approved Mine, and would either use the river where the Project rail spur crosses the Namoi River (VIC06) or pass through it.

No silver perch were collected from the Namoi River sites during the February/March survey period; however, when water levels increased again later in March and the series of isolated pools become connected, silver perch will probably have spread throughout the system, given the presence of suitable habitat and the fact that silver perch are regularly stocked in the Namoi River (Namoi Valley Independent, 1 March 2016).

4.5 Threatened Ecological Communities

The *Lowland Darling River Aquatic Ecological Community* is listed as an EEC under the FM Act, and as the Namoi River eventually flows into the Darling River, it is considered part of this community. The *Lowland Darling River Aquatic Ecological Community* occurs in a lowland riverine environment characterised by meandering channels and a variety of habitats that form an integral part of the river system, including deep channels and pools, wetlands, gravel beds and floodplains. In its natural state, many of the waterbodies in this area are characterised by variable and unpredictable patterns of high and low flows.

The *Lowland Darling River Aquatic Ecological Community* includes all native fish and aquatic invertebrates within all natural creeks, rivers, streams and associated lagoons, billabongs, lakes, anabranches (a secondary channel that diverts from and rejoins the river), flow diversions to anabranches and the floodplains of the Darling River within NSW, and including Menindee Lakes and the Barwon River (NSW DPI 2007).

Specifically, these areas include the main Barwon–Darling channel from Mungindi (Queensland–NSW border) to the confluence with the Murray River, the arid zone intermittent intersections streams (Warrego, Culgoa, and Narran Rivers), Border Rivers (Macintyre, Severn and Dumaresq Rivers) and regulated tributaries (Gwydir, Namoi, Macquarie, Castlereagh, and Bogan Rivers). Excluded from the definition are man-made/artificial canals, water distribution and drainage works, farm dams and off-stream reservoirs (NSW DPI 2007).

The Namoi River, Driggle Draggie Creek, Deadmans Gully and Stratford Creek are naturally occurring watercourses that lie within the area of this EEC. An assessment of significance for the *Lowland Darling River Aquatic Ecological Community* is provided in Appendix A of this report.

5 Impact Assessment

5.1 Aquatic Habitat Clearance

Large woody debris was present at all of the Namoi River sites, providing plenty of habitat structure for fish. Sites along the Namoi have a high to moderate level of habitat complexity, which provides moderate to good habitat for fish and aquatic fauna. Despite this, the macroinvertebrate community was characterised by few taxa, low numbers, and was dominated by pollution-tolerant families. The reason for this is that the macroinvertebrate sampling occurred during a period of low flow when the pools were largely isolated.

Construction of the Project rail spur would not include any dredging or reclamation works within the Namoi River. If detailed design indicates that the bridge is not able to span the full width of the river, a piled foundation may need to be placed in the river bed or bank. If this is required, the piled foundation would be driven into the ground using a piling rig during a period of low/no flow within the Namoi River. Any construction works would be temporary, and the pile would not restrict flow or result in the restriction of fish passage during or after construction. In addition, sediment controls would be used on the river bank to minimise sediment generation and bank disturbance. With the implementation of these measures, it is not expected that the Namoi River crossing would significantly impact the aquatic ecology values of the Namoi River.

There are mature river red gum trees within the approximate path of the Project rail spur where it crosses the Namoi River. Some of these may need to be removed, although the final number would depend on exactly how the rail bridge is constructed and whether raised rail embankments are needed on the approach and exit of the bridge. It is likely that any river red gum saplings growing on the gravel bar at this site would also be removed or damaged during construction, although this is not a major concern as many would possibly be removed and replenished during floods.

Prior to crossing the Namoi River, the Project rail spur would traverse Stratford Creek. Once across the Namoi River, the Project rail spur will continue west before turning south and crossing the ephemeral Deadmans Gully; at this point it reassumes its westerly direction and adjoins the Werris Creek Mungindi Railway (Figure 5).

The construction/installation of the Project rail spur over the ephemeral drainage lines would require minor disturbance of stream banks. However, construction would have an insignificant impact on aquatic ecology as:

- there is limited aquatic habitat within the watercourse; and
- the design and construction of the Project rail spur would be undertaken in accordance with *DPI Fisheries Policy and Guidelines for Fish Habitat Conservation and Management (Update 2013)* (DPI Fisheries 2013) through the use of box culverts.

The installation of a pumping station on the banks of the Namoi River has been approved as part of the Approved Mine (SSD-5000), and would be required for Project-related water extraction (Figure 2). Other drainage lines within the Vickery Extension Project (EPBC 2016/7649) Footprint would be traversed by the Whitehaven Private Haul Road and the Blue Vale Road realignment (Figure 2) (Whitehaven 2013). The Approved Mine will include an up-catchment diversion of a drainage line into the Driggie Draggie Creek catchment to the north (Whitehaven 2013).

The disturbance to these creeks associated with the Approved Mine was assessed in the *Vickery Coal Project Environmental Impact Statement* (Whitehaven 2013), and it was concluded that the impacts to aquatic ecology associated with the disturbance to these watercourses would be minimal (Whitehaven 2013); therefore, impacts to these creeks have not been considered further in the current assessment.

No significant impact to aquatic habitat is likely to occur due to habitat clearance as a result of the Project and, as such, offsetting or compensatory efforts would not be required (Section 7).

5.2 Surface Water Extraction

Consistent with the Approved Mine (SSD-5000), operational water requirements would be primarily sourced from mine water dams containing runoff from disturbed mine areas or mine-affected water. Additional make-up water would be sourced from water storages containing runoff from undisturbed/rehabilitated areas, from licensed groundwater bores and/or surface water licensed extraction from the Namoi River.

Existing design and operating procedures for the approved pumping station to avoid and minimise potential impacts on aquatic ecology include:

- starting the pump slowly and then gradually ramping up velocity;
- installing a suitable self-cleaning screen; and
- regular inspection of the screen.

These existing design features and operating procedures would continue to be implemented for the Project.

Whitehaven holds a number of Water Access Licences (WALs) for extraction from the Namoi River. Water would be extracted from the Namoi River in accordance with the WALs and the rules prescribed in the relevant water sharing plan (i.e. the *Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016*) (Advisian 2018).

5.3 Surface Water Quality

Advisian (2018) concludes the Project would have negligible adverse impacts to water quality as the Project water management strategy would involve:

- separation of undisturbed area runoff from disturbed area runoff;
- collection and reuse of surface runoff from disturbed areas;
- management and capture of sediment-laden runoff using sediment dams designed and constructed in accordance with Landcom (2004) *Managing urban stormwater: soils and construction – Volume 1, 4th Edition*;
- capture of pit inflows and reuse as process water;
- containment of mine-affected water; and
- extraction of water to meet operational demands only in accordance with licences held by Whitehaven.

Surface water management and monitoring would be described in the Water Management Plan prepared for the Project.

The Project would not have a significant impact to the aquatic flora and fauna of the Namoi River system, given the Project water management strategy.

