8 Surface water

8.1 Assessment objectives

Relevant general requirements of the DGRs are:

> A detailed assessment of the key issues specified below, and any other significant issues identified in the risk assessment, which includes:
>
> - a description of the existing environment, using sufficient baseline data;
> - an assessment of the potential impacts of the project, including any cumulative impacts, taking into consideration any relevant guidelines, policies, plans and statutory provisions; and
> - a description of the measures that would be implemented to avoid, minimise and if necessary, offset the potential impacts of the project, including detailed contingency plans for managing any significant risks to the environment.

The key issues in the DGRs that relate specifically to water resources are:

> - detailed modelling of the potential surface and groundwater impacts of the project;
> - a detailed site water balance, including a description of site water demands, water disposal methods (inclusive of the volume and frequency of any water discharges), water supply infrastructure and water storage structures;
> - a demonstration that water supplies for the construction and operation of the mine can be obtained from an appropriately authorised and reliable supply in accordance with the operating rules of any relevant Water Sharing Plan (WSP) and/or requirements of the *Water Act 1912* and NSW Inland Groundwater Shortage Zone Embargo for water sources outside of any relevant WSP;
> - a description of the measures proposed to ensure the project can operate in accordance with the proximity and water source protection criteria of the relevant Water Sharing Plan;
> - identification of any licensing requirements under the *Water Act 1912* or *Water Management Act 2000*;
> - a detailed assessment of potential impacts on:
>   - the quality and quantity of existing surface and groundwater resources;
>   - affected licensed water users and basic landholder rights;
>   - the riparian, ecological, geo-morphological and hydrological values of watercourses resulting from any proposed diversion works, including environmental flows; and
>   - groundwater dependent ecosystems;
> - a detailed description of the proposed water management system and water monitoring program for the project and other measures to mitigate surface and groundwater impacts; and
> - a detailed flood impact assessment identifying the impact of the project on flooding and the measures proposed to mitigate potential flood impacts.

This chapter focuses on the surface water aspects of the requirements listed above.

8.2 Assessment method

The surface water assessment for the Project has been prepared by Parsons Brinckerhoff Australia Pty Limited (Appendix E) and the results are summarised in this chapter. The assessment was in accordance with the following regulations, methods and guidance documents as specified in the DGRs:

- *National Water Quality Management Strategy: Australian Guidelines for Fresh and Marine Water Quality* (ANZECC/ARMCANZ 2000a);
- *National Water Quality Management Strategy: Australian Guidelines for Water Quality Monitoring* (ANZECC/ARMCANZ 2000b);
- *National Water Quality Management Strategy: Guidelines for Sewerage Systems – Effluent Management* (ARMCANZ/ANZECC 1997);
- *National Water Quality Management Strategy: Guidelines for Sewerage Systems – Use of Reclaimed Water* (ARMCANZ/ANZECC 1999);
- *Using the ANZECC Guidelines and Water Quality Objectives in NSW* (DEC 2006a);
- *State Water Management Outcomes Plan* (Anonymous undated);
- *Water Sharing Plan for the Macquarie and Cudgegong Regulated Rivers Water Source* (DWE 2003);
- *NSW Government Water Quality and River Flow Objectives* (DEC 2006b);
- *Approved Methods for the Sampling and Analysis of Water Pollutants in NSW* (DEC 2004)*;*
- *Managing Urban Stormwater: Soils & Construction* (Landcom 2004);
- *Managing Urban Stormwater: Treatment Techniques* (EPA 1997);
- *Managing Urban Stormwater: Source Control* (EPA 1998);
- *Floodplain Development Manual* (DIPNR 2005a)*;*
- *Floodplain Risk Management Guideline* (DECC 2007);
- *A Rehabilitation Manual for Australian Streams* (CRCCH and LWRRDC 2000);
- *Technical Guidelines: Bunding & Spill Management* (DECC 2001); and
- *Environmental Guidelines: Use of Effluent by Irrigation* (DECC 2004).

Additional regulations, methods and guidance documents used in the assessment include:

- *Water Act 1912;*
- *Water Management Act 2000;*
- *Dams Safety Act 1978;*

- *Protection of the Environment Operations Act 1997;*

- *Draft Water Sharing Plan for the Macquarie Bogan Unregulated and Alluvial Water Source* (NOW 2011c)*;*

- *Draft Murray-Darling Basin Plan* (MDBA 2011);

- *Australian Rainfall and Runoff — A Guide to Flood Estimation* (EA 2001);

- *Australian Runoff Quality* (EA 2006);

- *Central West Catchment Action Plan 2006–2016* (CWCMA 2007)*;*

- *Guidelines for Management of Stream/Aquifer Systems in Coal Mining Developments – Hunter Region* (DIPNR 2005b);

- *Strategic Water Management in the Minerals Industry* (MCMPR 2006); and

- *Water Management — Leading Practice Sustainable Development Program for the Mining Industry* (SRET 2008).

8.2.1 Surface water investigations

i Hydrology

NOW operates a gauging station, 421042, located on the Talbragar River at Elong Elong, about 10 km north-west and downstream of the PAA (shown on Figure 8.1 as SW4). Additional stream flow records are available from discontinued NOW stream gauges. These are located on the Talbragar River at Cobbora (close to SW5 on Figure 8.1) and on Sandy Creek at Medway (close to SW3 on Figure 8.1).

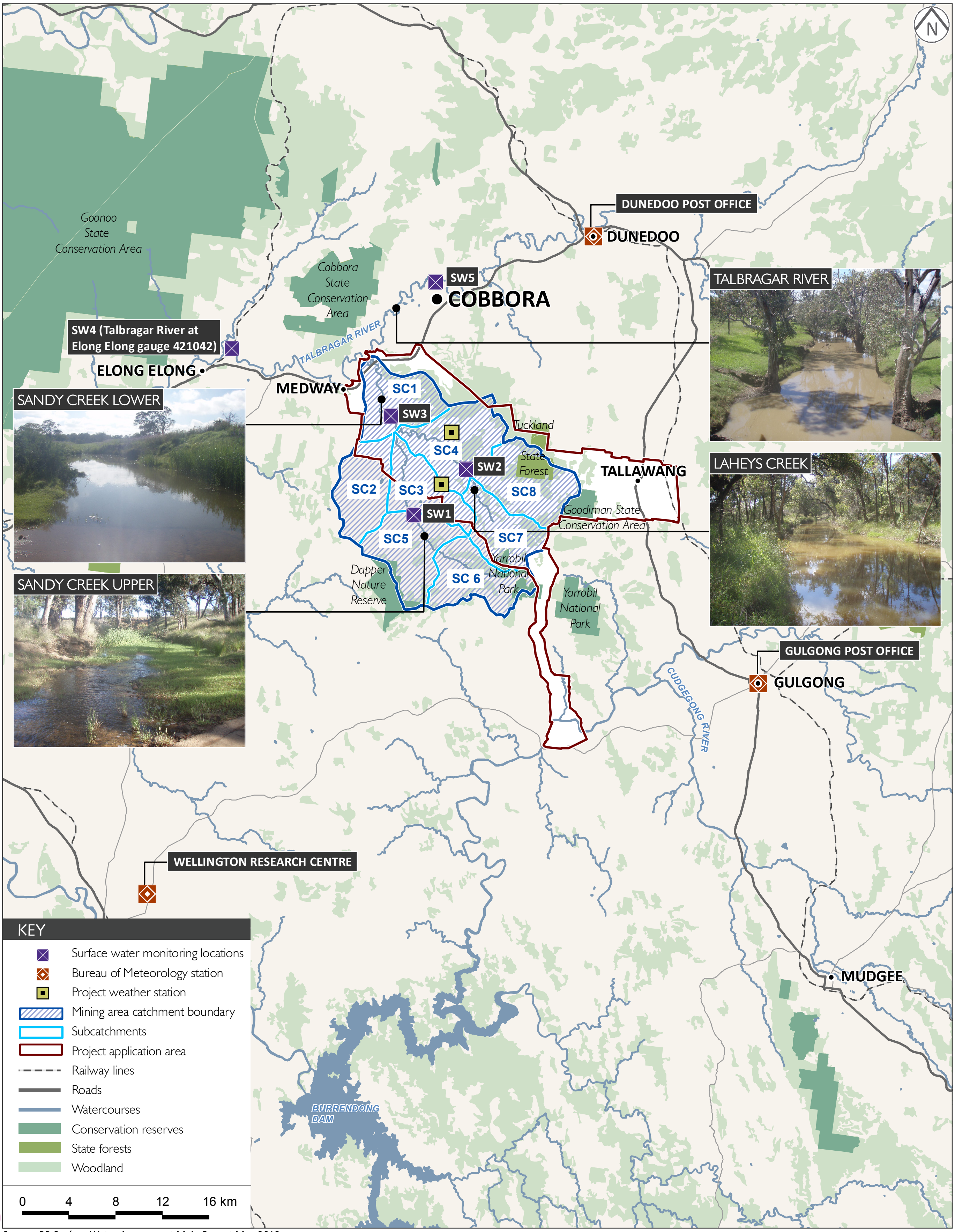
Four stream gauging stations (SW1, SW2, SW3 and SW5) have been operating on the Talbragar River and Sandy and Laheys creeks since November 2009 as part of the Project's ongoing baseline surface water monitoring program. Their locations are shown in Figure 8.1.

The hydrology and flow assessment involved using:

- water level data for stream gauges SW1, SW2, SW3 and SW5 to determine flows during water quality sampling events. Cross-sectional survey information and manual flow measurements collected during November 2011 were used to develop stage discharge rating curves;

- water level and daily discharge data, as well as a recent cross-section and rating curve developed by the NOW, for the Elong Elong station; and

- daily discharge data from the discontinued NOW gauges. These data were converted to instantaneous flows at one of the sites (Sandy Creek at Medway) and used to supplement the more recent data.



