



Springvale Coal/EnergyAustralia

Amended Springvale Water Treatment Project

Water Resources Impact Assessment

December 2016

Executive summary

Springvale Coal Pty Limited (Springvale Coal) is seeking consent for the Springvale Water Treatment Project (the Project). The proposed Water Treatment Plant (WTP) will be developed in partnership between Springvale Coal and EnergyAustralia NSW Pty Ltd (EnergyAustralia). Springvale Coal proposes an amendment to the Project to allow for the transfer of excess treated water from the WTP into Thompsons Creek Reservoir (TCR) (the amended Project).

A Water Resources Impact Assessment has been developed to determine the potential impact of the amended Project on the surface water environment. The assessment investigated the potential impacts of the amended Project on the local water cycle, surface water quality, the fish community within TCR, stream health and downstream water users.

Existing conditions

The characterisation of existing conditions for the surface water in TCR and in the downstream receiving environment was undertaken to determine baseline conditions. TCR forms a part of the Coxs River water supply system for EnergyAustralia power generation water demands at Mount Piper Power Station (MPPS). The system draws water primarily directly from Lake Lyell, however water can be transferred via TCR as a staging dam. Water via the Coxs River water supply system can also be transferred from Lake Lyell to Lake Wallace. This was utilised during the operation of the Wallerawang Power Station which is now closed.

TCR is maintained full with an operating level approximately 0.3 m below the full supply level. This allows MPPS significant flexibility in the operation of the reservoir with a freeboard above the operating level, catering for rainfall and runoff from the catchment. TCR has not spilled via its emergency spillway, however it does have a riparian release requirement which is based on seasonal thresholds. This release is met each year from riparian releases via a valve downstream of the dam wall, which has varied historically between 0.5 ML/day to 1.0 ML/day. Historically, the outlet from TCR to Pipers Flat Creek has not been operated to manage water levels within TCR.

The water and salt balance modelling undertaken for the Project and presented in the Environmental Impact Statement (EIS) was updated to assess the amended Project. The water and salt balance model was modified to provide refined simulation of the operation of TCR, Lake Lyell and the Coxs River water supply system. The model was also updated for the improved calibration undertaken on the Springvale Coal Services site (SCSS) water and salt balance. The groundwater inflows to Angus Place Colliery and Springvale Mine proposed to be transferred from the Springvale-Delta Water Transfer Scheme (SDWTS) to the WTP have been slightly modified as part of the amended Project to consider a change in the predictive modelling prepared by CSIRO. The revised peak groundwater inflow volume remains the same as previous predictions, however the timing of the peak occurs 16 months later than previously predicted.

The assessment of surface water quality indicated that the water in TCR is slightly alkaline and moderately saline. The influence of riparian releases from TCR contributing to surface flows in Thompsons Creek is evident in the salinity and major ion chemistry of the water sampled in the creek. Catchment contributions from surface flows and shallow alluvial groundwater are shown to dilute the riparian releases and add low concentrations of iron and manganese. No elevated concentrations of metals or nutrients were observed for TCR or Thompsons Creek. In the historical data record for Pipers Flat Creek, elevated concentrations of manganese, iron, cadmium, copper and nitrate were occasionally observed.

A fish survey of TCR found three species present in the reservoir: rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*), which are exotic species stocked in TCR by the Department of Primary Industries in order to promote recreational fishing activities, and flathead gudgeon, a native species.

Proposed conditions

The amended Project proposes to utilise TCR for the transfer of any excess treated water not immediately required for use within the MPPS cooling water system. The existing water supply infrastructure already allows for excess water to be transferred from MPPS to TCR as required. The existing system is proposed to be upgraded as part of the amended Project, supported by increased pumping capacity.

The modification of the operating level of TCR under proposed conditions was assessed for the power generation scenarios of 0%, 25%, 50%, 75% and 100%. As the water and salt balance modelling assumed constant power generation rates for the life of the Project for each scenario, a consideration of operational scenarios was also added to the assessment. This considered the assumption of a power station shutdown, or equivalent, of five or ten days in length.

The results of the water and salt balance modelling indicated that, for the 50% power generation scenario, the amended Project is predicted to increase the flow into Wangcol Creek at the confluence with the Coxs River by up to 2% on average compared to existing conditions and by up to 4% compared to the do nothing scenario. The electrical conductivity (EC) in Wangcol Creek was predicted to increase as a result of the discharges from the SCSS, by up to 16% compared to the do nothing scenario. However, future changes in the water management system at SCSS were found to mitigate this increase, with only a 1% increase in EC compared to existing conditions.

For the results for proposed conditions modelled in the 50% power generation scenario, inflows to Lake Wallace, Lake Lyell and Lake Burragorang from the Coxs River were predicted to decrease, compared to existing conditions and the do nothing scenario. The EC of inflows to the major reservoirs within the Coxs River was also predicted to decrease compared to both existing and do nothing scenarios. This occurs as a result of the treatment of mine water make using reverse osmosis processes to decrease EC as part of the Project, compared to the modelled discharge of untreated mine water to Sawyers Swamp Creek in the do nothing scenario.

The water and salt balance modelling results indicated that, for 0% and 25% power generation scenarios, the use of TCR to store excess treated water is not sustainable over the life of the Project. A power generation requirement of 32% at MPPS was predicted to be the upper limit for the sustainable use of TCR to store excess treated water. In the event that water supply from the SDWTS exceeds power generation demands, TCR can be utilised for a two year timeframe (for the 0% power generation scenario) before additional extraction from the reservoir is required. If the water level of TCR is required to be reduced, the preferred operation is to transfer water Lake Wallace via the Wallerawang Pipeline. The likelihood of an extended downturn in power generation below 32% for a constant period greater than two years is highly unlikely and hence the need to transfer significant volumes elsewhere is also unlikely, specifically for the volumes considered as part of the 0% and 25% power generation scenarios.

The assessment of 50% power generation scenario indicated that the operating level with TCR would need to be reduced to hold excess water during the peak water supply from SDWTS. The reduction in water level would be approximately 1.2 m below the current operating level. This predicted change is within the historical fluctuation level of TCR.

The assessment of the 75% and 100% power generation scenarios indicated that the current operating level of TCR could be maintained (± 0.1 m). This is largely due to the fact that 100% of

the water supplied by the Project will be consumed by MPPS over the life of the Project. A power generation requirement of 61% at MPPS was predicted to be the lower limit to maintain the current operating level of TCR (± 0.1 m).

The assessment of operational scenarios for emergency storage of excess treated water considered the maximum potential supply of 42 ML/day. The assessment indicated that for a five and ten day emergency storage of excess treated water would require approximately 0.4 m and 0.6 m reduction in water level in TCR respectively.

The treated water from the proposed WTP is predicted to be considerably less saline than the water in TCR, with a neutral pH and low concentrations of metals and nutrients. Any effect on the water quality of TCR will be that of dilution, though minimal change is predicted due to the large volume of TCR and the improbability of any sustained, high-volume discharges of treated water to the reservoir.

Negligible change to the water quality in the downstream receiving environments of Thompsons Creek and Pipers Flat Creek is predicted. Site specific guideline values (SSGVs) were derived based on the historical water quality monitoring record for Pipers Flat Creek. No exceedances of these SSGVs are predicted as a result of the amended Project.

The environmental tolerances of the fish species present in TCR was established based on a literature review, with consideration of the predicted treated water quality. It was deemed unlikely that the amended Project would have an impact on the fish community. Thermal tolerances of trout species are close to or just under the modelled temperature of the proposed releases to TCR, which is not likely to affect the fish community given the size and depth of the impoundment.

The distribution of trout species within the reservoir is predicted to change in response to changes in water level, which will vary the availability of preferred habitat. However, this is not predicted to result in any mortality or reduction in survival of the species.

Water monitoring requirements for the amended Project have been proposed with a reduction of monitoring requirements within Wangcol Creek and an increased monitoring requirement at TCR and downstream of Pipers Flat Creek and Lake Wallace (in the event that transfers from TCR to Lake Wallace are required).

A trigger action response plan has been conceptualised as an example of typical management requirements that would be likely as a result of the amended Project. Such a response plan is likely to be implemented as part of Project water management plans for the WTP. .

The commissioning phase report remains a key requirement for the implementation of the proposed WTP following approval of the Project. As part of the amended Project, this will be modified to address the requirements of mitigating risk to TCR and for the new connection requirements of excess treated water to the main supply line from TCR to MPPS.

Table of contents

1.	Introduction.....	1
1.1	Background.....	1
1.2	Modifications to the Springvale Water Treatment Project	1
1.3	Objectives of the Water Resources Impact Assessment.....	5
1.4	Scope of work	5
1.5	Report structure	6
2.	Statutory context	7
2.1	Legislation	7
2.2	Policies.....	9
3.	Site description.....	10
3.1	Topography.....	10
3.2	Geology.....	10
3.3	Surface water environment.....	10
3.4	Groundwater environment	10
3.5	Sensitive receptors	10
4.	Assessment methodology.....	12
4.1	Potential impacts.....	12
4.2	Water and salt balance assessment.....	12
4.3	Surface water quality	15
4.4	Fish community.....	21
4.5	Stream health.....	23
4.6	Downstream water users	23
5.	Existing conditions	24
5.1	Water management	24
5.2	Water and salt balance assessment.....	28
5.3	Surface water quality	35
5.4	Fish community.....	45
5.5	Stream health.....	47
5.6	Downstream water users	47
6.	Impact assessment	49
6.1	Proposed water management.....	49
6.2	Water and salt balance assessment.....	50
6.3	Surface water quality	87
6.4	Fish community.....	91
6.5	Stream health.....	93
6.6	Neutral or beneficial effect.....	93
6.7	Downstream water users	94
7.	Licensing requirements.....	96

7.1	Protection of the Environment Operations Act 1997	96
7.2	Water Management Act 2000	96
8.	Avoidance, mitigation and management.....	97
8.1	Monitoring and management requirements	97
8.2	Trigger action response plan	98
8.3	Reporting	99
8.4	Review	99
9.	Conclusions.....	105
10.	References.....	1