5.4 Groundwater Dependent Ecosystems

Aquatic Ecology

As stated in Section 2.2, the Namoi River (i.e. the river and associated riparian vegetation) is considered a GDE because groundwater contributes to baseflow in the main channel and also sustains riparian vegetation communities. Interaction between the Namoi River and the underlying alluvium varies with rainfall conditions (HydroSimulations 2018).

As described in Section 1.1, the Project would include the construction and use of the Project borefield and borefield pipeline. The Project would present a low risk to the Namoi River (or its associated aquatic ecology values) due to groundwater drawdown because (HydroSimulations 2018; Advisian 2018):

- the Project would not involve open cut mining intercepting alluvium (i.e. inflows to the open cut would originate from the hard rock, not the alluvium);
- recent drilling has confirmed that a thin veneer of alluvium on the fringes of the Namoi River floodplain is further away from the boundary of the western extent of the Project mining area than previously conceptualised and modelled;
- the thin veneer of alluvium is interspersed with clays that would result in a lower yield than the highly productive alluvial aquifers associated with the Namoi River;
- the thin veneer of alluvium was found to be unsaturated and, therefore, does not provide a direct pathway for drawdown impact to either the Namoi River or the highly productive Upper Namoi alluvium;
- the predicted river loss (i.e. baseflow reduction) due to the Project is negligible; and
- the Project is predicted to have negligible impact on water quality in the Namoi River.

Loss of water from the Namoi River is expected to be negligible. These changes would not have a significant impact on the aquatic ecosystem of the Namoi River, and would not threaten any listed aquatic species known to occur in the area.

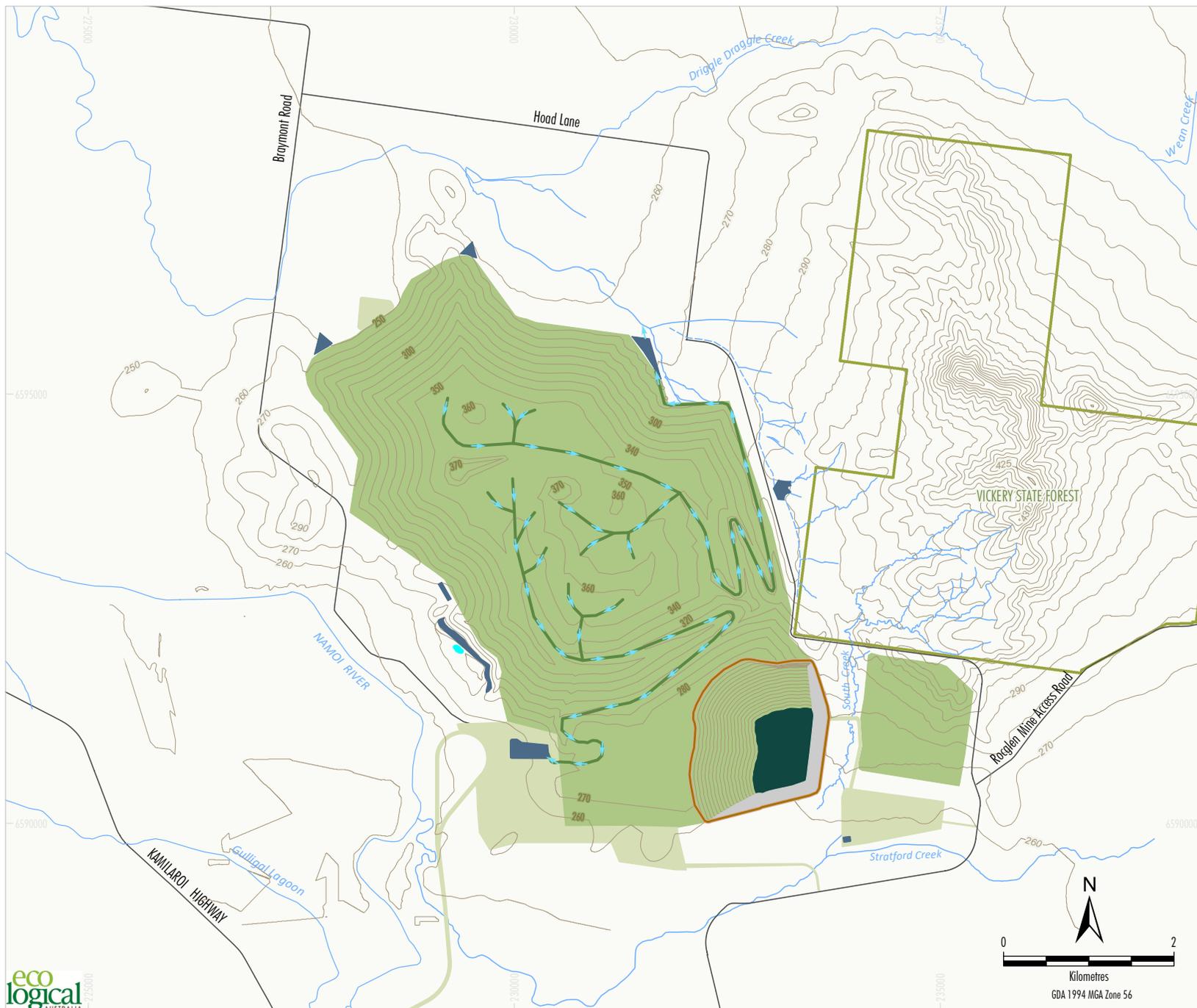
Stygofauna

Stygofauna were collected from the Namoi alluvium south of the Project area, and to the north of the Project area. Two taxa, Cyclopoida and Notobathynellidae, occurred in both the northern and southern bores, indicating that the groundwater invertebrate community extends between these bores and probably along the alluvium beyond. As negligible drawdown in the Upper Namoi Alluvium is predicted due to the Project, no significant impact to stygofauna is predicted.

5.5 Final Landform

At the cessation of mining, one final void would remain in the south-eastern corner of the Vickery Open Cut (Figure 8). The Project would, therefore, reduce the number of final voids in comparison to the Approved Mine, which would have resulted in two final voids.

The surface catchment of the final void would be reduced as far as is reasonable and feasible.



- LEGEND**
- State Forest
 - Indicative Up-catchment Diversion
 - Indicative Sediment Dams
 - Indicative Constructed Channels
 - Indicative Pasture Area
 - Indicative Woodland/Forest Area
 - Indicative Final Void
 - Indicative Final Void Highwall
 - Final Void Perimeter Bund

Source: Department of Land and Property Information (2014);
Department of Industry (2015)



VICKERY EXTENSION PROJECT
Conceptual Final Landform -
Rehabilitation Areas

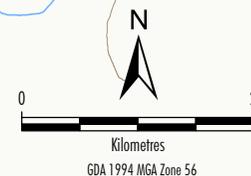


Figure 8

It is anticipated that the final void would create a localised groundwater sink that would both prevent salts or poorer-quality groundwater from migrating out from the Project area and prevent any adverse impacts on the beneficial use of local groundwater aquifers (HydroSimulations 2018).