Source: PB Surface Water Assessment Main Report May 2012

Integrated Design Solutions | 030518 Cobbora Coal Project- EA F8-1 Rev A - 19 September 2012

EMM

Cobbora Holding Company Pty Limited

Surface Water Monitoring Locations and Sandy Creek Catchments

Cobbora Coal Project - Environmental Assessment

Figure 8.1

ii Water quality

Baseline water quality samples were collected monthly from each of the gauge locations SW1, SW2, SW3, SW4 and SW5 from August 2009 to September 2011 (inclusive). Samples were analysed for physical parameters (EC, pH, turbidity, temperature, DO), major ions, nutrients and a suite of metals (Al, As, B, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Mo, Ni, Se, Ag, and Zn).

iii Geomorphology

A baseline geomorphology review was undertaken to provide a snapshot of current geomorphic condition and inform other studies. Fluvial geomorphology classifications were assigned according to the RiverStyles™ system (Thompson et al. 2001).

8.2.2 Surface water modelling

i Hydrologic and hydraulic modelling

A Watershed Bounded Network Model (WBNM) was used to estimate peak flood flow rates in Sandy Creek, Laheys Creek and minor tributaries for a range of extreme flood events.

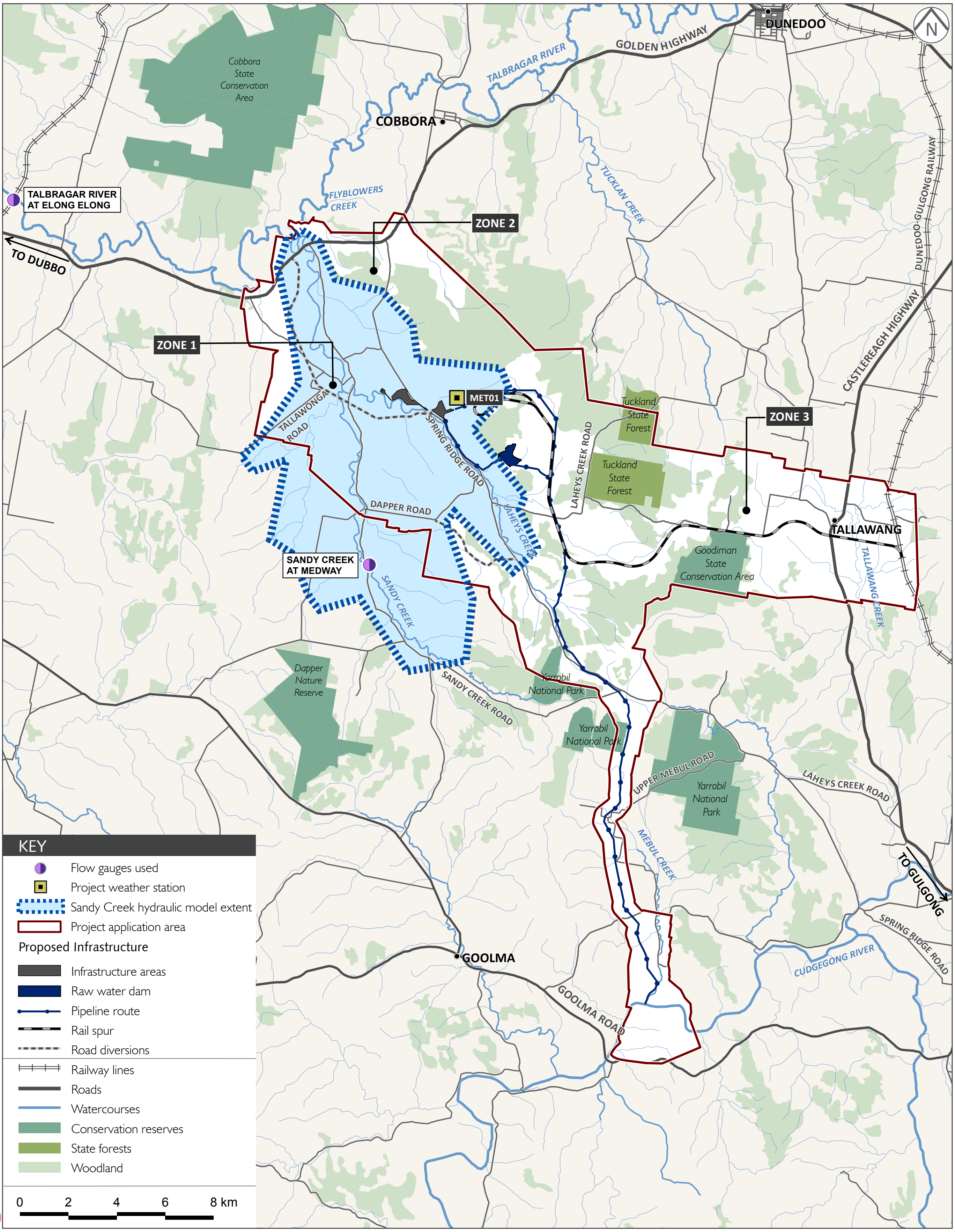
Hydraulic models for Sandy Creek were developed using HEC-RAS software to assess baseline and future flood conditions near the mine in Year 20. Year 20 is the critical catchment disturbance case for flooding due to diversion of water from the Sandy Creek catchment to a small tributary which joins the Talbragar River less than 1 km upstream of Sandy Creek.

The model determined flood levels, extents and velocities in watercourses. It also informed the preliminary design of access, haul road crossings and flood protection levees. The model's extent is shown in Figure 8.2. The assessment examined three zones where flood impacts could be significant (refer Figure 8.2):

- Zone 1 – Sandy Creek (the hydraulic model was used for this zone since most of the mining areas and mine infrastructure are in this catchment);
- Zone 2 – Flyblowers Creek; and
- Zone 3 – Proposed rail spur corridor.

The hydraulic model simulated flood conditions for the 2, 5, 100 and 2,000 year ARI events. The 2,000 year ARI event was included as an upper limit event for assessing flood risk.

A detailed report describing the development and results of the hydrologic and hydraulic model is provided in Appendix E 'Surface water assessment' of Appendix E.



Integrated Design Solutions | 030518 Cobora Coal Project - EA F8-2 Rev A - 02 July 2012

EMM

Cobbora Holding Company Pty Limited

Flood Impact Study Zones

Cobbora Coal Project - Environmental Assessment

Figure 8.2

ii Water quality modelling

A mass balance model was set up using Excel software to predict Project associated changes in downstream water quality. The model calculated baseline load (base load), baseline concentration, operational load and operational concentration to compare against the customised water quality objectives (WQOs).

The model was set up for 20 November 1970 to 1 January 2011, with a daily time step to coincide with flow data availability. Chemical concentrations from 31 August 2009 to 28 June 2011 were matched to the flow data record using median concentrations.

The pre-mining or base load water quality model included dissolved metals (Al, As, Cd, Cr, Cu, Fe, Mn, Ni, Se, and Zn), TDS, total N, total P and TSS.

For the operational load calculations, displacement of water from the sedimentation dams was assumed to occur during wet conditions.

In the mass balance model, the water released from the Project's water management system is added to the unregulated water in the stream and water quality concentrations are calculated. This does not consider physical or geochemical processes within the watercourse and hence the results are conservative.

A detailed report describing the development and results of the mass balance model is provided in Appendix E ('Surface water assessment') of Appendix E.

iii Water balance modelling

A water balance model was used to simulate the Project's water management system using the catchment boundaries shown in Figure 8.3. The model used GoldSim software, a widely used platform for mine site water balance studies. Inputs into the model were:

- surface water runoff;
- groundwater seepage to the open pits; and
- imported water.

Water demands for the Project included in the model were:

- CHPP make-up water;
- mine infrastructure areas, such as workshops and vehicle washdown areas;
- haul road dust suppression;
- potable water; and
- miscellaneous uses, such as for construction.

The GoldSim model calculated the volume of water in storages at the end of each day. This took into account daily rainfall-runoff inflow, groundwater inflow, evaporation from the storages, water usage, pumping between storages and storage overflow. Separate GoldSim models were developed for years 1, 4, 12, 16 and 20. Each model simulated 111 years of climate data based on a daily time step.

The Australian Water Balance Model (AWBM) was incorporated into the GoldSim model to generate a daily time series of runoff from undisturbed, disturbed and rehabilitated catchments.

A detailed report describing the development and results of the groundwater model is provided in Appendix E ('Surface water assessment') of Appendix E.

iv Final void water balance modelling

A water balance model estimated the long-term behaviour of the final void following mining. The model used Excel software to calculate the volume of water in the final void at the end of each month. These calculations took into account monthly rainfall-runoff inflow, groundwater inflows/outflows and evaporation, and used 1,000 years of synthetic rainfall and evaporation data. The model also estimated corresponding salinity levels in the void lake.

A detailed description of the model, assumptions and output results is provided in Appendix E ('surface water assessment') of Appendix E.