Table index

Table 1-1	Amended Project components.....	5
Table 1-2	Report structure	6
Table 4-1	Period of surface water quality data assessed	17
Table 4-2	ANZECC (2000) protection categories	17
Table 4-3	Default guideline values for the assessment of water quality (ANZECC 2000)	17
Table 4-4	Australian Drinking Water Guideline values for the assessment of water quality (NHMRC 2016)	19
Table 4-5	Electrofishing settings summary.....	23
Table 5-1	Summary of average annual water inputs and outputs for Wangcol Creek catchment under existing conditions in 2016.....	29
Table 5-2	Summary of average annual water inputs and outputs for the Coxs River catchment under existing conditions in 2016.....	31
Table 5-3	Summary of average annual salt inputs and outputs for Wangcol Creek catchment under existing conditions in 2016.....	32
Table 5-4	Summary of average annual salt inputs and outputs for the Coxs River catchment under existing conditions in 2016.....	33
Table 5-5	Surface water quality in Thompsons Creek Reservoir	36
Table 5-6	Surface water quality in Thompsons Creek and Pipers Flat Creek	41
Table 5-7	Fish species collected in Thompsons Creek Reservoir during survey	45
Table 5-8	Identified downstream water users.....	47
Table 6-1	Summary of average water inputs and outputs for Wangcol Creek catchment under proposed conditions in 2031.....	55
Table 6-2	Summary of average water inputs and outputs for Coxs River catchment under proposed conditions in 2031.....	56
Table 6-3	Summary of average salt inputs and outputs for Wangcol Creek catchment under proposed conditions in 2031.....	70

Table 6-4	Summary of average salt inputs and outputs for Coxs River catchment under proposed conditions in 2031	72
Table 6-5	Changes to operating water level	80
Table 6-6	Predicted excess water required to be managed (scenarios 1 and 2)	83
Table 6-7	Summary of change in water volume results under proposed conditions	86
Table 6-8	Summary of change in electrical conductivity results under proposed conditions	86
Table 6-9	Treated water quality	87
Table 6-10	Site-specific guideline values for the amended Project	89
Table 6-11	Environmental tolerances of fish collected in Thompsons Creek Reservoir	91
Table 6-12	NorBE test outcomes for flow and water quality (based on electrical conductivity)	94
Table 6-13	Impacts to downstream water users	94
Table 8-1	Thompsons Creek Reservoir water quality monitoring	97
Table 8-2	Water quality monitoring for the proposed point of release to Thompsons Creek Reservoir	97
Table 8-3	Aquatic ecology monitoring downstream of potential discharge locations	98
Table 8-4	Trigger action response plan	100

Figure index

Figure 1-1	Locality plan	2
Figure 1-2	Overview of amended Project	3
Figure 1-3	Water management schematic	4
Figure 3-1	Topography and watercourses	11
Figure 4-1	Water cycle schematic	13
Figure 4-2	Predicted groundwater inflows into Angus Place Colliery and Springvale Mine (CSIRO 2016)	14
Figure 4-3	Surface water quality monitoring locations	16
Figure 4-4	Electrofishing survey transects	22
Figure 5-1	Environmental flow releases from Thompsons Creek Reservoir	25
Figure 5-2	Environmental flow releases from Lake Lyell	27
Figure 5-3	Lake Lyell storage volume and environmental inflows	27
Figure 5-4	Lake Wallace storage volume	28
Figure 5-5	Annual water transfers – Existing conditions (2016)	30
Figure 5-6	Annual salt transfers – Existing conditions (2016)	34
Figure 5-7	Flathead Gudgeon (<i>Philypnodon grandiceps</i>)	45
Figure 5-8	Brown Trout (<i>Salmo trutta</i>)	46

Figure 5-9	Rainbow Trout (<i>Oncorhynchus mykiss</i>).....	46
Figure 5-10	Eastern shore of Thompsons Creek Reservoir	46
Figure 5-11	Licensed surface water users	48
Figure 6-1	Proposed modifications to the water supply system of Thompsons Creek Reservoir.....	49
Figure 6-2	Annual water transfers – Proposed conditions (2031) Do nothing scenario	53
Figure 6-3	Annual water transfers – Proposed conditions (2031) Scenario 3	54
Figure 6-4	Regional modelling locations – Project area extent.....	59
Figure 6-5	Regional modelling locations – Regional extent.....	60
Figure 6-6	Do nothing scenario – Predicted flow of Wangcol Creek at LDP006	61
Figure 6-7	Do nothing scenario – Predicted flow of Wangcol Creek at the confluence with the Coxs River	62
Figure 6-8	Do nothing scenario – Predicted flow from Coxs River to Lake Wallace	62
Figure 6-9	Do nothing scenario – Predicted flow from Coxs River to Lake Lyell.....	63
Figure 6-10	Do nothing scenario – Predicted flow from Coxs River to Lake Burragorang	63
Figure 6-11	Scenario 3 – Predicted flow of Wangcol Creek at LDP006	64
Figure 6-12	Scenario 3 – Predicted flow of Wangcol Creek at the confluence with the Coxs River.....	64
Figure 6-13	Scenario 3 – Predicted transfer from Mount Piper Power Station to Thompsons Creek Reservoir	65
Figure 6-14	Scenario 3 – Predicted flow from Coxs River to Lake Wallace	66
Figure 6-15	Scenario 3 – Predicted flow from Coxs River to Lake Lyell.....	66
Figure 6-16	Scenario 3 – Predicted flow from Coxs River to Lake Burragorang	67
Figure 6-17	Annual salt transfers – Proposed conditions (2031) Do nothing scenario.....	68
Figure 6-18	Annual salt transfers – Proposed conditions (2031) Scenario 3	69
Figure 6-19	Do nothing scenario – Predicted EC of Wangcol Creek at LDP006.....	74
Figure 6-20	Do nothing scenario – Predicted EC of Wangcol Creek at the confluence with the Coxs River	75
Figure 6-21	Do nothing scenario – Predicted EC of flow from the Coxs River to Lake Wallace	75
Figure 6-22	Do nothing scenario – Predicted EC of flow from the Coxs River to Lake Lyell.....	76
Figure 6-23	Do nothing scenario – Predicted EC of flow from the Coxs River to Lake Burragorang	76
Figure 6-24	Scenario 3 – Predicted EC of Wangcol Creek at LDP006.....	77
Figure 6-25	Scenario 3 – Predicted EC of Wangcol Creek at the confluence with the Coxs River.....	77
Figure 6-26	Scenario 3 – Predicted EC of transfer from Mount Piper Power Station to Thompsons Creek Reservoir	78
Figure 6-27	Scenario 3 – Predicted EC of flow from the Coxs River to Lake Wallace	78

Figure 6-28 Scenario 3 – Predicted EC of flow from the Coxs River to Lake Lyell.....	79
Figure 6-29 Scenario 3 – Predicted EC of flow from the Coxs River to Lake Burragorang	80
Figure 6-30 Changes to operational water level	82
Figure 6-31 Transfer pathway of excess water to Lake Wallace	84
Figure 6-32 Daily flow volumes downstream of Lake Wallace.....	85
Figure 6-33 Reservoir bathymetry.....	92

Appendices

Appendix A – Assessment requirements
Appendix B – Additional water and salt balance results
Appendix C – Surface water quality assessment
Appendix D – Fish data collected at Thompsons Creek Reservoir

Glossary

Alkalinity	A measure of the ability of an aqueous solution to neutralise acids. Alkalinity of natural waters is due primarily to the presence of hydroxides, bicarbonates and carbonates. It is expressed in units of calcium carbonate (CaCO ₃).
Alluvial	Deposition from running waters.
Ambient	Pertaining to the surrounding environment or prevailing conditions.
Aquifer	An underground layer of permeable material from which groundwater can be usefully extracted.
Australian Height Datum	A common national surface level datum approximately corresponding to sea level
Average recurrence interval	A statistical estimate of the average period in years between the occurrence of a flood of a given size or larger, e.g. floods with a discharge equivalent to the 1 in 100 year average recurrence interval flood event will occur on average once every 100 years.
Baseflow	The component of flow in a watercourse that is driven from the discharge of underground water.
Baseline monitoring	Monitoring conducted over time to collect a body of information to define specific characteristics of an area (e.g. species occurrence or water quality) prior to the commencement of a specific activity.
Bore	Constructed connection between the surface and a groundwater source that enables groundwater to be transferred to the surface either naturally or through artificial means.
Catchment	The land area draining through the main stream, as well as tributary streams, to a particular location.
Dewatering	The removal or pumping of water from an above or below ground storage, including the mine water within the water collection system of mine workings. Water removed from mine workings is regarded as dewatering unless the workings are flooded and at equilibrium with the surrounding strata (in which case the removal is considered groundwater extraction).
Discharge	The quantity of water per unit of time flowing in a stream, for example cubic metres per second or megalitres per day.
Electrical conductivity	A measure of the concentration of dissolved salts in water.
Flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or overland runoff before entering a watercourse and/or coastal inundation resulting from super elevated sea levels and/or waves overtopping coastline defences.

Floodplain	Area of land that is periodically inundated by floods up to the probable maximum flood event.
Geomorphology	Scientific study of landforms, their evolution and the processes that shape them. In this report relates to the form and structure of waterways.
Goaf	The part of a mine from which the mineral has been partially or wholly removed, including the waste left in workings.
Groundwater	Water occurring naturally below ground level.
Groundwater extraction	For the purposes of this assessment, groundwater extraction has been defined as the removal of groundwater from a groundwater source or aquifer, either via direct removal for use via a production bore or via incidental flow of groundwater from the aquifer into the mine workings during and after mining. Groundwater extraction includes the pumping of underground water from flooded mine workings in equilibrium with the surrounding strata as well as the removal of water from perched aquifers recharged directly from rainfall infiltration.
Guideline	A numerical concentration or narrative statement that provides appropriate guidance for a designated water use or impact.
Hardness	The concentration of multivalent cations present in water. Generally, hardness is a measure of the concentration of calcium and magnesium ions in water and is expressed in units of calcium carbonate (CaCO_3) equivalent. Hardness may influence the toxicity and bioavailability of substances in water.
Ion	Electrically charged atom.
Licensed discharge point	A location where the premises discharge water in accordance with conditions stipulated within the site Environmental Protection License.
Median	The middle value, such that there is an equal number of higher and lower values. Also referred to as the 50th percentile.
Percentile	The value of a variable below which a certain percent of observations fall. For example, the 80th percentile is the value below which 80 percent of values are found.
pH	The value taken to represent the acidity or alkalinity of an aqueous solution. It is defined as the negative logarithm of the hydrogen ion concentration of the solution.
Potable water	Water of a quality suitable for drinking.
Riparian	Pertaining to, or situated on, the bank of a river or other water body.
Runoff	The amount of rainfall which actually ends up as streamflow, also known as rainfall excess.
Run of mine	Raw coal production (unprocessed).
Sediment	Soil or other particles that settle to the bottom of lakes, rivers, oceans and other waters.