In addition, the final landform is likely to cause only minor changes to volume of the runoff entering the Namoi River or infiltrating the alluvial aquifer (Advisian 2018). Subsequently, impacts to aquatic ecology from the final void are unlikely.

5.6 Key Fish Habitat and Fish Passage under the FM Act

The Project rail spur would cross the Namoi River approximately 200 m upstream of VIC06, south-west of the Approved Mine, as well as Deadmans Gully and Stratford Creek. These waterways are classified as key fish habitat, so the type of crossing required is determined by the habitat class of each waterway.

The Project borefield pipeline would traverse Driggle Draggie Creek, which is mapped by DPI Fisheries as key fish habitat². Despite this, and given that this watercourse is ephemeral, has ill-defined drainage channels and very few features that would provide suitable habitat for fish, Driggle Draggie Creek actually meets the definition of a 'minimally sensitive' Class 4 waterway (i.e. 'unlikely key fish habitat'), according to the criteria specified in DPI Fisheries (2013). In consideration of this, and given that the Project borefield pipeline would only consist of a narrow flexi pipe (a few centimetres in diameter) the Project borefield pipeline would not result in the restriction of fish passage along Driggle Draggie Creek during or after construction.

The Namoi River is a Class 1 (major) habitat, and so would require a bridge crossing, whereas Deadmans Gully and Stratford Creek are Class 4, and would require fish-friendly culverts. The Namoi River has in-stream gravel beds, rocks greater than 500 mm, snags greater than 300 mm diameter, aquatic plants, and several species listed under the FM Act, so the Namoi River is classified as Type 1 (highly sensitive) fish habitat (DPI Fisheries 2013). It is also a Class 1 (major) key fish habitat because there are threatened fish species present in the system: Murray cod and freshwater catfish were both collected from the Namoi River, and silver perch could also occur. All Class 1 habitats require a bridge crossing (DPI Fisheries 2013).

Given that the Project rail spur would be designed and constructed in accordance with DPI Fisheries (2013), the Project rail spur would not result in the restriction of fish passage during or after construction. Potential impacts to the Namoi River from the Project include the extraction of water and a negligible reduction in the groundwater contribution to baseflow (HydroSimulations 2018; Advisian 2018). The potential impacts associated with the Project would be minimal and would not result in any restriction of fish passage in the Namoi River.

² defined to include all marine and estuarine habitats up to highest astronomical tide level (that reached by 'king' tides) and most permanent and semi-permanent freshwater habitats including rivers, creeks, lakes, lagoons, billabongs, weir pools and impoundments up to the top of the bank. Small headwater creeks and gullies (known as first and second order streams), that only flow for a short period after rain are generally excluded, as are farm dams constructed on such systems. Wholly artificial waterbodies such as irrigation channels, urban drains and ponds, salt and evaporation ponds are also excluded except where they are known to support populations of threatened fish or invertebrates (DPI Fisheries 2013).

Deadmans Gully and Stratford Creek have been mapped as key fish habitat and, given that they are ephemeral, have an ill-defined drainage channel and very few features that would provide suitable habitat for fish, meet the definition of a Class 4 waterway (i.e. 'unlikely key fish habitat') according to the criteria specified in DPI Fisheries (2013). In consideration of this, and given that the Project rail spur would be designed and constructed in accordance with DPI Fisheries (2013), the Project would not result in the restriction of fish passage during or after construction.

No net loss of key fish habitat is predicted to occur as a result of the Project and, as such, offsetting of fish habitat or compensatory efforts would not be required.

5.7 Threatened Fauna under the FM Act

Two threatened aquatic species listed under the *Fisheries Management Act, 1994* (FM Act) were identified as present, or potentially occurring, within the Namoi River (Section 5.4). These were the:

- Murray–Darling Basin population of eel-tailed catfish (an endangered population under the FM Act) – recorded in the Namoi River; and
- Silver perch (listed as vulnerable under the FM Act) – predicted to occur in the Namoi River.

Potential impacts to these species are assessed in accordance with section 5A of the *Environmental Planning and Assessment Act, 1979* (EP&A Act) and the *Threatened Species Assessment Guidelines: the Assessment of Significance* (Department of Environment and Climate Change [DECC] 2007) (Appendix A) (note, the Project is a 'pending or interim planning application' under the *Biodiversity Conservation [Savings and Transitional] Regulation, 2017*, therefore, the relevant provisions of the EP&A Act that would be in force if that Act had not been amended [such as section 5A of the EP&A Act] apply to the Project).

Eel-tailed catfish were collected from two sites in the Namoi River during the field survey. Key threats to the catfish population are river regulation, changes to temperature regimes, removal of woody debris, and recreational angling. The Project would not pose any of these threats, and would not significantly impact on the Namoi River population of the eel-tailed catfish (Appendix A).

Silver perch have been introduced into the Namoi River, with stocking in February 2016 (Namoi Valley Independent, 1 March 2016). Silver perch are regularly stocked in NSW waterways, although they often fail to reproduce, contributing little to natural genetic stocks (NSW DPI 2006). Key threatening processes include structures blocking passage, blackwater events, and decreased temperature. The key potential impact to the Namoi River would be the extraction of water, and this would not threaten the populations of silver perch (Appendix A).

5.8 Threatened Ecological Communities under the FM Act

As described in Section 4.5, the regulated reach of the Namoi River forms part of the *Lowland Darling River Aquatic Ecological Community*, which is listed as endangered under the FM Act.

Potential impacts to this community are assessed in accordance with section 5A of the EP&A Act and the *Threatened Species Assessment Guidelines - the Assessment of Significance* (DECC 2007) (Appendix A). Key threats to this community include flow regulation, cold water pollution, the removal of large woody debris from the river, and clearing of the riparian zone. The Project would not result in any of these impacts (Appendix A).

Another potential impact from the Project would be the extraction of water from pools in the Namoi River. If extraction occurs at low flows, it could result in slightly prolonged dry periods, and increased frequency of drying. As all extraction from the Namoi River would be conducted in accordance with the licensed entitlements issued by the DI Water, and in accordance with the rules in the water sharing plan (including provisions to prevent increased frequency of drying), Advisian (2018) concludes that impacts to the Namoi River water source are not anticipated to be significant. The Project would not significantly impact the *Lowland Darling River Aquatic Ecological Community*.

5.9 Threatened Fauna under the EPBC Act

Two threatened aquatic species listed under the EPBC Act were identified as having the potential to occur, or have potential habitat in the Namoi River (Section 4.4). These were the:

- Murray cod (listed as vulnerable under the EPBC Act) – recorded in the Namoi River; and
- Silver perch (listed as critically endangered under the EPBC Act) – predicted to occur in the Namoi River.

The significance of potential impacts to these species was assessed in accordance with the *Significant Impact Guidelines 1.1 - Matters of National Environmental Significance* (DotE 2013a), and is provided in Appendix B. The *Draft EPBC Act Referral Guidelines for the Vulnerable Murray Cod (Maccullochella peelii)* (DEE 2018) was also considered whilst undertaking these assessments.

Threats to these species include river regulation, the removal of large woody debris and native riparian trees, and overfishing. The Project would not include any of these threats (Appendix B).