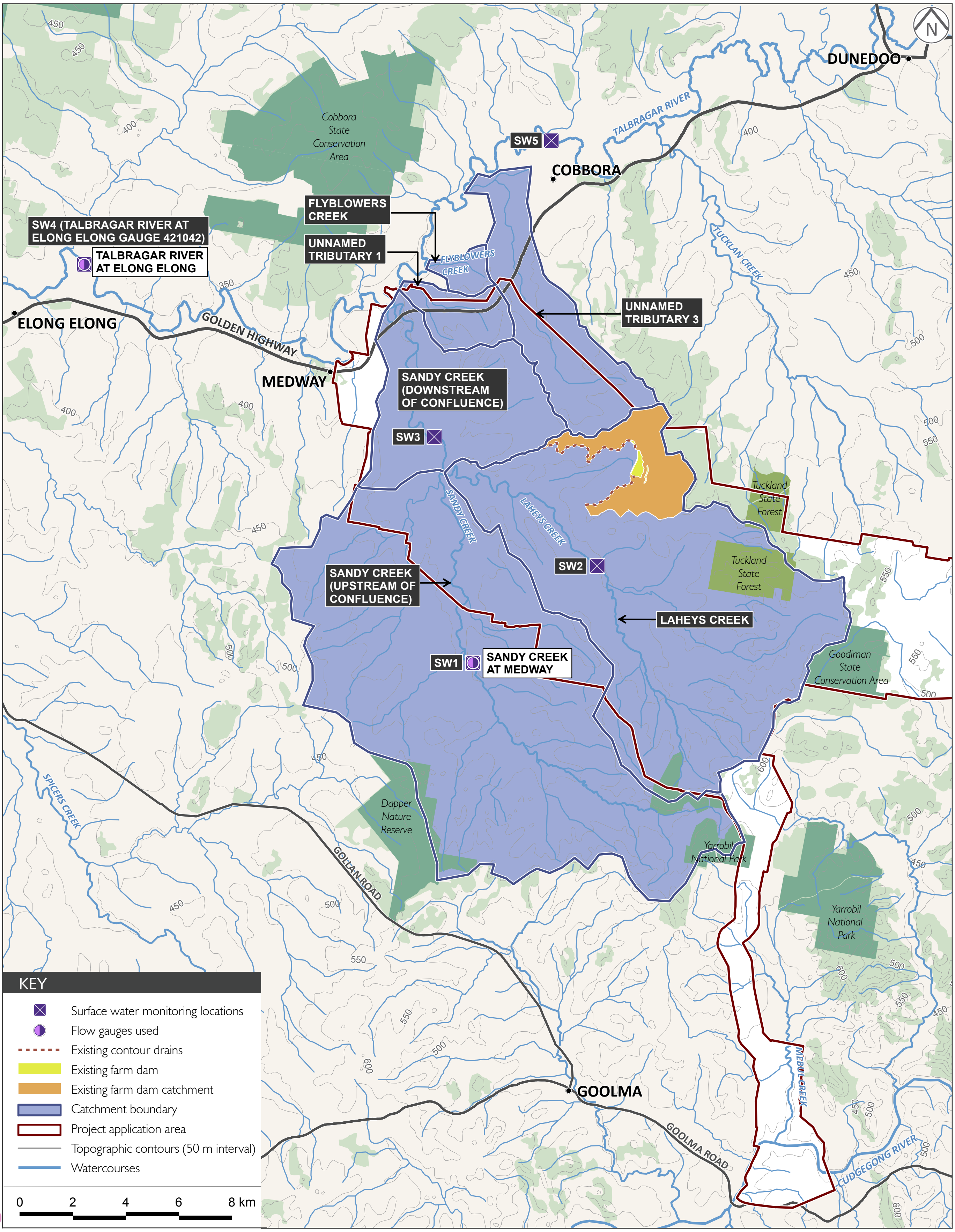
8.2.3 Surface water assessment criteria

The assessment presented in this chapter examines site water management and changes in downstream water quality and flow, flood behaviour, Project water demand and potential impacts on available resources and mine operations, and post-mining impacts.

i Water quality impacts

Water quality impacts are generally assessed by comparing values for specific water quality parameters with WQOs. The WQOs for this assessment are described in the Macquarie-Bogan River Water Quality and River Flow Objectives that are contained in the *NSW Government Water Quality and River Flow Objectives* (DEC 2006b), and ANZECC/ARMCANZ (2000a) guidelines. The WQOs from the latter were based on values for 'slightly to moderately disturbed systems'. This reflects the dominant land use being agriculture and pastoral activities.

Default water quality objectives (WQOs) derived directly from DEC (2006b) are shown in Table 8.1. These take into account the different environmental values of the creeks and rivers, where environmental values are particular values or uses of the environment that require protection (and several environmental values may apply to a particular water body). Maintaining or improving aquatic ecosystems often requires the highest level of water quality. Default values for toxicants that were not included in DEC (2006b) were based on ANZECC/ARMCANZ (2000a). Default WQOs for specific toxicants are outlined in Table 8.2. As with the physical and chemical parameters listed in Table 8.1, aquatic ecosystem requirements form the basis of the values in Table 8.2. WQOs for certain metals depend on the hardness of the water and conversion factors are shown in Appendix E 'Surface water assessment' of Appendix E.



Existing Catchments for the Water Balance Study

Cobbora Coal Project - Environmental Assessment

Figure 8.3

Integrated Design Solutions | 030518 Cobbora Coal Project - EA F8-3 Rev A - 19 September 2012

EMM

Cobbora Holding Company Pty Limited

Table 8.1 Macquarie-Bogan uncontrolled rivers water quality objectives

Parameter	Most stringent requirement	Environmental values
Total P	50 µg/L	Aquatic ecosystems
Total N	500 µg/L	Aquatic ecosystems
Chlorophyll-a	5 µg/L*	Aquatic ecosystems
Turbidity	5 Nephelometric Turbidity Units (NTU)	Homestead water use
Salinity (electrical conductivity)	30–350 µS/cm (upland rivers**)	Aquatic ecosystems
Dissolved oxygen	>6.5 mg/L (>80% saturation)	Drinking water
pH	6.5 to 8.5	Drinking water
Temperature	15–35°C for prolonged exposure.	Primary contact
Chemical toxicants	Refer to ANZECC/ARMCANZ (2000a) guidelines	
Faecal coliforms	95% of samples should be 0 coliforms/ 100 mL throughout the year. Up to 10 coliform organisms may be accepted occasionally in 100 mL. Coliform organisms should not be detected in 100 mL in any two consecutive samples.	Drinking water
Surface films and debris	Oils and petrochemicals should not be noticeable as a visible film on the water, nor should they be detectable by odour.	Visual amenity
Total dissolved solids	500–1,000 mg/L is acceptable based on taste.	Homestead water supply
Total suspended solids	<40 µg/L (freshwater)	Aquatic foods

Note: 1. * In absence of an upland rivers guideline the lowland rivers guideline was applied
2. **>250 m AHD

Table 8.2 Selected toxicant water quality objectives

Parameter	Most stringent requirement (mg/L)
Aluminium	0.055 (pH>6.5) Not established (pH<6.5)
Arsenic	0.024
Boron	0.37
Cadmium	0.0002
Chromium	0.001
Copper	0.0014
Lead	0.0034
Manganese	1.9
Nickel	0.011
Zinc	0.008

Baseline water quality conditions were found to exceed the default guidelines for a number of water quality parameters. In particular, aluminium, iron, total N and TSS required customised or Project-specific WQOs for both the SW3 (Sandy Creek) and SW4 (Talbragar River) sites. Project-specific WQOs were therefore developed for these parameters. Customised WQOs were also required for manganese and TDS at SW3 and total P at SW4. Developing customised WQOs involved a procedure generally accepted in NSW, which is based on a variation of the standard ANZECC assessment procedure (DEC 2006a). This is fully discussed in Appendix E ('Surface water assessment') of Appendix E. The customised WQOs are shown in Table 8.3.

Table 8.3 Customised WQOs for SW3 and SW4

Parameter	Customised water quality objectives (mg/L)	
	SW3	SW4
Total suspended solids	34	202
Total dissolved solids	1,978	-*
Total N	0.9	2.7
Total P	-*	0.5
Aluminium	0.5	8.4
Iron	1.5	10.2
Manganese	2.1	-*

Note: * Default water quality values were used.

The default WQO for total P at SW3 is 50 µg/L. The corresponding values for TDS and manganese at SW 4 are 500 mg/L to 1,000 mg/L and 1.9 mg/L, respectively.

The results from the mass-balance model were compared against the WQOs for various stages of the mine life. Suitable mitigation measures were then identified to minimise or avoid Project related impacts on the surrounding surface waters. These included establishing sedimentation dam water quality requirements. Potential cumulative impacts on water quality in the Talbragar River were also assessed.

ii Downstream flow

Downstream flow impacts were determined by identifying river flow objectives for the Macquarie-Bogan catchment. Flow duration curves (which show the percentage of time that flows are equalled or exceeded) were then developed for Sandy Creek at Medway gauge and the Talbragar River at Elong Elong gauge. Mine water balance model outputs were then analysed to understand the impact of mining on flow regimes in Sandy Creek and the Talbragar River (ie impacts were assessed by reference to existing conditions). Potential cumulative impacts on flow in the Talbragar River were also assessed.

iii Flooding

The flood impact assessment was based on the catchment breakdown prescribed by the year 20 mine plan. Impacts were assessed by reference to existing conditions.

iv Project water demand and impacts on available resources and mine operations

The water demand assessment was based on the Project's water balance and analysis of available water sources. In particular, the potential need to import water from an appropriately authorised and suitable supply was assessed.

v Final voids

This assessment initially examined whether water would overtop the pit after mining. Subsequent assessment examined salinity and potential impacts on nearby surface water bodies and surrounding groundwater quality.

8.3 Existing environment

8.3.1 Regional context

The Project is located in the subregions of Talbragar Valley and Upper Slopes in the Central West Catchment. Figure 1.1 shows the Project's location in relation to existing regional surface water resources.

Rivers in the greater Cobbora area include the Talbragar River and Cudgegong River, both of which are tributaries of the Macquarie River. The Macquarie River is formed near Bathurst and flows through the Macquarie Marshes, which are one of the largest semi-permanent wetlands in south-eastern Australia and cover more than 150,000 ha around 466 km downstream of the Project.

The Cudgegong River rises in the Great Dividing Range above Rylstone and drains an area of 3,880 km^2. The river flows into Windamere Dam upstream of its confluence with the Macquarie River.

The Talbragar River is the closest major river to the mine and joins the Macquarie River just north of Dubbo. The Talbragar River and its tributaries are ephemeral near the mine. There is no sustained baseflow during dry periods, despite artesian groundwater pressures in nearby and underlying rocks.