Stream order	Stream classification system, where order 1 is for headwater (new) streams at the top of a catchment. Order number increases downstream using a defined methodology related to the branching of streams.
Surface water	Water that is derived from precipitation or pumped from underground and may be stored in dams, rivers, creeks and drainage lines.
Topography	Representation of the features and configuration of land surfaces.
Toxicity	The inherent potential or capacity of a substance to cause adverse effects in a living organism.
Tributary	A stream or river that flows into a main river or lake.
Trigger value	The concentration or load of physicochemical characteristics of an aquatic ecosystem, below which there exists a low risk that adverse ecological effects will occur. They indicate a risk of impact if exceeded and should 'trigger' action to conduct further investigations or to implement management or remedial processes.
Turbidity	A measure of clarity (turbidity) of water. Turbidity in excess of 5 NTU is just noticeable to the average person.

Abbreviations

ADWG	Australian drinking water guideline
AHD	Australian height datum
ARI	Annual recurrence interval
ARR	Australian Rainfall and Runoff
AWBM	Australian Water Balance Model
BOM	Bureau of Meteorology
Centennial Angus Place	Centennial Angus Place Pty Ltd
Centennial Coal	Centennial Coal Pty Limited
Centennial Springvale	Centennial Springvale Pty Limited
CRD	Cumulative rainfall departure
DGV	Default guideline value
DOC	Dissolved organic carbon
DPE	Department of Planning and Environment
DPI-Water	Department of Primary Industries – Office of Water
DTA	Direct toxicity assessment
EC	Electrical conductivity
EC _{xx}	Effective concentration for XX percent of a bioassay
EIS	Environmental impact statement
EnergyAustralia	EnergyAustralia NSW Pty Ltd
EP&A Act	<i>Environmental Planning and Assessment Act 1979</i>
EPA	Environment Protection Authority
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
EPL	Environment protection licence
ESA	Ecotox Services Australasia
FSL	Full supply level
GDE	Groundwater dependent ecosystem
GHD	GHD Pty Ltd
GMR WSP	Greater Metropolitan Region Groundwater Sources WSP
GMRU WSP	Greater Metropolitan Region Unregulated River Water Sources WSP
ha	Hectare
km	Kilometre
km ²	Square kilometre
L/s	Litre per second
LDP	Licensed discharge point
Lidsdale Siding	Lidsdale Siding Rail Loading Facility

m	Metre
m/s	Metre per second
m ³ /s	Cubic metre per second
MHRDC	Maximum harvestable right dam capacity
ML	Megalitre
ML/day	Megalitre per day
ML/year	Megalitre per year
mm	Millimetre
mm/hr	Millimetre per hour
MNES	Matters of national environmental significance
MPPS	Mount Piper Power Station
Mtpa	Million tonnes per annum
NATA	National Association of Testing Authorities
NOEC	No observable effect concentration
NTU	Nephelometric turbidity units
NWQMS	National Water Quality Management Strategy
OEH	Office of Environment and Heritage
POEO Act	<i>Protection of the Environment Operations Act 1997</i>
RCBC	Reinforced concrete box culvert
REA	Reject emplacement area
RMS	Roads and Maritime Services
RO	Reverse osmosis
ROM	Run of mine
SCSS	Springvale Coal Services site
SDWTS	Springvale-Delta Water Transfer Scheme
SEAR	<i>Secretary's Environmental Assessment Requirements Application Number SSD 16_7592</i>
SILO	Scientific Information for Land Owners
Springvale Coal	Springvale Coal Pty Limited
Springvale SK Kores	Springvale SK Kores Pty Ltd
SSD	State Significant Development
SSGV	Site-specific guideline values
SWTP	Springvale Water Treatment Project
TARP	Trigger Action Response Plan
t/year	Tonnes per year
TDS	Total dissolved solids
TKN	Total Kjeldahl nitrogen
TOC	Total organic carbon
TSS	Total suspended solids

WAL	Water access licence
WM Act	<i>Water Management Act 2000</i>
WRIA	Water Resources Impact Assessment
WSP	Water sharing plan
WTP	Water treatment plant
µS/cm	Microsiemens per centimetre

1. Introduction

1.1 Background

Springvale Coal Pty Limited (Springvale Coal) submitted an Environmental Impact Statement (EIS) in September 2016 to assess a State Significant Development (SSD) application (SSD 16_7592) for the Springvale Water Treatment Project (the Project). Approval for the Project is being sought under Part 4, Division 4.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The overall objective of the Project is to improve environmental outcomes and water quality within the upper Cocks River catchment by reusing underground mine water from Angus Place Colliery and Springvale Mine at Mount Piper Power Station (MPPS). The Project involves the transfer of water from existing and future underground mine dewatering facilities on the Newnes Plateau to a new water treatment plant (WTP) at MPPS. Treated water will be used within the MPPS cooling water system, with excess treated water proposed to be released to Wangcol Creek. The Project Application Area is presented in Figure 1-1.

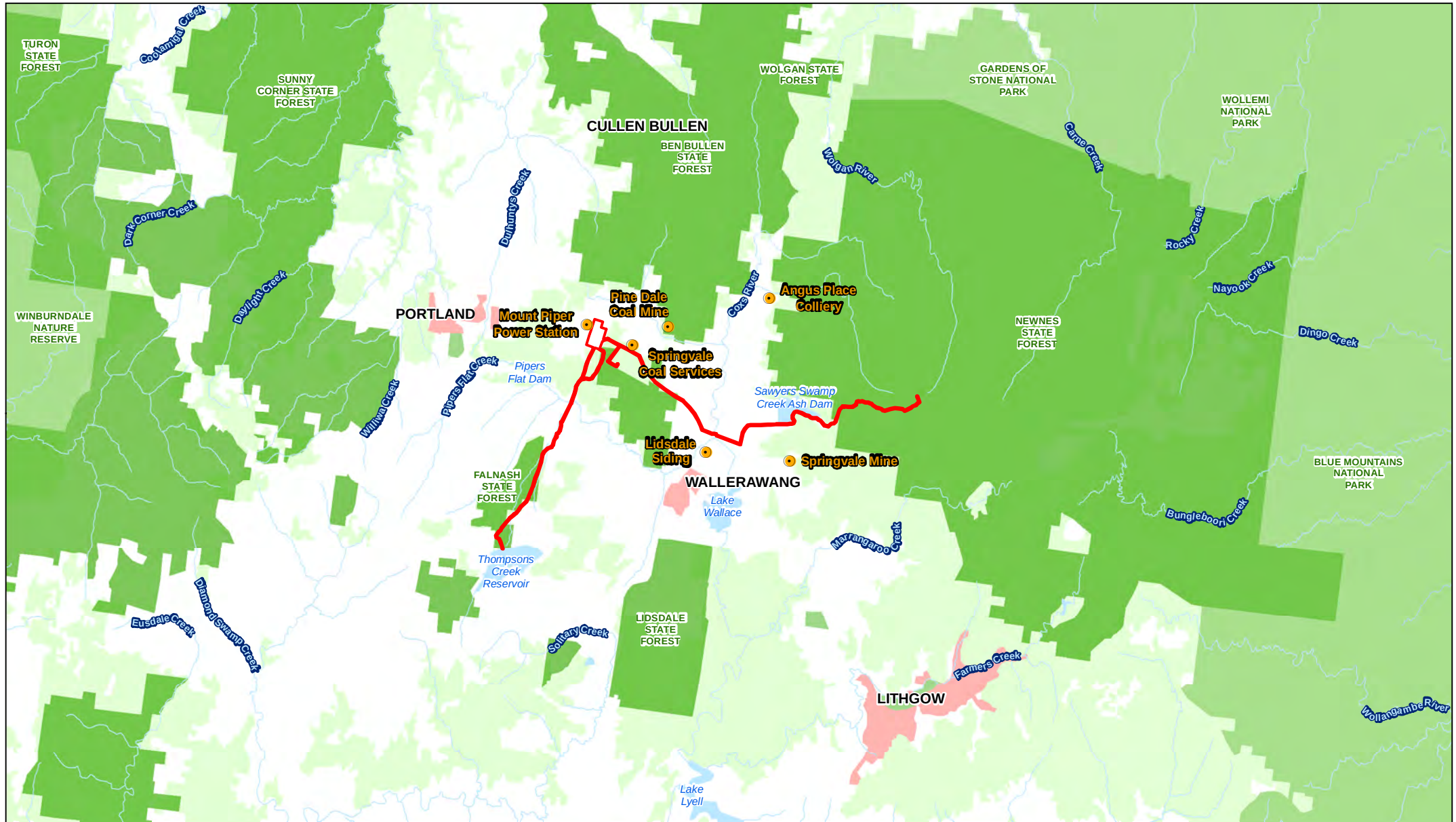
Following stakeholder feedback on the SSD application for the Project, Springvale Coal, in collaboration with EnergyAustralia NSW Pty Ltd (EnergyAustralia), has undertaken further investigations to identify alternative options for the management of treated water in excess of the cooling water make-up requirements at MPPS. The preferred alternative identified involves the transfer of excess treated water to Thompsons Creek Reservoir (TCR) for storage. This will facilitate subsequent reuse in the MPPS cooling water system during periods of high cooling water demand and remove the need for discharge to Wangcol Creek.