It was concluded the Project would not have a significant impact on any threatened aquatic species listed under the EPBC Act (Appendix B).

5.10 Cumulative Impacts

Cumulative impacts from proposed/approved (but not yet existing) developments in the local area are also considered in this assessment.

Operating mines in the vicinity of the Project include (Figure 1):

- Rocglen Coal Mine (formerly known as the Belmont Coal Project), approximately 5 km;
- Tarrawonga Coal Mine, approximately 10 km north;
- Boggabri Coal Mine, approximately 12 km north; and
- Maules Creek Coal Mine, approximately 15 km northwest.

The Rocglen Coal Mine (GSS Environmental 2011) and Tarrawonga Coal Mine (Cenwest 2011) do not require the extraction of water from the Namoi River, and were determined to have a minimal impact to aquatic ecology values in the region.

Similar to the Project, both the Boggabri Coal Mine (Parsons Brinkerhoff 2010) and Maules Creek Coal Mine (Cumberland Ecology 2011) involve water extraction from the Namoi River for use in their water management systems. Cumulative impacts from the extraction of water from the Namoi River for these three Projects is not expected to be significant, given that all water extraction would be undertaken in accordance with the relevant WALs and the rules prescribed in the relevant water sharing plan (i.e. the *Water Sharing Plan for the Upper Namoi and Lower Namoi Regulated River Water Sources 2016*) (Advisian 2018). Water Sharing Plans aim to minimise potential cumulative impacts which multiple users may have on environmental values associated with the Namoi River (including aquatic ecology).

The projects have been designed to minimise the potential impacts associated with mine water runoff on the surrounding environment through the use of water storages (e.g. sediment dams) (GSS Environmental 2011; Cenwest 2011; Parsons Brinkerhoff 2010; Cumberland Ecology 2011).

Whitehaven would prepare a Water Management Plan for the Project (HydroSimulations 2018; Advisian 2018).

The Project would not result in a significant cumulative impact to the aquatic flora and fauna of the Namoi River system, given the limited potential impacts associated with the Project and the implementation of mitigation and management measures described above.

6 Summary of Avoidance, Mitigation and Monitoring Measures

6.1 Avoidance

Sections of the Project rail spur cross the Namoi River, Deadmans Gully and Stratford Creek. Deadmans Gully and Stratford Creek are ephemeral and considered unlikely to be key fish habitat. While the Namoi River (and associated riparian vegetation) is major key fish habitat, the crossing would be constructed in a way that avoids significant impact to the river and its aquatic and riparian communities.

6.2 Existing Mitigation Measures

There are a number of measures that will be implemented at the Approved Mine to avoid and minimise impacts on aquatic biodiversity. These existing measures would be continued for the Project and include the following:

- Design and operating procedures for the approved pumping station, including:
 - starting the pump slowly and then gradually ramping up velocity;
 - installing a suitable self-cleaning screen; and
 - regular inspection of the screen.
- Progressive rehabilitation of the Project area.
- Implementation of a surface water monitoring program that would be implemented over the life of the Project as described in Advisian (2018).

6.3 Additional Mitigation Measures

Additional mitigation measures associated with the Project (in addition to those already implemented at the Approved Mine [Section 6.2]) include designing and constructing the Project rail spur in accordance with the *Policy and Guidelines for Fish Habitat Conservation and Management (Update 2013)* (DPI Fisheries 2013) through the implementation of bridges/culverts when crossing waterways mapped as key fish habitat, such as the Namoi River, Deadmans Gully and Stratford Creek.

7 Biodiversity Offsets

As detailed in Section 5, the Project would:

- not result in a significant impact to any aquatic threatened species, population or community listed under the FM Act, as assessed against the *Threatened Species Assessment Guidelines - the Assessment of Significance* (DECC 2007);
- not result in a significant impact to any aquatic threatened species listed under the EPBC Act, as assessed against the *Significant Impact Guidelines 1.1 - Matters of National Environmental Significance* (DotE 2013a) and relevant guidelines, recovery plans or listing advice; or
- not result in any net loss of key fish habitat as identified by DPI Fisheries (2013).

As such, the Project would not require any biodiversity offset or compensatory measure for potential impacts to aquatic ecology in accordance with DPI Fisheries (2013) *Policy and Guidelines for Fish Habitat Conservation and Management (Update 2013)* or the *EPBC Act Environmental Offsets Policy* (SEWPaC 2012).

8 Conclusion

The Namoi River is located more than 1 km south-west of the Project mining area (at its closest point). Sites along the Namoi River were in a condition typical of inland rivers that are in the drying phase of their hydrograph. Flow in the Namoi River was low when sampled in late February and early March, with water restricted to standing pools, but was flowing continuously when visited in December 2016. Large woody debris was present at all of the Namoi River sites, meaning that there was plenty of structure for fish. Eel-tailed catfish were collected from two sites on the Namoi, while Murray cod was collected from a third.

The two Driggle Draggie Creek sites were dry during the field survey, but they were assessed for their potential to act as aquatic habitat. Neither site had areas that are likely to create deep pools when surface water flows through the site, and neither appeared to provide habitat that would be suitable for threatened fish species.

Ten bore sites were sampled for stygofauna during the study. Four stygofauna taxa were collected from three bores in the Namoi River alluvial aquifer. These included Notobathynellidae, Parabathynellidae, Cyclopoida and Harpacticoida. The stygofauna collected during this survey are all widespread taxa and consequently have low conservation value. They are likely to occur throughout large sections of the Namoi River alluvial aquifer; as such, the Project would not have a significant impact on the stygofauna community.

The installation of a pumping station on the banks of the Namoi River (required for Project-related water extraction) has been approved as part of the Approved Mine (SSD-5000). Advisian (2018) concludes the Project would have negligible adverse impacts to water quality given the Project water management strategy, and HydroSimulations (2018) concludes the Project would present a low risk to the Namoi River due to groundwater drawdown. As such, the Project would not have a significant impact on aquatic ecology within the Project area or surrounds.

The construction of the Project rail spur would require the crossing (including minor disturbance to the stream bank) of Deadmans Gully and Stratford Creek, ephemeral drainage lines, as well as the main channel of the Namoi River. Design and construction of the Project rail spur would be in accordance with DPI Fisheries (2013) and the Project rail spur would not result in the restriction of fish passage.

The potential impacts of the Project on threatened species and communities listed under the EPBC Act and/or the FM Act were assessed in accordance with the *Threatened Species Assessment Guidelines - the Assessment of Significance* (DECC 2007) and the *Significant Impact Guidelines 1.1 - Matters of National Environmental Significance* (DotE 2013a). In summary, the Project would not have a significant impact on any threatened species, population or community known or likely to occur within the Project locality.

There are a number of existing mitigation measures implemented for the Approved Mine that would be continued for the Project, including the design and operating procedures for the approved pumping station, progressive rehabilitation of the Project area and implementation of a surface water monitoring program. In addition to the existing measures, the design and construction of the Project rail spur would be undertaken in accordance with the DPI Fisheries (2013). This would include a bridge over the Namoi River (a CLASS 1 waterway) and culverts over Deadmans Gully and Stratford Creek (CLASS 4 waterways).