The mine lies largely in the catchment of Sandy Creek, a subcatchment of the Talbragar River (see Figure 8.3). Sandy Creek, Laheys Creek (a tributary of Sandy Creek) and Blackheath Creek (a tributary of Laheys Creek) flow in a generally northerly or north-westerly direction through the mine. Sandy Creek/Laheys Creek catchments have an area of about 280 km^2. Tucklan Creek flows north of the PAA into the Talbragar River, about 10 km upstream of the Sandy Creek-Talbragar River confluence. Tucklan Creek has a similar catchment area to Laheys Creek, but only about 1 km of headwaters lies in the PAA. No infrastructure will be constructed in the Tucklan Creek catchment and therefore Tucklan Creek has not been assessed.

Two farm dams have been built on Blackheath Creek, a tributary of Laheys Creek, on the eastern side of the PAA catchment (see Figure 8.3). They were built by the landowner about 30 years ago to service the property's irrigation needs. The larger dam has a capacity of 1,470 ML. The upstream smaller dam (referred to as the 'sausage dam') receives inflow from groundwater springs higher in the catchment and has a capacity of around 15 ML.

8.3.2 Existing geomorphology

The valley floors of the Talbragar River, Sandy Creek, Laheys Creek and other minor catchments in and around the PAA dominantly contain a Quaternary alluvium base. The alluvium is characterised by gravels and sands interspersed with clays and ranges in thickness from 0 m to 28 m. These soils retain runoff and release it slowly, particularly when vegetation is intact. They are also long-term sediment stores. Other geomorphological features include:

- short bedrock-controlled sections that occur at intervals within the alluvial deposits In the Sandy Creek upper catchment. The creek bed drops down at these sections resulting in an overall longitudinal stepped profile;

- low energy conditions downstream of those sections in Sandy Creek and Laheys Creek, with water flooding out into the broader valley floors. Many of these valley floors have been altered (eg by constructing channels) to allow cultivation and cropping; and

- the broad valley floor of the Talbragar River, with the channel being moderately sinuous and having a gravel/sand bed. Channel development is still minimal and flows are largely unconfined.

8.3.3 Existing hydrology

The Talbragar River is characterised by a seasonal discharge pattern, with low flows during summer and autumn and floods in winter and spring. The median annual discharge at Elong Elong (see SW4 in Figure 8.1) is 21,509 ML/a. The maximum and minimum recorded annual discharge was 264,366 ML in 1998 and 653 ML in 2005, respectively. Flows at Elong Elong are less than 11.9 ML/d for 50% of the time and there is no flow for 32% of the time.

The flow record from Sandy Creek at Medway (close to SW3 on Figure 8.1) shows that, for the period of record (1966 to 1985), the highest recorded mean daily flow was 8,937 ML/d in February 1971. Flows are less than 0.04 ML/d for 50% of the time there is no flow for 46% of the time.

The ephemeral nature of the Talbragar River, Sandy Creek and Laheys Creek means these watercourses cease to flow during dry periods, which results in the formation of pools that can act as refuges for biota (see Figure 10.7).

Flood frequency analysis coupled with hydrologic and hydraulic modelling determined in the following baseline design flood conditions:

Talbragar River at Elong Elong

- 2 year ARI – estimated flow is 43 m^3/s;

- 5 year ARI – estimated flow is 169 m^3/s;

- 50 year ARI – estimated flow is 893 m^3/s; and

- 100 year ARI – estimated flow is 1,234 m^3/s.

Sandy Creek at Medway

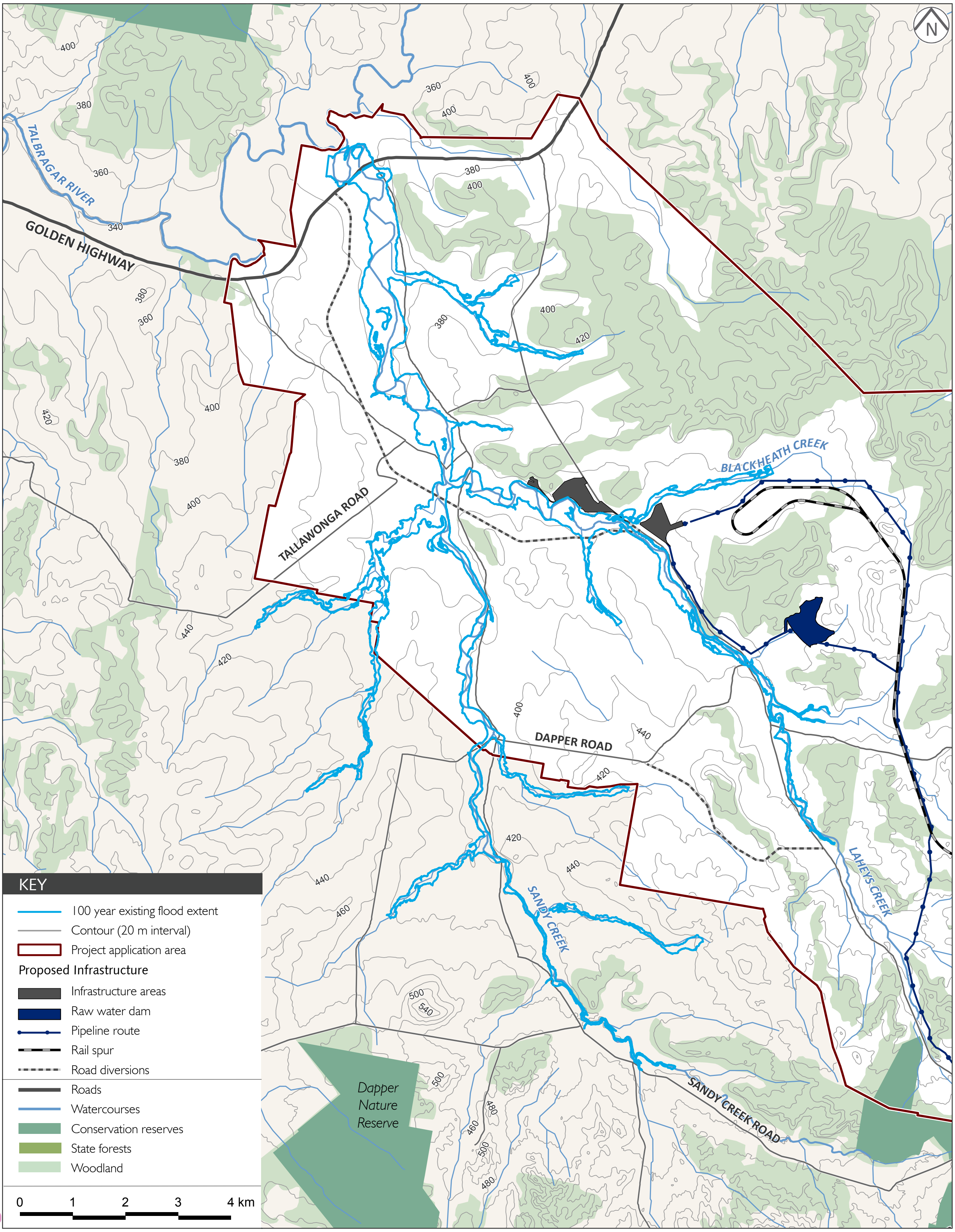
- 2 year ARI – estimated flow is 17 m^3/s (modelled peak flow is 29 m^3/s);

- 5 year ARI – estimated flow is 74 m^3/s (modelled peak flow is 78 m^3/s); and

- 100 year ARI – estimated flow is 599 m^3/s (modelled peak flow is 429 m^3/s).

As shown in Figure 8.4, the 100 year ARI flood is contained in the channel in the upper tributaries of Sandy Creek and the upper reach of Laheys Creek. Some floodplain flow occurs once the catchment flattens out in the middle to lower reaches of these watercourses.

Existing 2 year and 5 year ARI flows are mainly in-channel for the middle to lower reaches with higher flows going over the bank in localised areas. The 2,000 year ARI flood produces mainly overbank flow, but flows are still contained by the valley in the lower reaches.



Existing 100 year ARI Flood Extent (Sandy Creek Catchment)

Cobbora Coal Project - Environmental Assessment

Figure 8.4

EMM

Cobbora Holding Company Pty Limited

Integrated Design Solutions | 030518 Cobora Coal Project - EA F8-4 Rev A - 02 July 2012

8.3.4 Existing water quality

Examination of stream flows corresponding to water quality sampling events shows that samples were largely collected during 'nil' or 'low' flow conditions rather than 'medium' or 'high' flow conditions. Low flow is the normal catchment condition. The largely 'nil' or 'low' flow sampling to date therefore represents typical conditions in these creeks. A summary of the baseline in-stream water quality data collected between August 2009 and September 2011 is presented in Table 8.4 to Table 8.8.