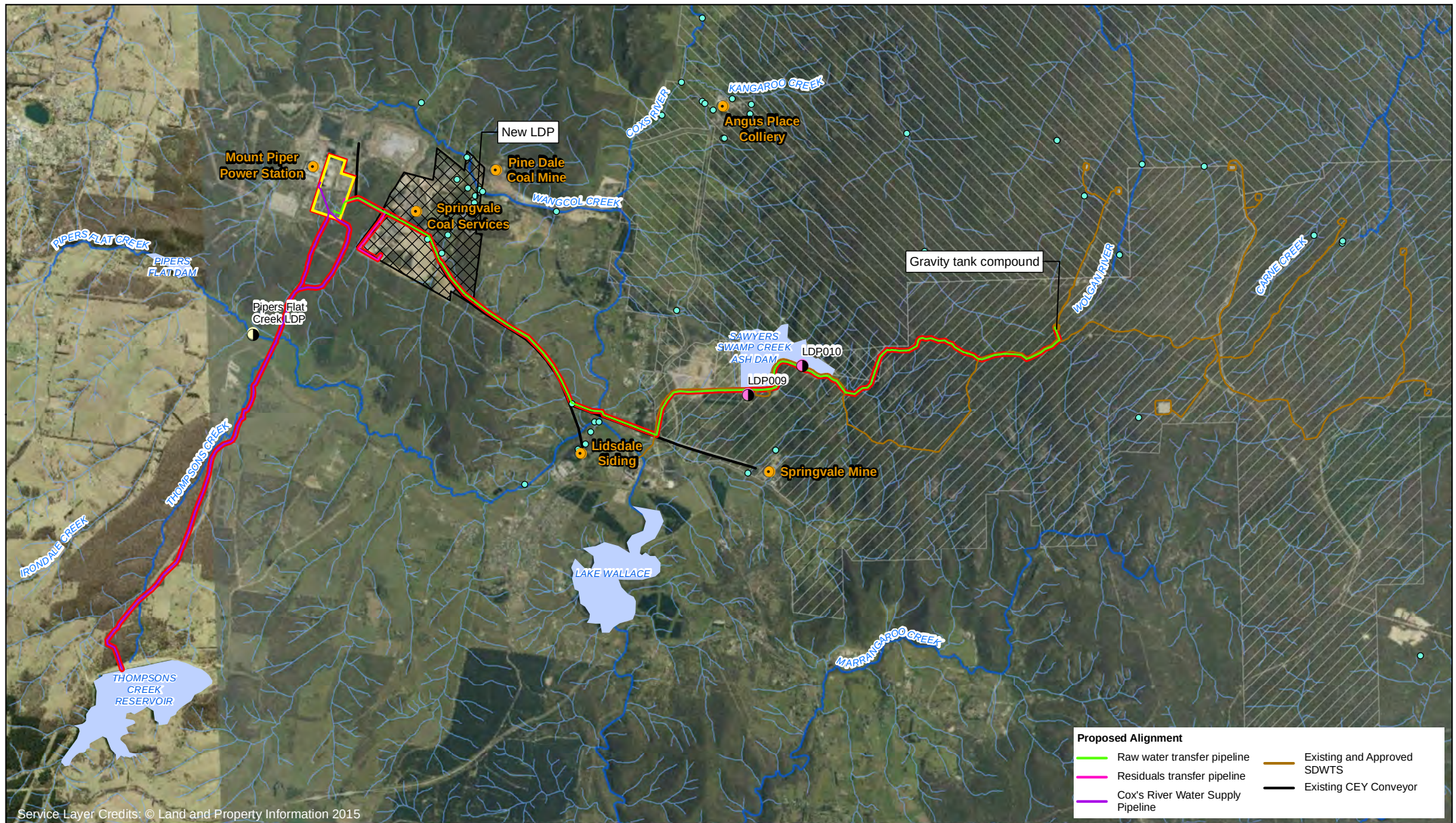
Springvale Coal propose a minor amendment to SSD application for the Project (SSD 16_7592) to include the transfer of excess treated water to TCR and remove the treated water discharge pipeline and associated infrastructure to Wangcol Creek. GHD Pty Ltd (GHD) has been commissioned to prepare a Water Resources Impact Assessment (WRIA) for amended Project. This assessment forms part of an environment assessment to support the amendment to the SSD application for the Project (SSD 16_7592) and has been prepared in accordance with relevant statutory conditions, the *Secretary's Environmental Assessment Requirements Application Number SSD 16_7592* (SEARs) and various submissions made by regulatory agencies related to the amendment.

It should be noted that the WRIA in Appendix B (GHD 2016a) and the Aquatic Ecology Impact Assessment in Appendix H (GHD 2016b) of the EIS remain the principal documents for the assessment of the potential impacts of the Project on surface water and groundwater environments. Only updated information and assessment of the amended Project is provided in this report.

1.2 Modifications to the Springvale Water Treatment Project

The amended Project will be undertaken in accordance with the project description included in Chapter 5 of the original EIS, subject to minor amendments. An overview of the amended Project is shown in Figure 1-2 and Figure 1-3 and a summary of amended Project components is presented in Table 1-1.





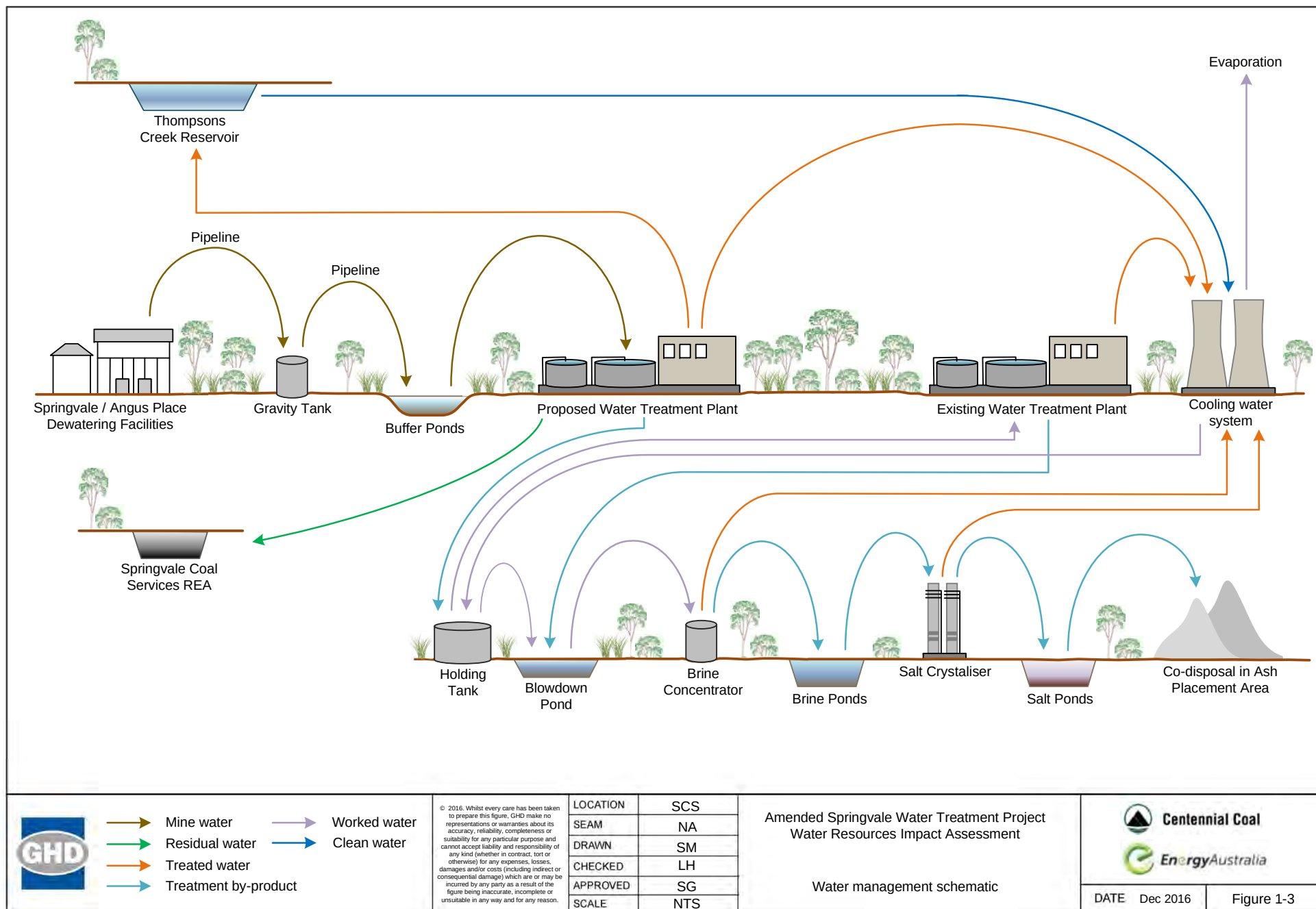


Table 1-1 Amended Project components

New Project components	Removed Project components
New treated water pipeline to lower valve station on existing Coxs River water supply pipeline.	Treated water discharge pipeline and associated release structure to Wangcol Creek.
Treated water pump station capacity to be upgraded to allow pumping to TCR.	Treated water pump station no longer required to pump water for the proposed catchment release.
Use of existing Coxs River water supply pipeline to transfer excess treated water to TCR.	No treated water to be released to Coxs River catchment via Wangcol Creek.
WTP with capacity to treat 42 ML/day.	WTP with capacity to treat 36 ML/day.
Mine water transfer system with sufficient hydraulic capacity to allow transfer of 42 ML/day.	Mine water transfer system with sufficient hydraulic capacity to allow transfer of 36 ML/day.

1.3 Objectives of the Water Resources Impact Assessment

The primary objective of this WRIA is to determine the potential impacts of the amended Project on both local and regional surface water environments. This involves an assessment of surface water in terms of water and salt balance, water quality, aquatic ecology and impacts on downstream water users.

This WRIA has been developed to address the water resources components of the existing EIS SEARs adopted for the amended Project. This also considers state government agency requirements from WaterNSW, which are presented in Appendix A.

1.4 Scope of work

The scope of work for the WRIA includes:

- Review existing assessments and data relevant to the amended Project.
- Review relevant statutory requirements.
- Establish the existing conditions for the surface water environment.
- Identify components of the amended Project with the potential to impact the surface water environment.
- Undertake an assessment of the potential impacts of the amended Project on:
 - Water and salt balance.
 - Surface water quality.
 - Aquatic ecology.
 - Downstream water users, including licensed water users and basic landholder rights.
- Undertake an assessment of the cumulative impacts of the amended Project in association with other operations in the upper Coxs River catchment.
- Determine the water licensing requirements for the amended Project.

- Develop measures to avoid, minimise and mitigate the identified potential impacts and provide recommended management, monitoring and reporting requirements.

1.5 Report structure

Table 1-2 provides a description of the structure of the WRIA.

Table 1-2 Report structure

Section	Content
Section 1 – Introduction	Purpose of the report and scope of work.
Section 2 – Statutory context	Legislative requirements, policies and guidelines relevant to the assessment of the water management and potential impacts.
Section 3 – Site description	Description of site topography, geology, hydrology and hydrogeology, as well as identification of sensitive receptors.
Section 4 – Assessment methodology	Description of assessment methodology used to assess surface water aspects of the amended Project.
Section 5 – Existing conditions	Outlines the existing conditions that are specific to the surface water environment.
Section 6 – Impact assessment	Identification and quantification of the potential impacts of the amended Project and discussion of the risk associated with the impacts occurring.
Section 7 – Licensing requirements	Description of the water licensing requirements for the amended Project.
Section 8 – Avoidance, mitigation and management	Description of recommended measures to avoid, minimise or mitigate potential impacts to surface water as a result of the amended Project.
Section 9 – Conclusion	Summary of key findings.
Section 10 – References	A list of the documents referenced within this report.