The Project would not require any biodiversity offset or compensatory measure for potential impacts to aquatic ecology in accordance with DPI Fisheries (2013) or the *EPBC Act Environmental Offsets Policy*.

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Appendix A - Assessment of Significance (FM Act)

The following assessments describe the nature and severity of any potential impacts arising during construction and operation of the Project on those threatened species and communities listed under the *Fisheries Management Act, 1994* (FM Act) and considered 'known', 'likely' or 'possible' to occur in the Project locality. The assessments have been prepared in accordance with section 5A of the Environmental Planning and Assessment Act, 1979 (EP&A Act) and the *Threatened Species Assessment Guidelines - the Assessment of Significance* (Department of Environment and Climate Change [DECC] 2007).

The Aquatic Ecological Community of the Lowland Darling River

The *Lowland Darling River Aquatic Ecological Community* is listed as an endangered ecological community (EEC) under the FM Act. The *Lowland Darling River Aquatic Ecological Community* occurs in a lowland riverine environment characterised by meandering channels and a variety of habitats that form an integral part of the river system, including deep channels and pools, wetlands, gravel beds and floodplains. In its natural state, many of the waterbodies in this area are characterised by variable and unpredictable patterns of high and low flows.

The *Lowland Darling River Aquatic Ecological Community* includes all native fish and aquatic invertebrates within all natural creeks, rivers, streams and associated lagoons, billabongs, lakes, anabranches (a secondary channel that diverts from and rejoins the river), flow diversions to anabranches and the floodplains of the Darling River within New South Wales (NSW), and including Menindee Lakes and the Barwon River (NSW Department of Primary Industries [DPI] 2007). Specifically, these areas include the main Barwon–Darling channel from Mungindi (Queensland–NSW border) to the confluence with the Murray River, the arid zone intermittent intersections streams (Warrego, Culgoa, and Narran Rivers), Border Rivers (Macintyre, Severn and Dumaresq Rivers) and regulated tributaries (Gwydir, Namoi, Macquarie, Castlereagh and Bogan Rivers). Excluded from the definition are man-made/artificial canals, water distribution and drainage works, farm dams and off-stream reservoirs (NSW DPI 2007).

- a. **in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.**

Not applicable.

- b. **in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction.**

Not applicable.

- c. in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
- **is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
 - **is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction.**

There would be negligible changes to the flow regime within the aquatic habitats as reductions of base flow would be negligible, and extraction of water would only be conducted in accordance with licences held by Whitehaven (HydroSimulations 2018; Advisian 2018). The Project would not have a significant impact on this community given the extent of the occurrence of this EEC throughout NSW and the predicted minimal impact associated with the Project.

The rail crossing of the Namoi River, and any associated infrastructure in the floodplain would conform to the *DPI Fisheries Policy and Guidelines for Fish Habitat Conservation and Management (Update 2013)* (DPI Fisheries 2013), and would have minimal impact on the aquatic fauna.

The Project would not place the local occurrence or substantially or adversely modify the composition of the *Lowland Darling River Aquatic Ecological Community* at risk of extinction.

- d. in relation to the habitat of a threatened species, population or ecological community:**
- **the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**

The naturally occurring watercourses within the study area are tributaries of the Namoi River downstream of its junction with the Manilla River and fall within the area of this EEC.

The construction/installation of the Project rail spur over the Namoi River may require minor disturbance of stream banks (Section 5.1 of the main text). However, its construction is expected to have an insignificant impact on the aquatic habitat in the river as the design and construction of the Project rail spur would be undertaken in accordance with *DPI Fisheries Policy and Guidelines for Fish Habitat Conservation and Management (Update 2013)* (DPI Fisheries 2013) through the implementation of a bridge across the Namoi River. Likewise, any crossing of Deadmans Gully and Stratford Creek would conform to the DPI Guidelines and would be a fish-friendly culvert.

The Project is not likely to indirectly impact the *Lowland Darling River Aquatic Ecological Community* given that:

- It is likely to have a negligible impact on baseflow contributions to the Namoi River (HydroSimulations 2018). This reduction is expected to have little effect on flow regime, low flows, water quality or fish passage.
- Water extraction would be controlled under the Water Sharing Plan licence (Advisian 2018). This would limit any impacts to stream flow, stream processes and aquatic habitat.
- The water management strategy for the Project would prevent any significant risks to downstream water quality (Advisian 2018).

- **whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**

There would be no long-term fragmentation of aquatic habitat in the river, as the design and construction of the Project rail spur would be undertaken in accordance with *DPI Fisheries Policy and Guidelines for Fish Habitat Conservation and Management (Update 2013)* (DPI Fisheries 2013) through the implementation of a bridge across the Namoi River. Likewise, any crossing of Deadmans Gully and Stratford Creek would conform to the DPI Guidelines and would be a fish-friendly culvert.

Embankments on the floodplain would be constructed in a way that reduces the fragmentation of floodplain habitat and the severing of drainage lines.

- **the importance of the habitat to be removed, modified, fragmented or isolated to the long term survival of the species, population or ecological community in the locality,**

Some riparian vegetation may need to be removed for the rail crossing and where the Project rail spur nears the river. This would consist of mature and juvenile river red gums and other species. Riparian habitat along the Namoi River is dominated by large river red gums, and the number of trees removed for the Project rail spur would be minimal.

The rail spur may cause some fragmentation of the floodplain; however, this would be minimal and unlikely to have a significant impact. Where necessary, flow would be facilitated by properly designed culverts, as specified in the DPI Fisheries (2013) guidelines.

The removal or modification of the habitat would not affect the long-term survival of the *Lowland Darling River Aquatic Ecological Community* in the locality, as the level of impact would be minimal.

- e. **whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),**

No critical habitat would be adversely affected by the Project.

- f. **whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,**

There is no published recovery plan for Lowland Darling River Aquatic Ecological Community.

The Project is not inconsistent with the recovery actions listed in the *Priorities Action Statement - Actions for Lowland Darling River Aquatic Endangered Ecological Community* (DPI Fisheries 2018a).

- g. **whether the proposed development or activity constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.**

The Project rail spur would result in the construction of minimal *in-stream structures and other mechanisms that alter natural flow* across the Namoi River and the ephemeral drainage lines it traverses, along with minor *degradation of native riparian vegetation along New South Wales water courses* (approximately 40 m wide, consisting entirely of derived native grassland [FloraSearch 2018] and mature river red gums) which are both listed as key threatening processes by DPI Fisheries (2016).

Conclusion

The Project would not significantly impact the *Lowland Darling River Aquatic Ecological Community* given:

- the extent of the occurrence of this EEC throughout NSW and the predicted minimal impact associated with the Project;
- the Project would comply with the *DPI Fisheries Policy and Guidelines for Fish Habitat Conservation and Management (Update 2013)* (DPI Fisheries 2013) for all crossings of the Namoi River, Deadmans Gully and Stratford Creek;
- the Project rail spur would have an insignificant impact on the limited aquatic habitat in the ephemeral drainage lines it traverses; and
- indirect impacts would be minimal.