Table 8.4 Water quality summary for Sandy creek, upstream of confluence with Laheys Creek, SW1 (21 samples)

Parameter	Units	Default water quality objectives	Minimum	Maximum	Mean
Aluminium	mg/L	0.055	0.02	0.70	0.19
Iron	Mg/L	1.5	0.24	1.6	0.77
Manganese	mg/L	1.9	0.11	1.5	0.65
pH	-	6.5–8.5	5	8.4	7.8
TDS	mg/L	2,000	522	6,000	2,100
TN	µg/L	500	300	3,100	1,200
TP	µg/L	50	<10	280	86
TSS	mg/L	<40	<2	140	25

Table 8.5 Water quality summary for Laheys Creek, SW2 (21 Samples)

Parameter	Units	Default water quality objectives	Minimum	Maximum	Mean
Aluminium	mg/L	0.055	0.03	1.64	0.34
Iron	mg/L	1.5	0.1	2.7	0.96
Manganese	mg/L	1.9	0.06	1.3	0.43
pH	-	6.5–8.5	7.0	8.1	7.6
TDS	mg/L	500–1,000	350	4,900	2,900
TN	µg/L	500	500	2,100	1,100
TP	µg/L	50	<10	190	65
TSS	mg/L	<40	3	55	16

Table 8.6 Water quality summary for Sandy creek, downstream of confluence with Laheys Creek, SW3 (21 Samples)

Parameter	Units	Default water quality objectives	Minimum	Maximum	Mean
Aluminium	mg/L	0.055	0.02	0.90	0.35
Iron	mg/L	1.5	0.39	3.29	1.13
Manganese	mg/L	1.9	0.08	2.8	1.19
pH	-	6.5–8.5	6.4	8.1	7.5
TDS	mg/L	<1,978[1]	410	2,290	1,400
TN	µg/L	500	100	1,800	780
TP	µg/L	50	<10	250	60
TSS	mg/L	<40	5	130	31

Notes: 1.Customised water quality objective

Table 8.7 Water quality summary for Elong Elong gauging station on Talbragar River, SW4 (16 Samples)

Parameter	Units	Default water quality objectives	Minimum	Maximum	Mean
Aluminium	mg/L	0.055	0.63	36	6.8
Iron	mg/L	1.5	0.86	44	8.1
Manganese	mg/L	1.9	0.01	0.45	0.09
pH	-	6.5–8.5	7.5	8.3	7.9
TDS	mg/L	500–1,000	252	1,500	570
TN	µg/L	2,700[1]	200	3,800	1,500
TP	µg/L	500[1]	100	2,900	470
TSS	mg/L	<202[1]	7	1400	200

Notes: 1. Customised water quality objective

Table 8.8 Water quality summary for Talbragar River at Cobbora, SW5 (16 Samples)

Parameter	Units	Default water quality objectives	Minimum	Maximum	Mean
Aluminium	mg/L	0.055	0.47	26	4.9
Iron	mg/L	1.5	0.5	29	5.6
Manganese	mg/L	1.9	0	0.35	0.05
pH	-	6.5–8.5	7.5	8.3	7.9
TDS	mg/L	500–1,000	250	1,500	570
TN	µg/L	500	200	3,800	1,500
TP	µg/L	50	100	2,900	500
TSS	mg/L	<40	7	1,400	200

i Salinity

Salinity in the upstream locations of Sandy Creek (SW1) and Laheys Creek (SW2) is relatively high. This is likely to be due to saline soils and evaporation in the isolated, nil-flow pools increasing the concentration of dissolved salts.

ii Nutrients

Elevated nutrient concentrations at all sites are likely to have been caused by local land uses and river flows. The land surrounding Sandy and Laheys creeks and the Talbragar River is mainly used for cattle and sheep grazing on improved pastures, and dryland cropping.

Sediment sources are likely to also contribute to the nutrient load. Watercourse crossings provide a mechanism to deliver and re-suspend sediment in creeks, with plumes of sediment caused by vehicle traffic.

Ephemeral streams, such as Laheys and Sandy creeks, also retain large amounts of particulate organic matter in the dry channel that may be carried downstream when flowing.

iii Metals

Some metal concentrations are above the protection threshold for 95% of species in aquatic ecosystems, which is applicable to slightly to moderately disturbed ecosystems. These metals include arsenic, copper, manganese, nickel and zinc. No industrial discharges occur upstream of the PAA, hence these levels are naturally occurring and reflect the local soils and geology. Toxicants can also accumulate in nil-flow pools, such as those occurring in Laheys and Sandy creeks.

8.4 Environmental management

A site water management plan (SWMP) will be developed for the Project before construction to ensure the mine's operational performance meets all relevant regulatory requirements. The SWMP will also include a set of operational procedures that describe how different aspects of the site's water management system are to be operated and maintained so as to minimise impacts to surface water.

Additional plans that will be prepared and are relevant to water management include:

- an erosion and sediment control plan (ESCP). This will be implemented during the construction of all mine infrastructure and maintained during operations; and

- a flood emergency management plan. This will identify vulnerable areas, including flood risk to external public roads that may be used by staff, contractors and visitors, and will include instructions on actions to take during a flood event.

8.4.1 Water management strategy

Water management will segregate water in the mine site according to its quality. This will minimise the volume of stored water that is affected by mining and will allow treatment to settle suspended sediment and to divert clean water away from mining activities. Five water classifications have been nominated for the mine site:

- clean water – runoff from undisturbed areas. This water is expected to have pre-mining water quality and can be diverted to the creek system;
- overburden water – runoff from overburden emplacements, topsoil stockpiles and other disturbed areas. This water will contain elevated suspended solids, which will be settled in sedimentation dams before release to the creek system or on-site reuse;
- pit water – runoff from the open pits and groundwater seepage into the mine. This water may contain suspended solids, salts and heavy metals. It will be stored on-site and will be re-used;
- infrastructure water – runoff from the areas around the CHPP, stockpiles and infrastructure. This water will be directed to the process water circuit; and
- process water – water that is used in the CHPP, including return water from the reject emplacement areas. This water will be continuously recycled within the system.

i Clean water system

The clean water system will generally comprise:

- clean water catch drains to divert runoff from minor catchments around the mine site, where practicable;
- clean water high wall dams and levees upslope of active mine pits to reduce peak flow rates and velocities from undisturbed catchments;
- a pump and pipeline system to pump clean water stored in clean water high wall dams to the creek system;
- a raw water dam to store water imported to the mine site from the Cudgegong/Macquarie Regulated River system;
- a pump and pipeline system from the raw water dam to deliver stored water to either the process water dam (CHPP), truck fill stations (dust suppression) or water treatment plant (potable water); and
- flood mitigation works, such as levees along the edge of the mine.

ii Overburden water system

The overburden water system will generally comprise:

- a drainage system to convey runoff from the overburden emplacements, topsoil stockpiles and other disturbed areas to sedimentation dams;
- several sedimentation dams strategically located throughout the mining area to capture water from the above sources; and
- a pump and pipeline system to transfer water for reuse at the mine site.

iii Pit, infrastructure and process water system

The mine water system will generally comprise:

- small sumps in the pit floor to collect and contain local surface water runoff from the pit floor, high wall, low wall and end walls, as well as groundwater seepage;
- pit dewatering pumps and associated dewatering pipelines to transfer pit water to the nearest mine water dam, if necessary via a small staging dam;
- a drainage system to convey runoff from disturbed areas to the nearest pit water storage dam;
- mine water dams to store and contain water from the above sources; and
- a return water pump and pipeline system from each dam to deliver stored water to either the CHPP (coal washing), mine infrastructure area (vehicle wash, workshop and dust-suppression sprayers), or truck fill stations (haul road dust suppression).

Water captured in the above water system will not be discharged to the natural creek system. It will be used as the primary water source to meet on-site demands. Imported raw water will only be used when there is a water deficit or high quality water is required for uses such as potable applications. During extended wet periods, surplus water will be stored in the pits once the mine water dams are full. The scale of the mine with multiple pits will allow pit water to be pumped between pits. This will provide flexibility in water management and will allow the mine to continue to operate without flooding active workings or relying on unscheduled discharges of surplus water.

iv Staging of the water management system

The water management system will evolve as the Project expands. Snapshots of the water management system at years 4 and 20 are shown in Figures 8.5 and 8.6, respectively. These illustrate the design flow paths of different classes of water, and the proposed locations of water management dams.

8.4.2 Site water balance

The water balance shows that not enough site runoff and groundwater inflows will be generated during mining to meet the Project's water demands under normal climatic conditions. The mine will therefore need to import water. The estimated imported water requirements for typical dry (10^{th} percentile), median (50^{th} percentile) and wet (90^{th} percentile) rainfall years are summarised in Table 8.9.

Table 8.9 Summary of imported water requirements

Year	Total site demand (ML/a)	Groundwater seepage (ML/a)	Imported water for a dry (10th percentile) year (ML/a)	Imported water for a median (50th percentile) year (ML/a)	Imported water for a wet (90th percentile) year (ML/a)
1	223	38	0	40	0
4	3,421	886	2,360	1,720	520
12	3,656	1,549	1,700	1,100	0
16	3,656	1,341	1,880	1,200	0
20	3,653	248	2,960	2,180	220

CHC holds 3,310 ML of high-security Water Access Licences (WALs) from the Macquarie and Cudgegong Regulated Rivers Water Source under the *Water Act 1912* and the *Water Management Act 2000.* Raw water will be pumped from the Cudgegong River and stored in a raw water dam. The maximum requirement for imported water is about 3,380 ML/a in Year 20 and exceeds the WAL limit for three years out of the 111 years simulated, or less than 3% of time. Specific measures to address this are described below.

Harvestable rights allow landholders to store a proportion of the runoff on their property in one or more farm dams without requiring a licence. The calculated maximum harvestable right dam capacity for CHC at Cobbora is about 6,760 ML. However, CHC will not access this water for mining purposes. Licensed farm dams will not be included in the Project's water management system.