2. Statutory context

2.1 Legislation

2.1.1 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is administered by the Commonwealth Department of the Environment and provides a legal framework to protect and manage nationally and internationally significant flora, fauna, ecological communities and heritage places defined as 'matters of national environmental significance' (MNES). As the potential impacts to MNES includes general criteria for whether an action is likely to have a significant impact on water resources (in relation to coal seam gas and large coal mining developments) the review of the *Significant Impact Guidelines 1.3* (Department of the Environment 2013) was undertaken. In accordance with the guidelines water resources need to be assessed based on their significance. A key factor to a water resources significance is its utility to third party users. If evidence can be provided that a proposed action would not materially affect the availability and quality for third party users, then the likelihood of an action having a significant impact would be reduced.

An assessment of whether the amended Project may have a significant impact on any MNES or on the environment of Commonwealth land was revised as part of this assessment. The *Significant Impact Guidelines 1.3* states that the development of associated infrastructure, such as pipelines and environment protection, monitoring and associated land management activities, that is not part of the extraction process does not need to be referred for its impacts on a water resource. As the amended Project remains to be a water transfer and treatment system that is not part of the extraction process of a large coal mining development, it was determined that the amended Project, similar to the original Project, did not need to be referred under the EPBC Act.

As the amended Project will not be referred, the review of the amended Project by the Independent Expert Scientific Committee (IESC) will not be required. Regardless of this, a revised assessment of the amended Project was undertaken considering the typical IESC requirements and guidelines for assessing potential impact to water resource in relation to coal seam gas development and large coal mining development.

The significant impact guideline and IESC checklist were completed and are provided in Appendix A.

2.1.2 Protection of the Environment Operations Act 1997

The amended Project is a scheduled activity under the *Protection of the Environment Operations Act 1997* (POEO Act) and will require a new environment protection licence (EPL) to be issued for the Project's operations. This EPL will cover water treatment of groundwater activities (system capacity greater than 100 ML/year) under Schedule 1 of the POEO Act. The amended Project will seek to reuse all treated water from the Springvale-Delta Water Transfer Scheme (SDWTS) with no discharge to the environment. In the event that discharges were to occur, this activity will be consistent with the current operational conditions available within the Cocks River water supply system.

2.1.3 Fisheries Management Act 1994

The *Fisheries Management Act 1994* (FM Act) is administered by the Department of Primary Industries (DPI). The objects of the FM Act are to conserve, develop and share the fishery resources of the State for the benefit of present and future generations. In the particular context of the amended Project, the relevant objective of the FM Act is “to promote quality recreational fishing opportunities”. The amended Project will indicate how the activities will be undertaken and managed such that this objective is protected.

2.1.4 Dams Safety Act 2015

Under the *Dams Safety Act 2015* it is the objective of Dams Safety NSW (formerly the Dams Safety committee under the *Dams Safety Act 1978*) to “ensure that any risks that may arise in relation to dams (including any risks to public safety and to environmental and economic assets) are of a level that is acceptable to the community”. TCR is a “declared dam” under the *Dams Safety Act 2015* and as such Dams Safety NSW is required to “maintain a surveillance” of it. This involves a requirement of regular surveillance and reporting by the owner, which for TCR is EnergyAustralia.

2.1.5 Water Management Act 2000

Water sharing plans

The amended Project remains completely located within the Greater Metropolitan Region Unregulated River Water Sources Water Sharing Plan (GMRU WSP). The amended Project will result in all works being located within the Wywandy Management Zone of the Upper Nepean and Upstream Warragamba Water Source.

Activity approvals

Any works within the defined riparian zone of a creek are to be carried out in accordance with the *Water Management Act 2000* (WM Act). Works undertaken on waterfront land (i.e. near a river, lake or estuary) require a controlled activity approval, unless defined as exempt. Controlled activity approvals are not required for projects that are defined as SSDs and as such no controlled activity approvals will be required for any aspect of the Project. However, DPI Water may be consulted in relation to proposed activities within existing riparian corridors, such as construction works, which would provide a means of determining the suitability of engineering controls and general mitigation measures.

It remains unlikely that pipeline trenching and boring activities will intercept significant groundwater volumes, however, during construction in the event that significant groundwater is intercepted, then an aquifer interference approval will be sought through DPI Water.

Water access licences

EnergyAustralia currently holds water access licence (WAL) 27428 under the GMRU WSP for the extraction of surface water from the Coxs River within the Upper Nepean and Upstream Warragamba Water Source up to 23,000 ML/year.

WaterNSW currently holds WAL 36230 for the Fish River water supply scheme under the Macquarie Bogan Unregulated and Alluvial Water Sources Water Sharing Plan. This WAL allows for the extraction of up to 15,876 ML/year from the Fish River Water Source, with up to 8,184 ML/year supplied to EnergyAustralia.

There are no proposed modifications to any WALs as part of the amended Project.

2.1.6 Water NSW Act 2014

The amended Project will seek to reuse all treated water as a closed loop system as part of the Coxs River water supply system used by EnergyAustralia. As the amended Project is located within the upper Coxs River catchment, part of Sydney's drinking water catchment, WaterNSW have a requirement to ensure that the catchment is protected from potential impacts of developments. The *Water NSW Act 2014* provides the legal mechanism to enable the catchment protection and regulation with respect to water management works.

2.2 Policies

2.2.1 State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011

The *State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011* replaced the Drinking Water Catchments Regional Environmental Plan No. 1 and specifically requires all proposed developments in the Sydney drinking water catchment to demonstrate a neutral or beneficial effect (NorBE). The management of the Sydney drinking water catchment is undertaken by WaterNSW.

The WRIA will detail how the amended Project will address potential impacts to quantity and quality of surface water. As there are no components of WaterNSW water supply infrastructure or Special Areas present within or surrounding the amended Project, it is unlikely that the amended Project will impact upon these.

3. Site description

3.1 Topography

TCR lies to the north of Mount Lambie and to the south of Pipers Flat Creek. The elevation of the full supply level (FSL) of TCR is 1,033 m Australian Height Datum (AHD). The overall terrain slopes to the north, with Thompsons Creek joining Pipers Flat Creek at an approximate elevation of 950 m AHD. Topography for the area surrounding TCR is presented in Figure 3-1.

3.2 Geology

The study area in the vicinity of TCR is underlain by Permian rocks of the Shoalhaven group, with occurrences of early Triassic rocks of the Narrabeen group on top of ridges. The Shoalhaven group is overlain by the Illawarra Coal Measures in the vicinity of MPPS.

3.3 Surface water environment

Watercourses in the vicinity of TCR are presented in Figure 3-1. TCR is located within the upper Hawkesbury River catchment, which includes the greater Warragamba Dam catchment and the upper Coxs River sub-catchment. The Coxs River is a perennial river that drains a catchment area of approximately 1,700 km² and is part of the greater Hawkesbury/Nepean catchment. The river rises within the Ben Bullen State Forest east of Cullen Bullen and flows generally in a south-east direction into Lake Burragorang (impounded by Warragamba Dam), which is the primary reservoir for drinking water supply to Sydney.

Flow in Coxs River is regulated by TCR and two other reservoirs: Lake Wallace and Lake Lyell. TCR and Lake Lyell reservoirs are used to supply water for power generation activities at MPPS.

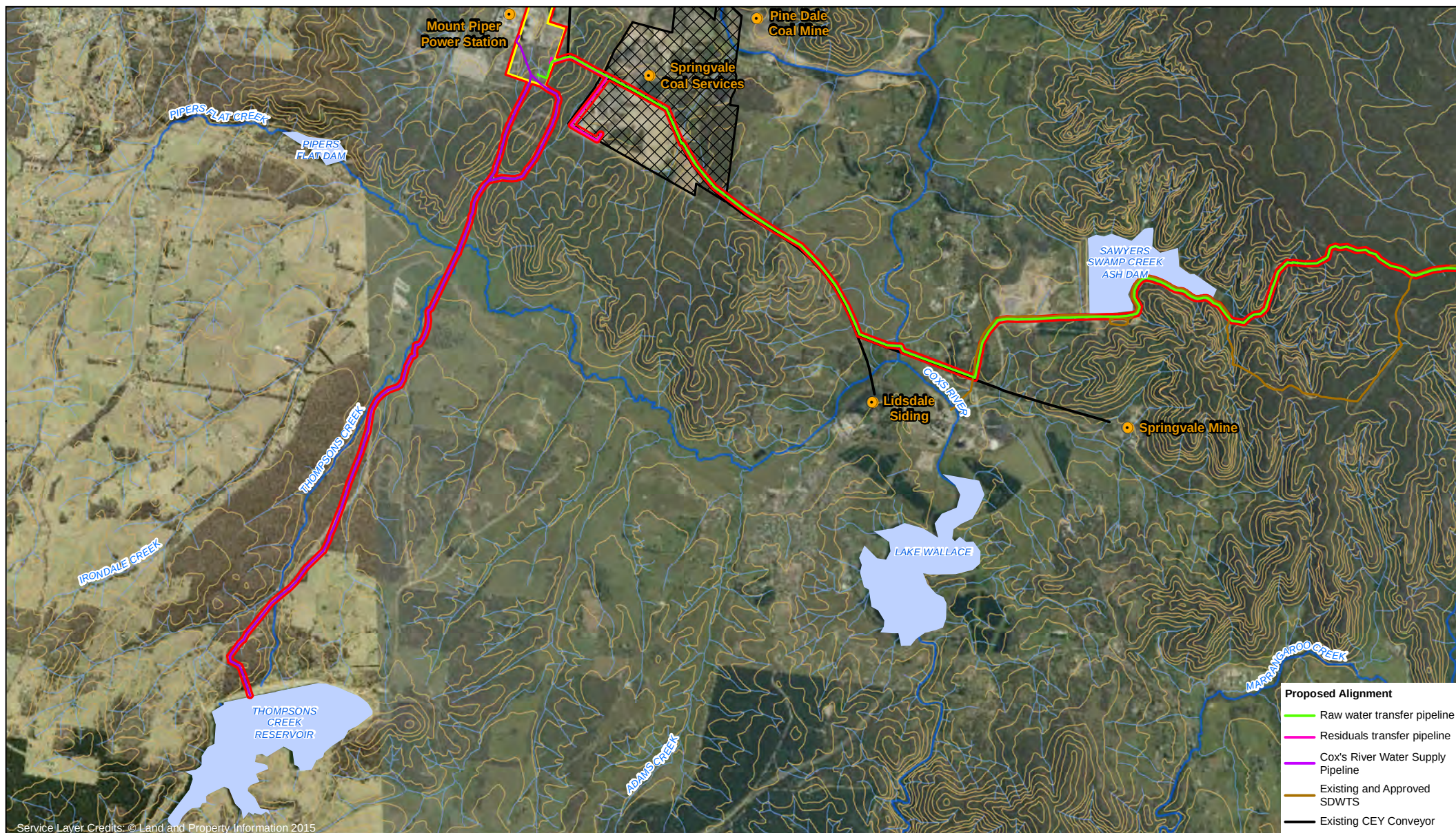
3.4 Groundwater environment

The Shoalhaven group in the vicinity of TCR is comprised of silty sandstone which is of low permeability and over 50 m thick. The approximately 1 m of alluvial soils which overlay the Shoalhaven group sandstone are of high permeability and are prone to seasonal waterlogging. Groundwater in the Thompsons Creek catchment flows generally to the north, in the direction of Pipers Flat Creek.