Murray–Darling Basin Population of Eel-tailed Catfish – *Tandanus tandanus*

Eel-tailed catfish are found in freshwater areas, including tidal reaches of coastal rivers from the Shoalhaven River to the Tweed River in NSW. Native fish, including catfish, have been translocated into coastal rivers from the Murray–Darling Basin and it is not known if the populations of eel-tailed catfish in those catchments south of the Karuah River are endemic to the eastern river systems (Fisheries Determination Committee 2008).

Eel-tailed catfish are naturally distributed throughout the Murray–Darling Basin and in the eastern drainages of NSW north of Newcastle. Eel-tailed Catfish numbers in the Murray–Darling Basin have declined due to a range of impacts including invasive species, habitat degradation, cold-water pollution and fishing pressures, and are now virtually absent from the Murray, Murrumbidgee and Lachlan catchments (Fisheries Determination Committee 2008).

- a. In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.**

Not applicable.

- b. In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction**

The eel-tailed catfish is a benthic species that prefers slow-flowing streams and lake habitats. They build nests from pebbles and gravel with coarser material in the centre. Spawning takes place in the spring and summer months when water temperatures are 20–24°C. The species is primarily an opportunistic carnivore, feeding on shrimp, yabbies and freshwater prawns; aquatic invertebrates and small fish also important (Lintermans 2009).

Eel-tailed catfish occur in the Namoi River, and may occur where the Project rail spur crosses the river. Silt curtains and any works that disturb the riverbed have the potential to disturb catfish and their breeding habitat, but any disturbance that occurs would have a minor impact (Section 5.1 of the main text). This is because catfish can move to suitable habitat nearby during the construction phase.

The Project is not likely to impact the eel-tailed catfish population in the Namoi River given:

- The Project rail spur would not include any dredging or reclamation works within the Namoi River.
- The Project is likely to have a negligible impact on baseflow contributions to the Namoi River (HydroSimulations 2018). This reduction is expected to have little effect on flow regime, low flows, water quality or fish passage.
- Water extraction would be controlled under the Water Sharing Plan licence (Advisian 2018). This would limit any impacts to stream flow, stream processes and aquatic habitat.
- The water management strategy for the Project would prevent any significant risks to downstream water quality (Advisian 2018).

c. In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

- **is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
- **is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Not applicable.

d. in relation to the habitat of a threatened species, population or ecological community:

- **the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**

Eel-tailed catfish would not occur within the ephemeral drainage lines proposed to be impacted by the construction of the Project rail spur.

Catfish do occur in the Namoi River and are likely to occur where the Project rail spur crosses the Namoi River. The Project rail spur would not include any dredging or reclamation works within the Namoi River and, as such, would not disturb any catfish habitat.

- **whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**

The Project is unlikely to fragment or isolate habitat for this species.

- **the importance of the habitat to be removed, modified, fragmented or isolated to the long term survival of the species, population or ecological community in the locality,**

The Project rail spur would not include any dredging or reclamation works within the Namoi River and as such would not disturb any catfish habitat.

e. whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

No critical habitat has been declared for this species.

f. whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

The objectives of the recovery plan for the eel-tailed catfish (Clunie and Koehn 2001) include:

- Protect and enhance existing populations of eel-tailed catfish.
- Prevent further decline in the distribution and abundance of eel-tailed catfish.
- Restore populations throughout the species' distribution within the *MurrayDarling* Basin.

The recovery plan outlines actions that encompass conservation status, priority protection, *population* assessment, population monitoring, community awareness, river regulation, research, weir removal, introduced species, water quality, habitat components, diseases, aquaculture industry, translocations and genetic implications, and fishing (Clunie & Koehn 2001).

The proposed rail crossing is consistent with the recovery plan objectives, although may cause some minor disturbance to gravel bed sites that are potentially used for spawning, due to the use of temporary silt curtains during construction. However, in the longer term, the Project would be consistent with the objectives of the *Freshwater catfish: a recovery plan* Arthur Rylah Institute for Environmental Research (Clunie and Koehn 2001).

In addition, the Project is not inconsistent with the recovery actions listed in the *Priorities Action Statement - Actions for Murray-Darling population of Eel Tailed Catfish* (DPI Fisheries 2018b).

g. whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The Project rail spur would result in the construction of minimal *in-stream structures and other mechanisms that alter natural flow* in the Namoi River and the ephemeral drainage lines it traverses, along with minor *degradation of native riparian vegetation along New South Wales water courses* (approximately 40 m wide, consisting of river red gum or derived native grassland [FloraSearch 2018]) which are both listed as key threatening processes by DPI Fisheries (2016).

Conclusion

The Project would not significantly impact the Murray–Darling Basin population of eel-tailed catfish (*Tandanus tandanus*) given:

- there would be no significant impact to this population from the Project rail spur where it crosses the Namoi River; and
- there would be limited indirect impact (e.g. to baseflow and water flow/quality) associated with the Project.

Silver Perch – *Bidyanus bidyanus*

Silver perch are native to the Murray–Darling Basin. They are most abundant in the Murray River downstream of Yarrowonga Weir (and in associated tributaries and anabranches) (DPI 2006). There are also reports of self-sustaining populations in other rivers, such as the Macintyre and Macquarie Rivers in northern NSW and Warrego River in Queensland, and a translocated population occurs in the Cataract Dam near Sydney. In many other parts of the Murray–Darling Basin, however, silver perch are now absent or rare (DPI 2006).

While silver perch have been well studied under culture conditions, there is a significant lack of information on their biology, environmental tolerances or habitat requirements in the wild (DPI 2006). This lack of information makes it difficult to be certain of the reasons for the decline of silver perch, although a range of likely factors can be identified (DPI 2006). Silver perch evolved in an environment characterised by extremely variable river flows, including periods of drought punctuated by major floods, and their life history and reproductive strategies are well adapted to these conditions (DPI 2006).

- a. in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,**

Silver perch were not recorded during the recent surveys of the Namoi River and the ephemeral drainage lines traversed by the Project rail spur do not provide habitat for this species. However, silver perch are regularly stocked in NSW waterways, including the Namoi River, and they may occur at the rail crossing site. However, they often fail to reproduce, contributing little to natural genetic stocks (DPI 2006).

The Project is not likely to indirectly impact the silver perch given that:

- It is likely to have a negligible impact on baseflow contributions to the Namoi River (HydroSimulations 2018). This reduction is expected to have little effect on flow regime, low flows, water quality or fish passage.
- A small number of river red gums would be removed along the rail spur. This would have negligible impact on the replenishment of large woody debris habitat.
- Water extraction would be limited in quantity and controlled under the Water Sharing Plan licence (Advisian 2018). This would limit any impacts to stream flow, stream processes and aquatic habitat.
- The water management strategy for the Project is consistent with the principles of the Approved Mine; therefore, the Project would not present a significant risk to downstream water quality due to controlled releases or passively managed storages (Advisian 2018).