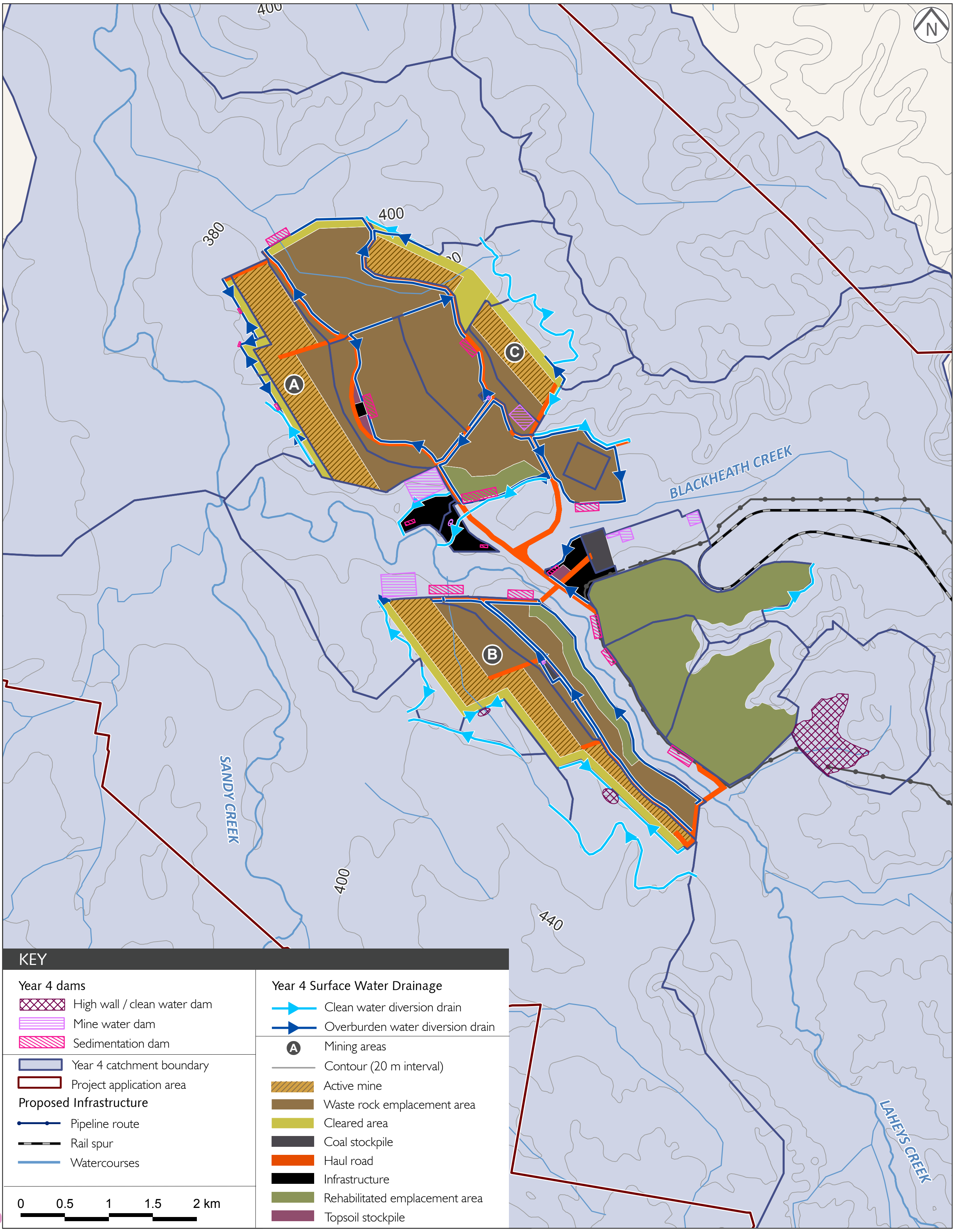
No further licenses under the *Water Act 1912* or the *Water Management Act 2000* have been identified to meet the Project's surface water requirements from the site.

8.4.3 Specific mitigation measures

i Operations – water sources

A number of water supply options are available to ensure the mine continues to operate under worst-case climatic conditions. In order of decreasing priority, these are:

- implementing additional water conservation measures to reduce mine water demand;
- purchasing 'General' WALs from the open water market, if they are available, and selling them back to the market when no longer required; and
- reducing coal production rates to match available water supplies. This is a worst-case scenario and assumes the above options are either not available or not effective.



Water Management System Concept for Year 4

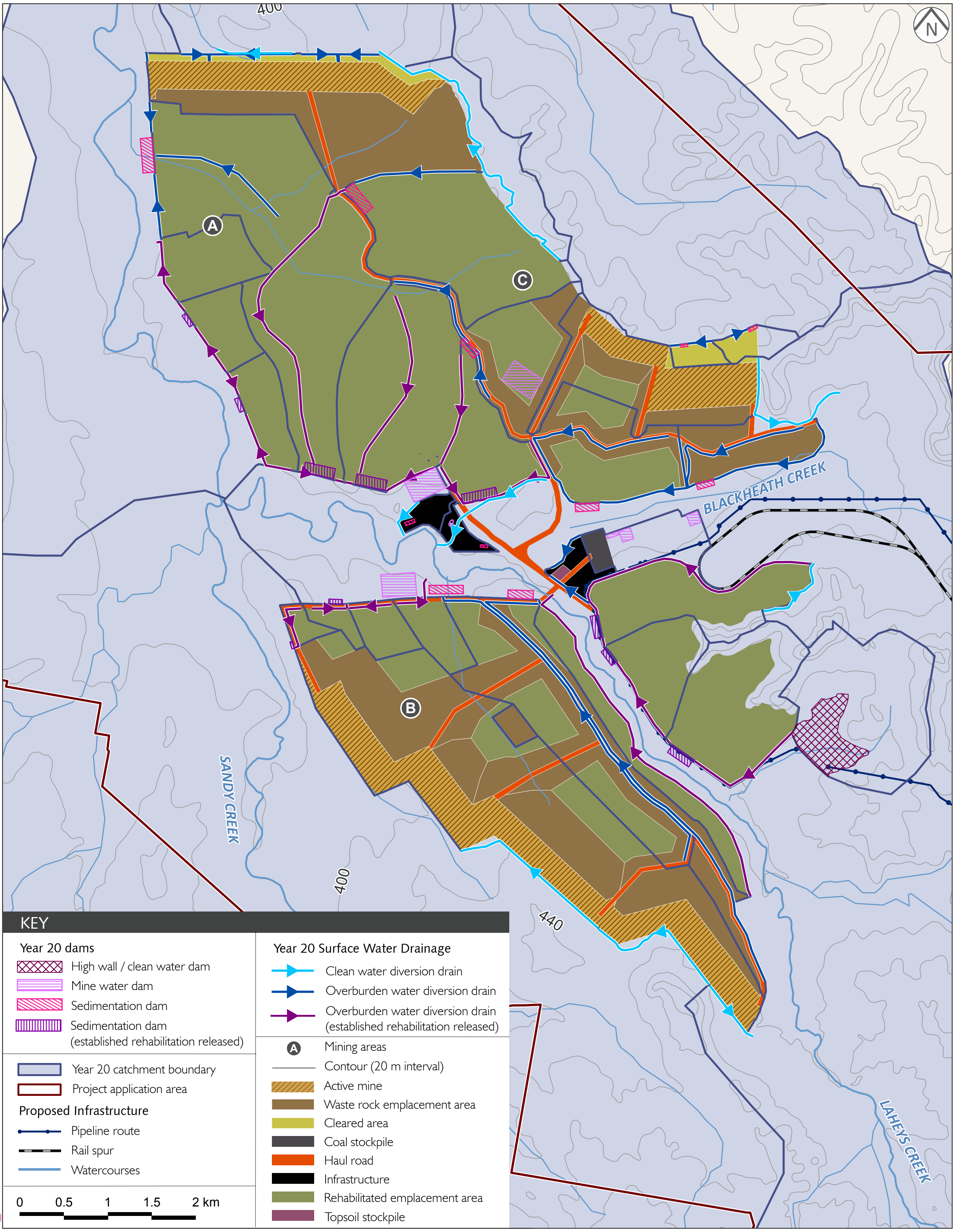
Cobbora Coal Project - Environmental Assessment

Figure 8.5

EMM

Cobbora Holding Company Pty Limited

Integrated Design Solutions | 030518 Cobora Coal Project - EA F8-5 Rev A - 14 September 2012



Integrated Design Solutions | 030518 Cobbora Coal Project - EA F8-6 Rev A - 02 July2012

Water Management System Concept for Year 20

Cobbora Coal Project - Environmental Assessment

Figure 8.6

EMM

Cobbora Holding Company Pty Limited

ii Operations – water quality

Surplus water from sedimentation dams will be returned to Sandy and Laheys creeks if it is not re-used in the mine. The proposed concentration limits applicable to all sedimentation dam releases are shown in Table 8.10. These will ensure that water quality in receiving watercourses is not adversely affected.

Table 8.10 Sedimentation dam performance limits

Parameter	Concentration (maximum, mg/L (apart from pH))	
	50^{th} percentile	100^{th} percentile
Aluminium	-	0.5
Iron	-	1.5
Manganese	-	2.0
pH	-	6.5–8.5
TDS	350	1,400
Total N	-	0.9
Total P	-	0.5
TSS	-	200

iii Operations – general

Other mitigation measures will include:

- flood protection levees will be constructed along the southern edge of Blackheath Creek to protect the coal stockpiles, and on the northern bank of the lower reaches of Laheys Creek to protect the workshop area;
- scour protection measures will be constructed for out-of-pit emplacement areas;
- a 70 ML dry detention basin on Flyblowers Creek will be constructed to prevent existing peak flows in this tributary being exceeded at the Golden Highway culvert;
- diversion channels will be used temporarily to redirect minor tributaries and drainage lines around the mine working areas during certain stages of mining; and
- wastewater from on-site facilities, such as workshops, process and administration buildings, will be treated by an on-site sewage treatment system that includes on-site disposal (see Chapter 3 ‘Project Description’).

iv Construction

Erosion and sediment controls will be established to a standard consistent with relevant guidelines and as documented in the erosion and sediment control plan. These controls will include:

- forward clearing will be minimised, particularly in areas around flow lines, drainage lines and watercourses;

- site disturbance will be minimised by restricting machinery access only to areas required for approved construction works, access tracks or material stockpiles;
- construction activities will be staged where practicable so that land disturbance is confined to the minimum possible area;
- work will be completed and disturbed areas rehabilitated quickly and progressively;
- erosion will be minimised from drainage lines that can be vulnerable to concentrated flow;
- clean water runoff from undisturbed areas will be intercepted and diverted so that it does not flow onto disturbed areas;
- clean water will pass through the site without mixing with runoff from disturbed areas;
- highly dispersive soils will be treated with gypsum to reduce the potential for tunnel erosion and surface rilling of disturbed areas;
- erosion potential within earthworks areas will be limited by managing runoff fetches and velocities with measures such as diversion banks;
- sediment traps, such as silt fences and check dams, will be located downstream of disturbed areas;
- runoff from large construction areas (greater than 2,500 m^2) will be treated in sedimentation basins or dams before water is displaced to watercourses; and
- shaker ramps and rock pads will be provided at the construction exit to remove excess mud from truck tyres and under bodies.