3.5 Sensitive receptors

The following sensitive surface and groundwater receptors have been identified:

- Groundwater dependent ecosystems (GDEs) located in the vicinity of the amended Project.
- Aquatic ecology maintained in local waterbodies, including macroinvertebrate fauna, frogs, macrophytes and algae, fish, semi-aquatic invertebrate species and semi-aquatic mammals.
- Waterways of Thompsons Creek, Pipers Flat Creek and Coxs River.
- The drinking water catchment for Warragamba Dam (Lake Burragorang), which receives inflows from a number of waterways including Coxs River.
- Users of surface water downstream of TCR, including licensed water users and basic landholder rights.



4. Assessment methodology

4.1 Potential impacts

The objective of the WRIA is to determine the potential impact of the amended Project on the surface water environment. The identification of potential impacts enables the development of measures to avoid or mitigate impacts or to provide the framework of monitoring programs that may be required for the amended Project.

The following potential impacts to surface water systems were identified:

- Changes to the local water cycle.
- Altered surface water quality in TCR receiving waterways.
- Changes in the fish community of TCR.
- Changes in stream health condition of waterways.

There are no likely impacts to the groundwater environment identified as a result of the amended Project, due to the minimal groundwater interactions expected with the construction of any additional pipeline alignments. Therefore, no groundwater impacts were assessed as part of this WRIA. The WRIA (GHD 2016a) in Appendix B of the EIS provides an assessment of the Project's impacts on the groundwater environment.

4.2 Water and salt balance assessment

4.2.1 Model modifications

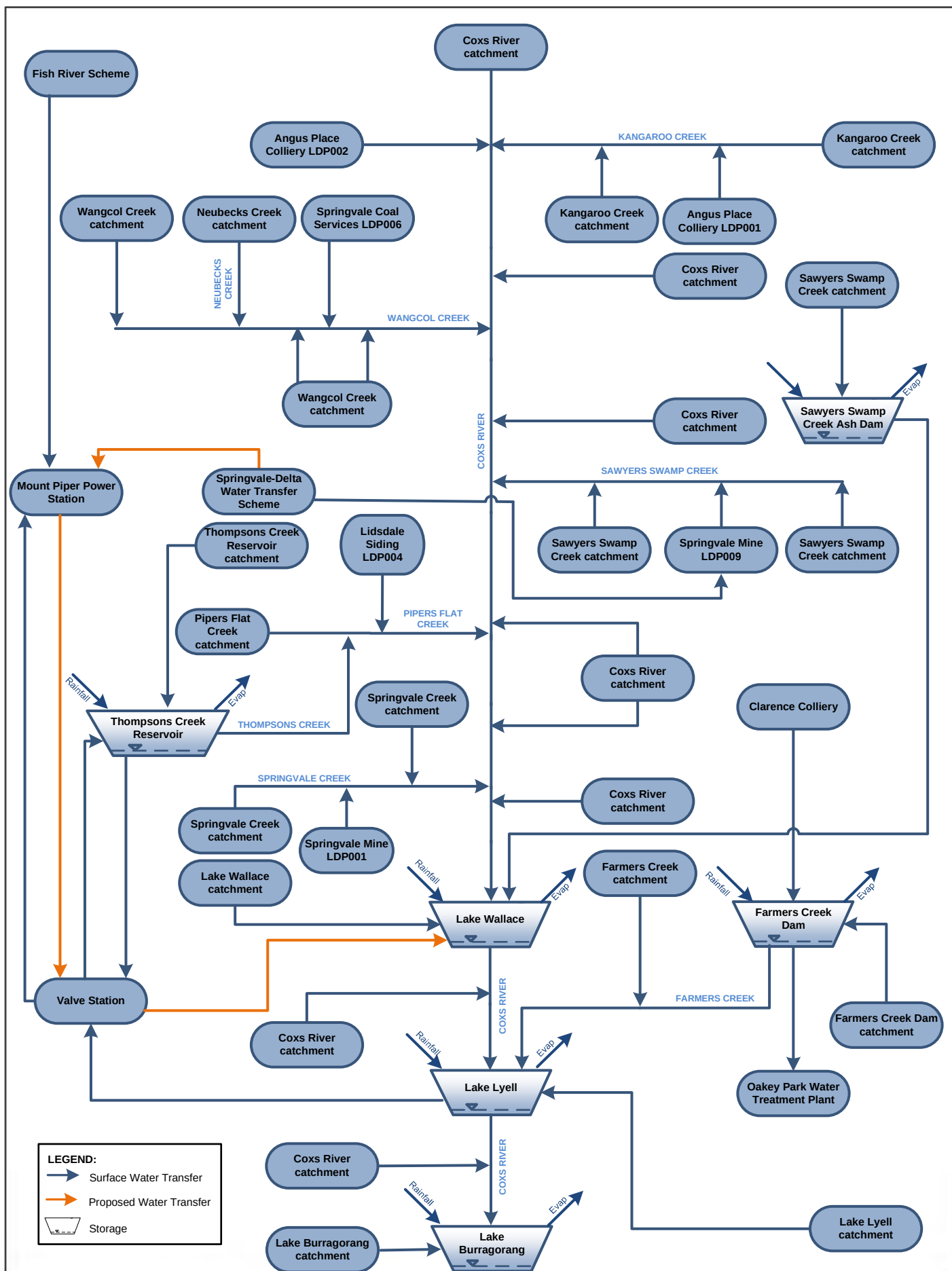
A water and salt balance model was developed in GoldSim (Version 11.1) for the Project to assess changes in the local and regional water and salt cycle. The modelling methodology is presented in Section 4.2 of the WRIA for the Project (GHD 2016a).

The following modifications were made to the GoldSim model to assess the impacts of the amended Project:

- Updated detailed water and salt balance model for Springvale Coal Services site (SCSS).
- Refined modelling of the operation of TCR, Lake Lyell and the Coxs River water supply system.
- Updated predictions of groundwater inflows transferred to the SDWTS.

Springvale Coal Services site water and salt balance model

The detailed water and salt balance model for SCSS has been updated to incorporate further refinement of the model, in particular the surface water and groundwater connectivity relationship, and future changes to the water management system to reduce the volume of clean water discharged through licensed discharge point (LDP) LDP006 to Wangcol Creek (GHD 2016c). These works were modelled to commence in June 2017 and result in a decrease in the volume of clean water through LDP006 and a corresponding increase in clean runoff to Wangcol Creek. As a result, the predictions for the revised water and salt balance model will change for Wangcol Creek, however the total volume and salt load contributing to the Coxs River from Wangcol Creek will not change from the results of the original water and salt balance model.



© 2016. Whilst every care has been taken to prepare this figure, GHD make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the figure being inaccurate, incomplete or unsuitable in any way and for any reason.

LOCATION	Coxs River
SEAM	NA
DRAWN	SM
CHECKED	TD
APPROVED	LH
SCALE	NTS



Amended Springvale Water Treatment Project
Water Resources Impact Assessment

Water cycle schematic



Centennial Coal



EnergyAustralia

DATE Dec 2016

Figure 4-1

Operation of the Coxs River water supply system

The operation of the Coxs River water supply system, specifically the supply of water to the MPPS cooling system from Lake Lyell and TCR, was refined to incorporate the amended Project. Any excess treated water from the WTP not able to be reused within the MPPS cooling water system was modelled to be released into TCR. The operational level (maintained storage level) of TCR was reduced to ensure sufficient freeboard to prevent overflows from the storage. Where additional water from the WTP was not able to be stored within TCR, excess water was modelled to contribute to Lake Wallace via the Wallerawang Pipeline. The operation of this pipeline is further discussed in Section 5.1.

Groundwater inflows

The groundwater inflows into the active underground workings of Angus Place Colliery and Springvale Mine were updated based on a revision to the hydrogeological model for Springvale Mine. The updated groundwater inflow predictions provided by CSIRO (2016) are presented in Figure 4-2. The revised results indicate that the combined inflow into the underground workings is predicted to peak in March 2031 at 36.1 ML/day. The revised peak groundwater inflow volume remains the same as previous predictions (CSIRO 2015), however the timing of the peak occurs 16 months later than previously predicted.