Impacts as a result of the Project are expected to be minimal, and it is considered unlikely that the Project would have an adverse effect on the life cycle of the silver perch or that it would be placed at risk of extinction.

- b. in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,**

Not applicable.

- c. in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**
- **is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or**
 - **is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,**

Not applicable.

- d. in relation to the habitat of a threatened species, population or ecological community:**
- **the extent to which habitat is likely to be removed or modified as a result of the action proposed, and**

Silver perch occur in the Namoi River and are potentially present at the rail crossing site. Parts of the river may be impacted by rail bridge construction, which would potentially entail the removal of some bank vegetation, relocation of large woody debris and disturbance of the gravel bed.

- **whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and**

The Project is unlikely to fragment or isolate habitat for this species.

- **the importance of the habitat to be removed, modified, fragmented or isolated to the long term survival of the species, population or ecological community in the locality,**

No habitat will be removed, modified, or fragmented as a result of this project, so there will be no long-term impact on the survival of this species.

- e. whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),**

No critical habitat for this species would be impacted by the Project.

- f. whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,**

The relevant objectives of the *NSW Recovery Plan: Silver Perch* include (DPI 2006):

- Protect and enhance remaining natural populations.
- Ameliorate the impacts of known major threats.
- Increase scientific knowledge of ecology.

No natural populations are known from the area surrounding the Project. Juvenile silver perch have recently been released in the Namoi River near Narrabri, Boggabri, and Gunnedah (Namoi Valley Independent, 1 March 2016).

The Project would be consistent with the objectives of the *NSW Recovery Plan: Silver Perch* include (DPI 2006).

In addition, the Project is not inconsistent with the recovery actions listed in the *Priorities Action Statement - Actions for Silver Perch* (DPI Fisheries 2018c).

g. whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The Project rail spur would result in the construction of minimal *in-stream structures and other mechanisms that alter natural flow* across the Namoi River and the ephemeral drainage lines it crosses, along with minor *degradation of native riparian vegetation along New South Wales water courses* (approximately 40 m wide, consisting of riparian river red gum and derived native grassland [FloraSearch 2018]), which are both listed as key threatening processes by DPI Fisheries (2016).

Conclusion

The Project would not significantly impact the silver perch given that:

- there would be negligible impact to this species from the Project rail spur where it crosses the Namoi River and ephemeral drainage lines; and
- there would be limited indirect impacts (e.g. to baseflow and water flow/quality) associated with the Project.

Appendix A - References

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Appendix B - Assessment of Significance (EPBC Act)

The following assessments describe the nature and severity of any potential impacts arising during construction and operation of the Project on those threatened species listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act) and considered 'known', 'likely' or 'possible' to occur in the Project locality. The assessments have been prepared in accordance with the *Matters of National Environmental Significance - Significant Impact Guidelines 1.1* (Department of the Environment [DotE] 2013a).

Murray Cod – *Maccullochella peeli*

The Murray cod is listed as Vulnerable under the EPBC Act.

The Murray cod is the largest freshwater fish found in Australia. It is a long-lived predator species that is highly territorial and aggressive. It occurs naturally in the waterways of the Murray-Darling Basin in a wide range of warm-water habitats that range from clear, rocky streams to slow-flowing turbid rivers and billabongs (Threatened Species Scientific Committee 2003). The upper reaches of the Murray and Murrumbidgee Rivers are considered too cold to contain suitable habitat (Department of Environment 2003); however, the Murray cod was formerly widespread and abundant in the lower and mid-altitude reaches of the Murray–Darling Basin. Commercial fisheries data indicate that natural populations declined in the 1920s and then again, dramatically, in the 1950s. The species now has a patchy distribution and abundance across its historic range and was listed as nationally threatened in 2003 (Murray–Darling Basin Commission [MDBC] 2007).

Will the action lead to a long-term decrease in the size of an important population of a species?

A single Murray cod was recorded in the Namoi River, downstream of the Project area, and the species is likely to occur along the Namoi River, including at the rail crossing site. However, there may be some negligible impacts to habitat for this species, such as the removal of riparian trees that may otherwise have become large woody debris. None of these impacts are likely to reduce the population size of Murray cod.

The ephemeral drainage lines within the Vickery Extension Project (EPBC 2016/7649) Footprint (i.e. South Creek, North Creek and Stratford Creek) would not provide suitable habitat for this species.

The Project is not likely to indirectly impact the Murray cod given that:

- It is likely to have a negligible impact on baseflow contributions to the Namoi River (HydroSimulations 2018). This reduction is expected to have little effect on flow regime, low flows, water quality or fish passage.
- Water extraction would be limited in quantity and controlled under the Water Sharing Plan licence (Advisian 2018). This would limit any impacts to stream flow, stream processes and aquatic habitat.
- The water management strategy for the Project is consistent with the principles of the Approved Mine; therefore, the Project would not present a significant risk to downstream water quality due to the operation of the water management system (Advisian 2018).

Given the above, the Project would not lead to a long-term decrease in the size of an important population of the species (as defined by the *Draft EPBC Act Referral Guidelines for the Vulnerable Murray Cod [Maccullochella peelii]* [DotE 2013b]).

Will the action reduce the area of occupancy of an important population?

The Project would not reduce the area of occupancy of an important population of the Murray cod given the minimal impacts associated with the Project on the Namoi River.

Will the action fragment an existing important population into two or more populations?

The Project would not fragment an existing important population into two or more populations as it would not impact habitat connectivity, and natural connectivity within the system would be maintained. Silt curtains may be needed temporarily during construction. These would not cross the river, but would run parallel to the bank and cause a narrowing of the waterway.

Will the action adversely affect habitat critical to the survival of a species?

There would be minor impact to habitat in the Namoi River at the rail crossing site, but this would not have a long-term impact on Murray cod habitat.

Will the action disrupt the breeding cycle of an important population?

The Project would not disrupt the breeding cycle of an important population as there are no predicted changes to higher winter/spring flows that are cues for Murray cod migration for breeding.

Will the action modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The Project would not modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

The Project water management strategy would involve (Advisian 2018):

- separation of undisturbed area runoff from disturbed area runoff;
- collection and reuse of surface runoff from disturbed areas;
- management and capture of sediment-laden runoff with sediment dams designed and constructed in accordance with Landcom (2004) *Managing urban stormwater: soils and construction – Volume 1, 4th Edition*;
- capture of pit inflows and reuse as process water;
- containment of mine-affected water; and
- extraction of water to meet operational demands in accordance with licences held by Whitehaven.

Evans and Peck (2013) concluded that the Approved Mine would result in a low risk of adverse water quality impacts from controlled releases at licensed discharge points. Given that the water management strategy for the Project is consistent with the principles of the Approved Mine, the Project would not present a significant risk to downstream water quality due to the operation of the water management system (Advisian 2018). Whitehaven would operate the Project in accordance with the requirements of an Environmental Protection Licence (EPL) issued under the New South Wales (NSW) *Protection of the Environment Operations Act, 1997* (Advisian 2018).

Will the action result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat?