A number of reasonably large creek crossings will be required as part of the Project's infrastructure. Mitigation measures associated with these will include:

- culverts will be sized to ensure minimal impact on upstream flood levels;
- crossings will be constructed during dry periods, where possible;
- work zones will be isolated during wet weather to avoid working areas flooding;
- erosion protection measures (eg rock revetments and scour protection for bridge abutments) will be incorporated in the detailed design;
- temporary flow diversions or bypass channels with capacity equal or similar to existing flow paths will be provided where required; and
- Fisheries NSW and the Project's aquatic ecologist will be consulted about creek crossing designs and construction methods.

Hazardous materials and effluents also require management during construction. Specific mitigation measures will include:

- designated storage facilities will be equipped with appropriate handling practices and safeguards, in accordance with relevant Australian Standards and guidelines;
- stormwater will be diverted from construction sites to nearby sedimentation dams to allow containment and treatment following any incidents; and
- a licensed contractor will be used for the lifetime of the construction camp to pump raw sewage from storage tanks and deliver it under contract to an existing town sewage treatment plant for disposal.

v Post-mining

The main post-mining mitigation measure is the long-term rehabilitation of the Project's footprint.

The current final landform design comprises a single final void corresponding to former mining area B. The design of the final landform backfills the voids in former mining areas A and C through considerable investment in spoil rehandling and rehabilitation. Backfilling the entire mining area B is not economically feasible; however, almost half the area of the void at the end of mining will be backfilled.

Conceptual modelling has determined that this void will not overtop and will act as a groundwater sink which will therefore not impact on the surface water environment. Given that the final landform has been designed to minimise void lake formation as far as economically practical, these mitigation measures are considered to be sufficient to safeguard the surrounding environment.

8.5 Impacts

The impacts to surface water after implementing the management measures described in Section 8.4 are described below. Construction impacts associated with mining infrastructure have been assessed with operational impacts. The main construction impacts will generally be related to erosion and sedimentation issues. These have been considered in the site water management and water quality assessments.

8.5.1 Water quality impacts

An increase in total dissolved solids (TDS) in the Talbragar River of up to 5% above baseline is predicted to occur due to mining. Some improvement in total N, total P and TSS during mining is expected. All parameters modelled for the Talbragar River are below the relevant customised WQOs.

In Sandy Creek, all parameters are predicted to remain below customised WQOs, apart from TDS and total N during mining. Water quality will remain acceptable for irrigation, and for contact recreation and livestock, apart from elevated TDS levels. Water quality also remains acceptable for aquatic ecosystems, apart from elevated total N levels.

The Project will change local land use from livestock pasture to mining, hence total N and total P concentrations are likely to markedly reduce over the life of the mine. Results for these parameters are therefore conservative.

The Ulan Coal Mine is located upstream of the confluence of Sandy Creek and the Talbragar River. Ulan Coal Mine is committed to meeting prescribed performance limits for TDS to ensure there are no adverse impacts on the river. The predicted maximum 5% increase in TDS values in the Talbragar River from the Project is still well below the default WQOs set for the Macquarie-Bogan catchment. The cumulative water quality impacts of the Project and the Ulan Coal Mine will therefore be acceptable.

8.5.2 Downstream flow impacts

The downstream flow impacts on the Talbragar River are predicted to be minor. The annual average flow volume at the Elong Elong gauge will be reduced by less than 1%, and low and high mean daily flow categories will increase by about 20% and 4%, respectively.

Annual average flows in Sandy Creek will reduce by up to 5% in average and dry years, although low flows will increase. More regular flow and less frequent drying due to surface water flows will occur in semi-permanent pools in Sandy and Laheys creeks.

Groundwater drawdown will also affect the semi-permanent pools. Groundwater modelling suggests that there will be no adverse impacts related to groundwater drawdown up to Year 12. However, from Year 12 onwards drawdowns will result in loss of groundwater inflow and potential loss of persistent groundwater fed pools at one site on Sandy Creek and one on Laheys Creek. Two other sites on Sandy Creek may also be affected; however, the magnitude of drawdown at these other locations is relatively low and within the margin of error of the groundwater modelling and the ground level data. Groundwater levels will fully recover at these sites within 20 to 50 years post-mining; therefore, the groundwater inflows to the affected pools will recover in the long term. Impacts on aquatic ecology are discussed in Section 10.5.2.

The mine will contribute more surface water to the Talbragar River during wet years but there will be minor losses of at most 0.5% in average and dry years at the Elong Elong gauge. Given the minor changes caused by the Project and the management actions proposed at Ulan Mine to release treated surplus mine water, the cumulative impact of both projects on Talbragar River flows will be negligible.

8.5.3 Flood impacts

The percentage changes in peak flood flows just upstream of the confluence of Sandy Creek and the Talbragar River are presented in Table 8.6.

Table 8.11 Percentage change in peak floods in Sandy Creek

Event	Peak flow (m^3/s)	Percentage Change (%)
2 year ARI	31	+7
5 year ARI	83	+6
100 year ARI	432	+1
2,000 year ARI	1,355	0

Peak flows in Flyblowers Creek will increase by around 30% across a range of ARIs (2 year, 5 year and 100 year) due to diverting a portion of the upper eastern Sandy Creek catchment in years 12 to 20. This could affect the existing watercourse crossings at Spring Ridge Road and a further 1.2 km downstream at the Golden Highway. The mitigation measures required to address this are described in Section 8.4.

The 100 year ARI flood extent in Year 20 (Figure 8.7) shows the mining infrastructure has relatively little interaction with the floodplain. However, some parts of the mine are located on the edge or just inside the 100 year ARI flood envelope. These include part of the workshop area, northern access road and the out-of-pit waste rock emplacements along the upper reaches of Laheys Creek near Area B. Parts of the mine footprint are within the 2,000 year ARI flood extent.

Overall, flooding behaviour is relatively unaffected by the mine and does not change in the upper and lower reaches of Sandy Creek. There is slightly more out of channel flow in the mid to lower reaches near the junction with Laheys Creek but this impact diminishes further downstream.

Average peak velocities for Sandy and Laheys Creek for the worst-case developed scenario are generally similar to the range of baseline flow velocities. Localised areas where velocities higher than 3 m/s occur in the Laheys Creek channel near proposed structures will require standard mitigation measures to ensure channel stability.

8.5.4 Project water demand and impacts on available resources and mine operations

CHC has entitlements authorising the extraction of water from the Macquarie and Cudgegong Regulated Rivers Water Source (see Section 7.5.6). These entitlements originally encompassed extracting 2,311 ML from the zone downstream of the upper limit of Burrendong Dam (ie on the Macquarie River) and 1,000 ML from the zone upstream of the upper limit of Burrendong Dam (ie on the Cudgegong River). CHC's purchase of the 2,311 ML WALs was conditional on NOW approving:

- the construction of a pump station on the Cudgegong River via a water supply works approval; and
- changing the extraction zone from downstream to upstream of the upper limit of Burrendong Dam.

NOW granted the works approval for the pump station and found that changing the extraction zone would have no significant environmental and third party impacts, including hydrological changes.

Regulated river (high security) WALs have priority of allocation over regulated river (general security) WALs. However, high security WALs associated with the Project will not receive an allocation before all town water supply and domestic and stock requirements are met. Licence entitlements will therefore not affect these uses because of the need to fully cater for critical human water needs before any water is allocated for other uses. This will be the case even under extreme prolonged dry weather conditions.

CHC is the last major water user on the Cudgegong River. In consultation with State Water Corporation, CHC is developing an extraction strategy agreement to ensure as much of its licence entitlement as possible will be extracted during periods of excess flows in the Cudgegong River. This will complement the current operation of the river to help State Water in minimising river transmission losses and, in turn, will leave more water in Windamere Dam for later use.

It is estimated that 2,960 ML/a of imported water would be required for a 10th percentile dry rainfall year at Year 20 of the mine plan. The water balance indicates that imported water entitlements will be sufficient for all except three years in the past 111 years modelled. If the driest year on record coincided with Year 20, water savings of about 2% would be needed.

8.5.5 Post-mining

The final void water balance indicates that the water level will initially rise and reach an average equilibrium over time. The void lake will not overtop and will act as a groundwater sink that will not impact nearby surface water bodies.

The salinity in the lake will increase over time. No groundwater will flow from this lake towards the creek, which means there will be no increased salinity in Sandy Creek. However, the void may potentially develop into a stratified lake which may lead to anoxic conditions. Water quality issues related to a confined stratified hypersaline lake have not been assessed at this stage because this would be undertaken as part of a detailed mine closure plan.

The final landform has been designed to eliminate two voids and minimise the scale of the third final void. An unavoidable impact will be the formation of an isolated saline lake that cannot be eliminated at an economically viable cost. As no saline groundwater will migrate from that lake, the final void impacts are considered acceptable for the local surface water environment.

8.5.6 Surface water outcomes

The impact assessment shows the Project's water management system and associated mitigation measures will minimise its impacts on surface water quality and flow during construction and operations. These limited impacts will largely be confined to Sandy Creek. The Project will not affect town water supply and domestic and stock requirements since these will be met before any river water is allocated to the mine. Management strategies will be adapted according to monitoring program data (see Section 8.6). A mine closure plan that CHC will prepare in Year 15 will detail measures to minimise potential post-mining impacts from the presence of void lake water. This reflects CHC's commitment to minimising adverse impacts.