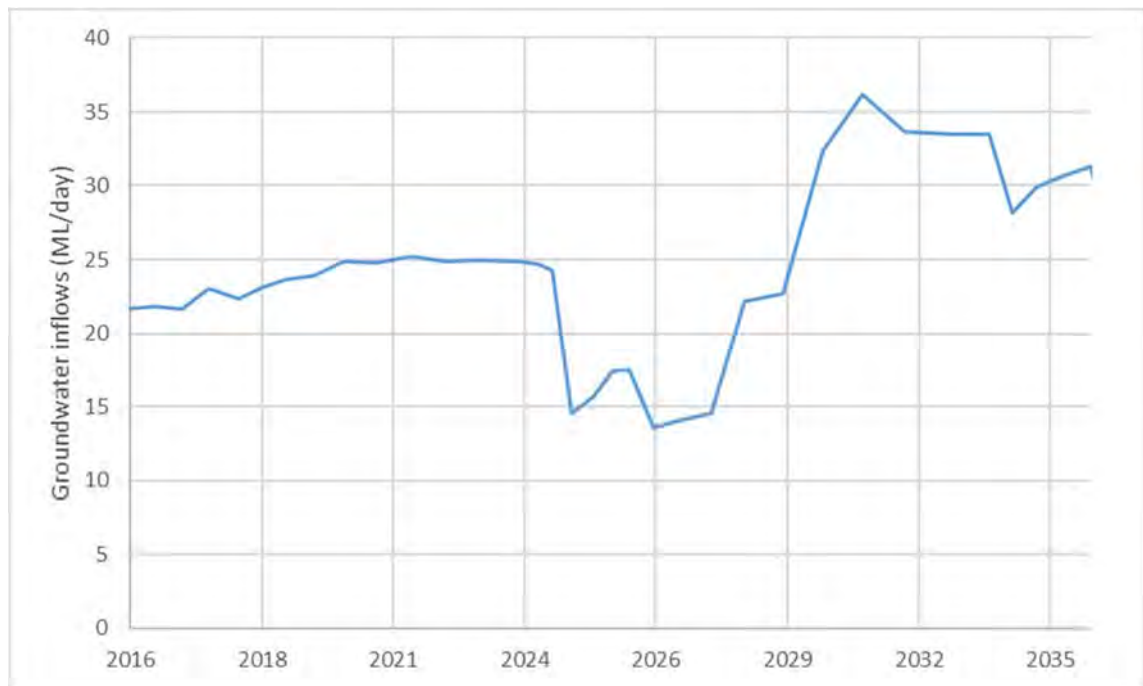


Figure 4-2 Predicted groundwater inflows into Angus Place Colliery and Springvale Mine (CSIRO 2016)

4.2.2 Modelling scenarios

Environmental assessment scenarios

Due to the variability associated with power generation requirements and water demand at MPPS, a number of scenarios were modelled. Results for the following operational scenarios are presented:

- Existing conditions – based on conditions in the year 2016, with a 50% power generation requirement at MPPS.

- Proposed conditions:
 - Scenario 1 – assumed a 0% power generation requirement at MPPS.
 - Scenario 2 – assumed a 25% power generation requirement at MPPS.
 - Scenario 3 – assumed a 50% power generation requirement at MPPS.
 - Scenario 4 – assumed a 75% power generation requirement at MPPS.
 - Scenario 5 – assumed a 100% power generation requirement at MPPS.
 - Do nothing – assumed that the Project will not be developed, with a 50% power generation requirement at MPPS and flows from the SDWTS discharged through LDP009 into Sawyers Swamp Creek.

The 50% power generation requirement was used to present the results for the modelling for the existing conditions, do nothing scenario and Scenario 3. The 50% power generation requirement is considered to be the most representative of existing and proposed conditions, as it correlates to recent historical trends of water demand at MPPS and corresponds to the approximate volume of water available from the SDWTS. All detailed model results for scenarios 1, 2, 4 and 5 are provided in Appendix B.

Operational assessment scenarios

The following two additional operational scenarios were modelled:

- Scenario A – five day shutdown of MPPS.
- Scenario B – ten day shutdown of MPPS.

The operational scenarios assumed a shutdown period of MPPS, with the proposed WTP continuing to operate. These scenarios modelled a transfer of a maximum 42 ML/day from the WTP to TCR (i.e. did not consider variation in groundwater inflows to Angus Place Colliery and Springvale Mine).

4.3 Surface water quality

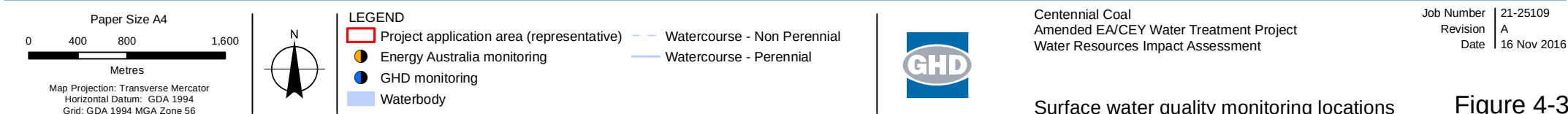
A surface water quality assessment was undertaken for the existing conditions in order to establish baseline water quality for TCR and receiving watercourses. This water quality assessment has been undertaken in accordance with the assessment framework and methodologies outlined by ANZECC (2000). Consideration has also been given to the Australian Drinking Water Guidelines (ADWGs) (NHMRC 2016) in the assessment methodology for water quality in accordance with the requirements of *State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011* (refer Section 2.2).

4.3.1 Monitoring locations

The water quality assessment has considered data from the following locations, as shown in Figure 4-3:

- TCR (EnergyAustralia monitoring site TC1).
- Thompsons Creek at the confluence with Pipers Flat Creek.
- Pipers Flat Creek downstream of the confluence with Thompsons Creek and TCR (Centennial monitoring site PFup).

The period of data reviewed for each location is provided in Table 4-1. Note that Thompsons Creek has only been sampled once, on 18 August 2016, by GHD.



Surface water quality monitoring locations

Figure 4-3

Table 4-1 Period of surface water quality data assessed

Location	Frequency	Count	From	To
TC1	Weekly	21–46	9 April 2014	29 September 2016
PFup	Monthly (before 2016) Quarterly (2016)	35–49	17 September 2009	17 August 2016

The monitoring site on from Pipers Flat Creek (PFup) was selected as the most appropriate reference site to provide background data to derive site-specific guideline values (SSGVs). This site is not measurably impacted by mining or power generation activities. It has previously been assessed by GHD (2016d) as part of the Water Management Plan for Lidsdale Siding.

4.3.2 Guideline values

To characterise the existing surface water quality, monitoring data has been compared to default guideline values (DGVs) recommended by ANZECC (2000) for the protection of 95% of aquatic species and the ADWGs (NHMRC 2016).

ANZECC (2000) default guideline values

Within the ANZECC (2000) guidelines, the upper Coxs River catchment falls into two different categories of ecosystem protection depending on the parameter reviewed, as identified in Table 4-2. The upper Coxs River catchment is considered to be a 'slightly to moderately disturbed' system, as the waterways have been adversely affected by human activities by a small to measureable degree.

Table 4-2 ANZECC (2000) protection categories

Parameter	Category
Physicochemical parameters and nutrients	NSW upland river (ANZECC 2000; Table 8.2.2 to 8.2.12).
Metals and toxicants	Freshwater category (ANZECC 2000; Table 3.4.1), with 95% species protection for slightly-moderately disturbed ecosystems.

A list of the DGVs recommended by ANZECC (2000) to assess water quality in the absence of adequate reference site monitoring data is presented in Table 4-3. Note that no hardness correction factors have been applied to any DGVs.

Table 4-3 Default guideline values for the assessment of water quality (ANZECC 2000)

Parameter	Units	DGV	Comments
Physicochemical parameters			
Electrical conductivity (EC)	µS/cm	350	NSW upland river (Table 8.2.9).
pH	pH units	6.5–9.0	NSW upland river (Table 8.2.8).
Total suspended solids (TSS)	mg/L	25	NSW upland river (Table 8.2.12).
Turbidity	NTU	25	NSW upland river (Table 8.2.11).

Parameter	Units	DGV	Comments
Nutrients			
Ammonia	mg/L	0.9	Freshwater guideline for 95% species protection (Table 3.4.1).
Nitrate	mg/L	0.7	Freshwater guideline for 95% species protection (Table 3.4.1).
Total nitrogen	mg/L	0.25	NSW upland river (Table 8.2.2).
Total phosphorus	mg/L	0.02	NSW upland river (Table 8.2.3).
Dissolved metals			
Aluminium	mg/L	0.055	Freshwater guideline for 95% species protection (Table 3.4.1). Applies for pH>6.5.
Arsenic	mg/L	0.024	Freshwater guideline for 95% species protection for As(III) (Table 3.4.1).
Boron	mg/L	0.37	Freshwater guideline for 95% species protection (Table 3.4.1).
Cadmium	mg/L	0.0002	Freshwater guideline for 95% species protection (Table 3.4.1).
Chromium	mg/L	0.001	Freshwater guideline for 95% species protection (Table 3.4.1).
Cobalt	mg/L	0.0025	Environment Canada (2013).
Copper	mg/L	0.0014	Freshwater guideline for 95% species protection (Table 3.4.1).
Iron	mg/L	0.3	Canadian guideline as recommended by ANZECC (2000; Section 8.3.7.1).
Lead	mg/L	0.0034	Freshwater guideline for 95% species protection (Table 3.4.1).
Manganese	mg/L	1.9	Freshwater guideline for 95% species protection (Table 3.4.1).
Mercury	mg/L	0.0006	Freshwater guideline for 99% species protection (Table 3.4.1).
Nickel	mg/L	0.011	Freshwater guideline for 95% species protection (Table 3.4.1).
Selenium	mg/L	0.011a	Freshwater guideline for 99% species protection (Table 3.4.1).
Silver	mg/L	0.00005	Freshwater guideline for 95% species protection (Table 3.4.1).

Parameter	Units	DGV	Comments
Zinc	mg/L	0.008	Freshwater guideline for 95% species protection (Table 3.4.1).

^a Guideline value for total selenium.

Australian Drinking Water Guidelines

A list of ADWG values (NHMRC 2016) is provided in Table 4-4. In the absence of a guideline for health values, aesthetic guideline values have been adopted.

Table 4-4 Australian Drinking Water Guideline values for the assessment of water quality (NHMRC 2016)

Parameter	Units	ADWG		Additional information
		Health	Aesthetic	
Physicochemical parameters				
pH	pH units	—	6.5–8.5	While extreme pH values (<4 and >11) may adversely affect health, there are insufficient data to set a health guideline value. <6.5 may be corrosive. >8 progressively decreases efficiency of chlorination. >8.5 may cause scale and taste problems.
Total dissolved solids (TDS)	mg/L	—	500	<500 mg/L is regarded as good quality drinking water based on taste. Concentrations of 500 mg/L to 1,000 mg/L is acceptable based on taste.
Turbidity	NTU	—	5	5 NTU is just noticeable in a glass. <0.2 NTU is the target for effective filtration of Cryptosporidium and Giardia. <1 NTU is the target for effective disinfection.
Dissolved metals				
Aluminium	mg/L	—	0.2	Guideline value based on post-flocculation problems; < 0.1 mg/L desirable. Lower levels needed for renal dialysis. No health-based guideline value can be established currently.
Antimony	mg/L	0.003	—	Exposure may rise with increasing use of antimony-tin solder.
Arsenic	mg/L	0.01	—	From natural sources and mining/industrial/agricultural wastes.
Barium	mg/L	2	—	Primarily from natural sources.