The eastern mosquitofish (*Gambusia holbrooki*) and the common carp (*Cyprinus carpio*) are considered threats to the Murray cod (Threatened Species Scientific Committee 2003; National Murray Cod Recovery Team 2010). Both of these species were recorded during the recent surveys and their spread is unlikely to be further increased by the development.

Invasive species are already present in the Vickery Extension Project (EPBC 2016/7649) Footprint (as evidenced by the recent surveys). Given the minimal impact the Project would have on the Namoi River (HydroSimulations 2018; Advisian 2018), it is unlikely that it would result in the introduction of additional invasive species that would cause the Murray cod population to decline.

Will the action introduce disease that may cause the species to decline?

Very little is known about the prevalence and impact of diseases on Murray cod (National Murray Cod Recovery Team 2010). The major concern most likely relates to those exotic diseases introduced to Australia with imported fish that have found their way into the environment (National Murray Cod Recovery Team 2010).

Given the minimal impact the Project would have on the Namoi River (HydroSimulations 2018; Advisian 2018) it is unlikely that it would introduce disease (particularly associated with invasive species) that would cause the Murray cod population to decline.

Will the action interfere substantially with the recovery of this species?

The Project would not interfere substantially with the recovery of this species, nor is it inconsistent with the recovery objectives listed in the *National Recovery Plan for the Murray Cod *Maccullochella peelii peelii** (National Murray Cod Recovery Team 2010).

Conclusion of EPBC Act Assessment

It is unlikely that the Project would significantly impact the Murray cod given:

- there would be no direct impact to this species from the Project as there would be little impact to existing cod habitat in the Namoi River at the crossing site; and
- there would be limited indirect impacts (e.g. to baseflow and water flow/quality) associated with the Project.

Silver Perch – *Bidyanus bidyanus*

The silver perch is listed as Critically Endangered under the EPBC Act. This species was listed as Endangered under the EPBC Act at the time of the controlled action decision (14 April 2016), and was, therefore, assessed as 'Endangered' not 'Critically Endangered' (refer to section 158A of the EPBC Act).

Silver perch are endemic to the Murray–Darling system (including all states and sub-basins) (Threatened Species Scientific Committee 2013). Hatchery-bred silver perch are also stocked out of their range in a number of impoundments on east coast river systems, where they seemingly fail to reproduce (Threatened Species Scientific Committee 2013).

Will the action lead to a long-term decrease in the size of a population?

The silver perch was not recorded during the recent surveys, although they are regularly stocked in NSW waterways, including the Namoi River. They often fail to reproduce, making little contribution to natural genetic stocks (NSW Department of Primary Industries [DPI] 2006). There is a chance that silver perch would occur in the Namoi at the rail crossing site, but the rail bridge would have negligible impact on the long-term population.

The Project is not likely to indirectly impact the silver perch in the Namoi River given that:

- It is likely to have a negligible impact on baseflow contributions to the Namoi River (HydroSimulations 2018). This reduction is expected to have little effect on flow regime, low flows, water quality or long-term fish passage.
- Water extraction would be limited in quantity and controlled under the Water Sharing Plan licence (Advisian 2018). This would limit any impacts to stream flow, stream processes and aquatic habitat.
- The water management strategy for the Project is consistent with the principles of the Approved Mine; therefore, the Project would not present a significant risk to downstream water quality due to the operation of the water management system (Advisian 2018).

Will the action reduce the area of occupancy of the species?

The Project would not reduce the area of occupancy of an important population of the silver perch given the minimal impacts associated with the Project on the Namoi River. There would be no in-filling of pools at the crossing site.

Will the action fragment an existing population into two or more populations?

The Project would not fragment an existing important population into two or more populations as it would not impact habitat connectivity and natural connectivity within the system would be maintained.

Will the action adversely affect habitat critical to the survival of a species?

No habitat critical to the survival of the species has been identified within the Vickery Extension Project (EPBC 2016/7649) Footprint or surrounds.

Will the action disrupt the breeding cycle of a population?

The Project would not disrupt the breeding cycle of silver perch. In the Namoi River, silver perch depend on stocking, and stocked populations often do not successfully reproduce (NSW DPI 2006).

Will the action modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline?

The Project would not modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline. There would be no restriction of fish passage during or after construction of the Project.

The Project water management strategy would involve (Advisian 2018):

- separation of undisturbed area runoff from disturbed area runoff;
- collection and reuse of surface runoff from disturbed areas;
- management and capture of sediment-laden runoff with sediment dams designed and constructed in accordance with Landcom (2004) *Managing urban stormwater: soils and construction – Volume 1, 4th Edition*;
- capture of pit inflows and reuse as process water;
- containment of mine-affected water; and
- extraction of water to meet operational demands in accordance with licences held by Whitehaven.

Evans and Peck (2013) concluded that the Approved Mine would result in a low risk of adverse water quality impacts from controlled releases at licensed discharge points. Given that the water management strategy for the Project is consistent with the principles of the Approved Mine, the Project would not present a significant risk to downstream water quality due to the operation of the water management system (Advisian 2018). Whitehaven would operate the Project in accordance with the requirements of an EPL issued under the NSW *Protection of the Environment Operations Act, 1997* (Advisian 2018).

Will the action result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat?

Invasive species are already present in the Vickery Extension Project (EPBC 2016/7649) Footprint (as evidenced by the recent surveys). Given the minimal impact the Project would have on the Namoi River (HydroSimulations 2018; Advisian 2018), it is unlikely that it would result in the introduction of additional invasive species that would cause the silver perch population to decline.

Will the action introduce disease that may cause the species to decline, or interfere with the recovery of the species?

Given the minimal impact the Project would have on the Namoi River (HydroSimulations 2018; Advisian 2018) it is unlikely that it would introduce disease (particularly associated with invasive species) that would cause the silver perch population to decline.

Will the action interfere with the recovery of the species?

The relevant objectives of the *NSW Recovery Plan: Silver Perch* include (DPI 2006):

- Protect and enhance remaining natural populations.
- Ameliorate the impacts of known major threats.
- Increase scientific knowledge of ecology.

No natural populations are known from the area surrounding the Project. Juvenile silver perch have recently been released in the Namoi River near Narrabri, Boggabri, and Gunnedah (Namoi Valley Independent, 1 March 2016), but the Project would not impact these.

The Project would not interfere substantially with the recovery of this species, nor is it inconsistent with the recovery objectives listed in the *NSW Recovery Plan: Silver Perch* (DPI 2006).

Conclusion of EPBC Act Assessment

It is unlikely that the Project would significantly impact the silver perch given that:

- there would be no significant impact to this species from the Project rail spur where it crosses the Namoi River; and
- there would be limited indirect impacts (e.g. to baseflow and water flow/quality) associated with the Project.

Appendix B - References

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Appendix C - Site Photos



Plate 1: VIC03 (Left) looking upstream and (Right) looking downstream



Plate 2: VIC04 (Left) looking upstream and (Right) looking downstream



Plate 3: VIC05 (Left) looking upstream and (Right) looking downstream



Plate 4: VIC06 (Left) looking upstream and (Right) looking downstream

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