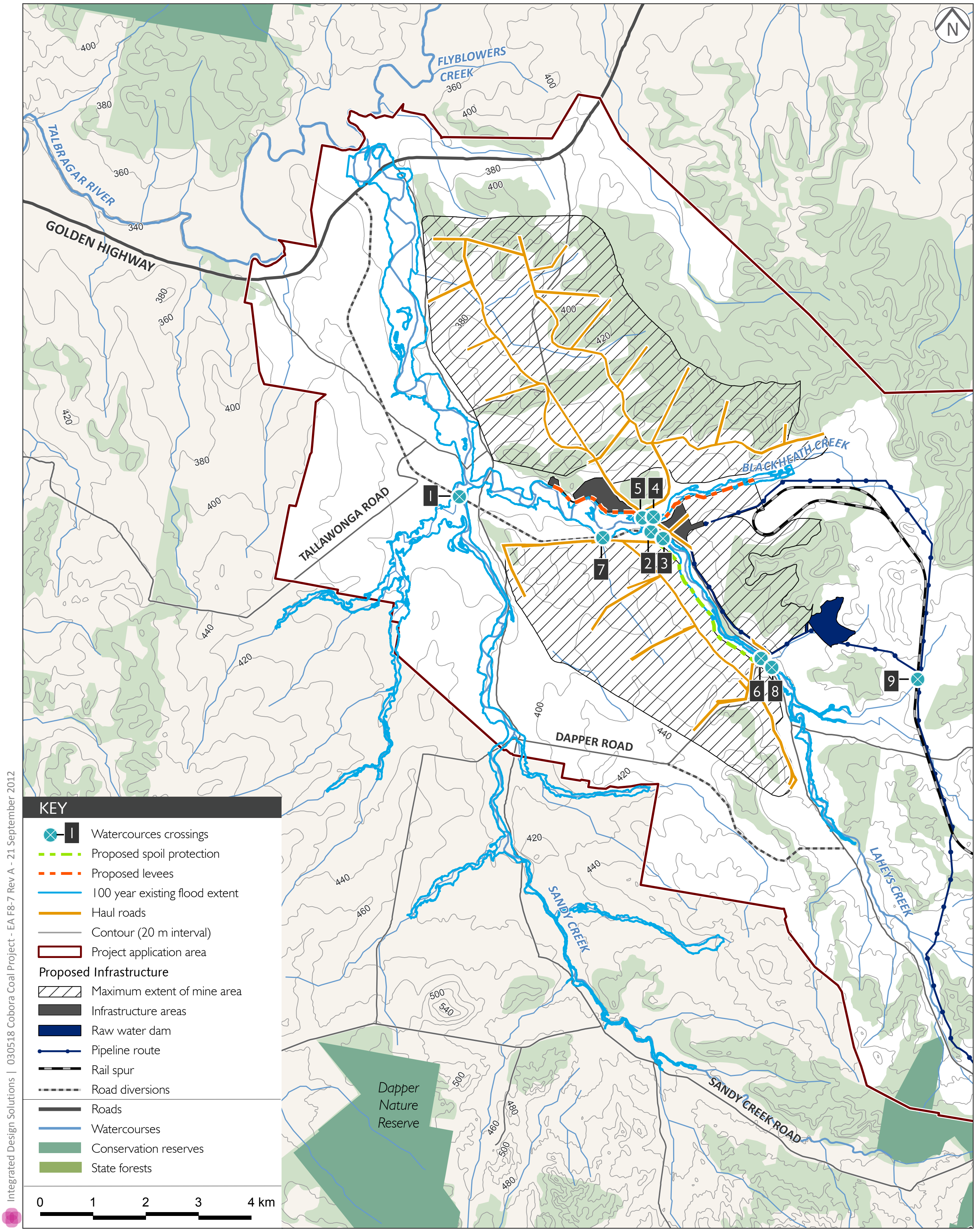
8.6 Monitoring

The full surface water monitoring program, which is summarised below, will be specified in the SWMP.

8.6.1 General principles

The following general principles will be used to develop the surface water monitoring program:

- all licensed points will be monitored, recorded and reported in accordance with the relevant EPL conditions;
- should WQOs be exceeded, the EPA will be notified as soon as possible. The cause of the exceedence and possible mitigation actions will then be investigated; and
- the monitoring program will also include monitoring points that are upstream and downstream from the licensed releases.



Predicted 100 year ARI Flood Extent (Sandy Creek Catchment)

Cobbora Coal Project - Environmental Assessment

Figure 8.7

EMM

Cobbora Holding Company Pty Limited

8.6.2 Monitoring program

Preliminary surface water monitoring locations are based on the existing surface water monitoring program that has been operational since 2009. These sites (Figure 8.8), which may be refined as the mine water management system and associated infrastructure is confirmed during detailed design, are:

- SD1, SD2 and SD3 – sedimentation dams where water may be displaced to a receiving watercourse. These points could be specified as the licensed points in the EPL for the Project;

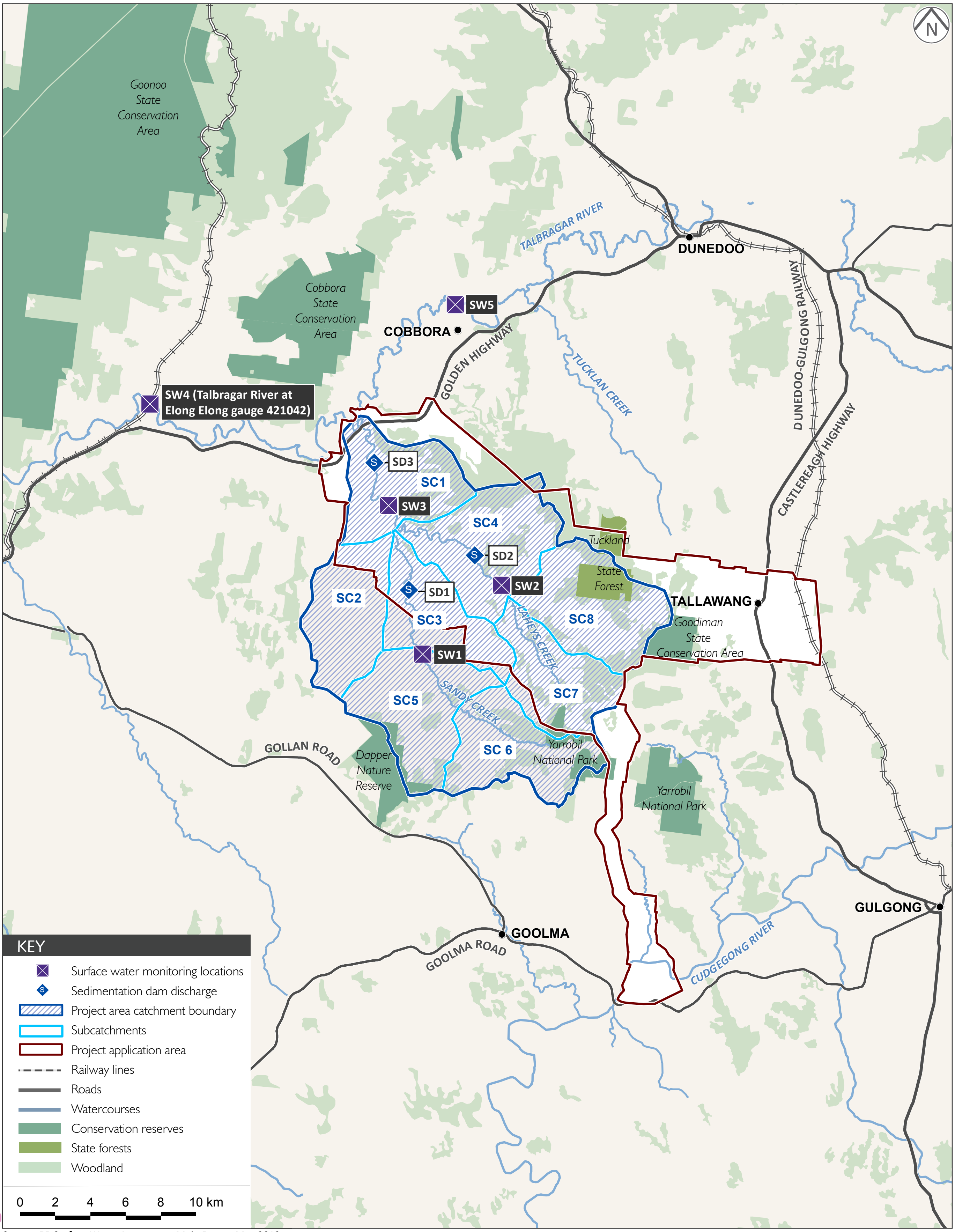
- SW01 (Sandy Creek), SW02 (Laheys Creek) and SW05 (Talbragar River) – control points (monitoring only) upstream from the site; and

- SW03 (Sandy Creek) and SW04 (Talbragar River at Elong Elong) – control points (monitoring only) downstream from the site.

Each monitoring point will have the capacity to monitor water quality (eg an outlet pit for sampling) and quantity (eg flow gauging weir) so as to test for compliance against relevant water quality criteria.

Samples will be collected by qualified and trained professionals in accordance with *Approved Methods for the Sampling and Analysis of Water Pollutants in New South Wales* (DEC 2004). Samples will be analysed at laboratories that are National Association of Testing Authorities (NATA) registered for each analysis required. All analytical equipment will be calibrated according to manufacturer's recommendations. Records of all calibrations will be kept.

Monitoring results will be recorded in the Project's EMS.



Source: PB Surface Water Assessment Main Report May 2012

Integrated Design Solutions | 030518 Cobbora Coal Project- EA F8-8 Rev A - 19 September 2012

EMM Cobbora Holding Company Pty Limited

Proposed Surface Water Quality Monitoring Locations

Cobbora Coal Project - Environmental Assessment

Figure 8.8