Parameter	Units	ADWG		Additional information
		Health	Aesthetic	
Boron	mg/L	4	–	From natural leaching of minerals and contamination. <1 mg/L in uncontaminated sources; higher levels may be associated with seawater intrusion.
Cadmium	mg/L	0.002	–	Indicates industrial or agricultural contamination; from impurities in galvanised (zinc) fittings, solders and brasses.
Copper	mg/L	2	1	From corrosion of pipes/fittings by salt, low pH water. Taste threshold 3 mg/L. High concentrations colour water blue/green. >1 mg/L may stain fittings. >2 mg/L can cause ill effects in some people.
Iron	mg/L	–	0.3	Occurs naturally in water, usually at <1 mg/L, but up to 100 mg/L in oxygen-depleted groundwater. Taste threshold 0.3 mg/L. High concentrations stain laundry and fittings.
Lead	mg/L	0.01	–	Occurs in water via dissolution from natural sources or household plumbing containing lead (e.g. pipes, solder).
Manganese	mg/L	0.5	0.1	Occurs naturally in water; low in surface water, higher in oxygen depleted water (e.g. groundwater at bottom of deep storages). >0.1 mg/L causes taste, staining. <0.05 mg/L desirable.
Mercury	mg/L	0.001	–	From industrial emissions/spills. Very low concentrations occur naturally. Organic forms most toxic, but these are associated with biota, not water.
Molybdenum	mg/L	0.05	–	Concentrations usually <0.01 mg/L; higher concentrations from mining, agriculture, or fly-ash deposits from coal-fuelled power stations.
Nickel	mg/L	0.02	–	Concentrations usually very low; but up to 0.5 mg/L reported after prolonged contact of water with nickel-plated fittings.
Zinc	mg/L	–	3	Usually from corrosion of galvanised pipes/fittings and brasses. Natural concentrations generally <0.01 mg/L. Taste problems >3 mg/L.

Site-specific guideline values

SSGVs were derived on the basis of the methodology outlined by ANZECC (2000) by calculating the 80th percentile of data collected at a reference site PFup (and 20th percentile for parameters reported as a range, for example pH). These values were then compared with the DGVs recommended by ANZECC (2000) as shown in Table 4-3 and the ADWGs determined by NHMRC (2016) as shown in Table 4-4.

4.3.3 Predicted treated water quality

The water quality of the treated water has been modelled using the AqMB software, which is a process simulation and concept design software based on accepted theories and empirical models for common unit processes. Its application is primarily for process design activities for physicochemical water treatment applications. The software was used to model a concept treatment train based on reverse osmosis to produce the required treated water quality parameters.

The modelling used the following input data for the predicted results:

- Historical Lake Lyell water quality (extrapolated to July 2017 to account for recent trends in EC and alkalinity).
- Historical mine water quality (LDP009 discharge).
- Annual average atmospheric condition (temperature, pressure, relative humidity).

4.4 Fish community

A fish survey was undertaken to improve understanding of the fish community of TCR. Fish sampling was carried out at TCR under Scientific Collection Permit: P07/0142-4.0 (issued 27 August 2013) and under the GHD Animal Ethics Committee approvals process.

Boat electrofishing was conducted by Tropical River Consulting under the direction of GHD. Tropical River Consulting has constructed a Cairns Custom Craft 4.1 m commercially surveyed vessel, fitted out with Smith-Root electrofishing equipment.

For the boat electrofishing a generator was used to develop an electronic current which was rectified by a pulsator to produce a pulsed direct current waveform. The waveform was delivered to the water via large electrodes on booms at the front of the boat, thereby producing an electric field in the water. This electric field was used to immobilise fish so that they could be collected for identification, enumeration and measurement.

Sampling was undertaken on 8 November 2016 along six transects, as shown in Figure 4-4. Details of the electrofishing settings for each transect are provided in Table 4-5. Settings remained the same for sites, with the exception of transects 1 and 2 where the range settings were lower on account of the large numbers of small fish being caught in an effort to reduce the likelihood of mortality.

Standing timber, submerged timber, rocky outcrops and macrophyte beds were targeted during the survey as these habitat types are of high value to many fish species. Focusing on these high value habitats increases the likelihood of detection of targeted species. The areas sampled included varying depths from 1 m to 6 m depth and various lake profiles including the edge of submerged channels.

TCR is managed by the DPI as a trophy fishery and is regularly stocked with rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*), which were returned to the water along with any native fish which were collected.



Service Layer Credits: © Land and Property Information 2015

Paper Size A4
0 100 200 400
Metres
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

- ▭ Project application area
- Cox's River Water Supply Pipeline
- Watercourse - Non Perennial
- Watercourse - Perennial
- Transect 1
- Transect 2
- Transect 3
- Transect 4
- Transect 5
- Transect 6
- Brown trout (*Salmo trutta*)
- Rainbow trout (*Oncorhynchus mykiss*)



Centennial Coal
Amended EA/CEY Water Treatment Project
Water Resources Impact Assessment

Job Number | 21-25109
Revision | A
Date | 16 Nov 2016

Electrofishing survey transects

Figure 4-4

G:\22\0105001\GIS\Maps\Deliverables\Western\Springvale\2125109\TCR_Options\2125109_TCR005_Electrofishing_survey_A.mxd

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 T 61 2 4979 9999 F 61 2 4979 9988 E ntlmail@ghd.com W www.ghd.com.au

© 2016. Whilst every care has been taken to prepare this map, GHD, Geoscience Australia, Centennial Coal and NSW LPI make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: Aerial Imagery: Sixmaps (2016) NSW LPI, General Topo: NSW LPI DTDB 2012 and Geoscience Australia 250K Topo. Centennial: Site location, boundaries, pipeline; imagery, 2016. Created by: tmorton

Table 4-5 Electrofishing settings summary

Transect	Description	Electrofisher settings		
		Volts	Hertz	Range (%)
1	Dam wall	500	120	40
2	Spillway and Western Shore	500	120	40
3	Western Shore and Quarry	500	120	50
4	Eastern Shore corner	500	120	50
5	Eastern Shore	500	120	50
6	North-eastern corner	500	120	50

The first 20 specimens of each species caught at a given site were measured, while any other individuals of those species observed at that site were counted. Freshwater fish species captured were identified using Allen *et al.* (2002).

4.5 Stream health

The potential impacts of the amended Project on the stream health of Pipers Flat Creek were assessed by desktop review. The assessment of risk to stream health was based on the results of the water and salt balance assessment, surface water quality assessment and previous aquatic ecology assessments.

Existing conditions of the aquatic ecology of Pipers Flat Creek were established based on the autumn and spring 2015 aquatic ecology monitoring reports prepared for Western Coal Services by Marine Pollution Research Pty Ltd (MPR 2015; MPR 2016).

4.6 Downstream water users

The potential impacts of the amended Project on licensed surface water users and basic landholder rights under the WM Act were assessed by identifying the downstream users within the potential area of impact of the Coxs River catchment. Licensed surface water users and domestic and stock rights users with a water supply work approval were identified by searching for all lots within the potential area of impact in the *NSW Water Register* (DPI Water 2016).

5. Existing conditions

5.1 Water management

Make-up water for the cooling water system at MPPS is supplied from the following sources:

- Treated process wastewater stored on site.
- Coxs River via Lake Lyell and Thompsons Creek Reservoir.
- Fish River water supply scheme.

The majority of the make-up water used at MPPS has historically been sourced from the Coxs River. A system of storage dams, interconnecting pipelines and pumping stations exist to supply water to MPPS. Make-up water is pumped from Lake Lyell directly to the cooling water system or to TCR for storage. The current system provides the indirect reuse of mine water discharge from the SDWTS via LDP009 located upstream in the Coxs River catchment. EnergyAustralia is currently licensed to extract up to 23,000 ML/year from the Coxs River under WAL 27428.

The major water storages include:

- Lake Wallace (also referred to as the Wallerawang Reservoir) with a capacity of approximately 2,206 ML.
- Lake Lyell with a capacity of approximately 32,000 ML.
- TCR with a capacity of approximately 27,500 ML.

Additional details are provided in the following sections on Lake Wallace, Lake Lyell and TCR as part of the Coxs River water supply system for MPPS. Water management aspects of SCSS and MPPS facilities remain consistent with the previously assessed components of the EIS (GHD 2016a).

5.1.1 Thompsons Creek Reservoir

Overview

As noted in Section 1.1, the main function of TCR is to provide additional off-stream storage of water for MPPS to that provided by Lake Lyell on the Coxs River. Key points for the reservoir include (Aurecon 2016a):

- TCR has only a small catchment compared to its surface area. The reservoir has a catchment area of 8.9 km² (reservoir surface is approximately 20% of catchment) with minimal natural inflow.
- TCR is mainly filled by pumping from Lake Lyell pumping station via a surge tank above Lake Lyell, which feeds a gravity main to TCR.
- TCR comprises an earth-core, random rockfill embankment, with a vertical downstream chimney drain and a horizontal blanket filter. A selected finer near-vertical drain on the upstream side of the clay core was also provided to act as a filter transition zone to protect the core during drawdown.
- The maximum height of TCR above stripped foundation level is approximate 55 m with a nominal crest at 1,035 m AHD. The crest is approximately 1,910 m long.

- The flood spillway cuts through the ridge that forms the left abutment of TCR. The spillway crest is 100 m wide, grassed with a mass concrete sill at a crest level of 1,033.3 m AHD. Over a distance of 150 m, the spillway channel narrows to 10 m wide and then travels via a 5 m wide grass lined channel to a rock-fill gabion and mattress drop structure which dissipates flood flows.
- The full storage level, at 1,033.0 m AHD, is 0.3 m below the spillway invert. Because the dam was intended as off-line storage, to be filled mainly by pumping, the FSL was set below the invert, to allow for the full reservoir to hold rainfall inflows without spilling.
- A submerged inlet/outlet structure 11.6 m tall and fitted with trash racks was provided to serve as an inlet structure while the dam is being filled and as an outlet structure when water is being drawn from the reservoir to MPPS.
- Aurecon (2016a) assessed TCR as having a 'HIGH A' consequence category for both sunny day and flood conditions, with loss of life and damage and loss assessed to be MAJOR.

Current management practices of MPPS regulate TCR on a day-to-day basis, typically 0.3 m below the FSL (at 1,032.7 m AHD). This current operating level considers management requirements in addition to safety freeboard requirements between the FSL level and spillway crest.

Environmental flows

Statement of Approval 10CA117220 issued to EnergyAustralia for the Coxs River water supply system requires the daily release of water from TCR equal to or greater than 0.8 ML/day between 1 September and 30 April and equal to or greater than 0.3 ML/day between 1 May and 31 August. This occurs from TCR via dedicated riparian releases from a valve downstream of the dam wall, which is presented in Figure 5-1.

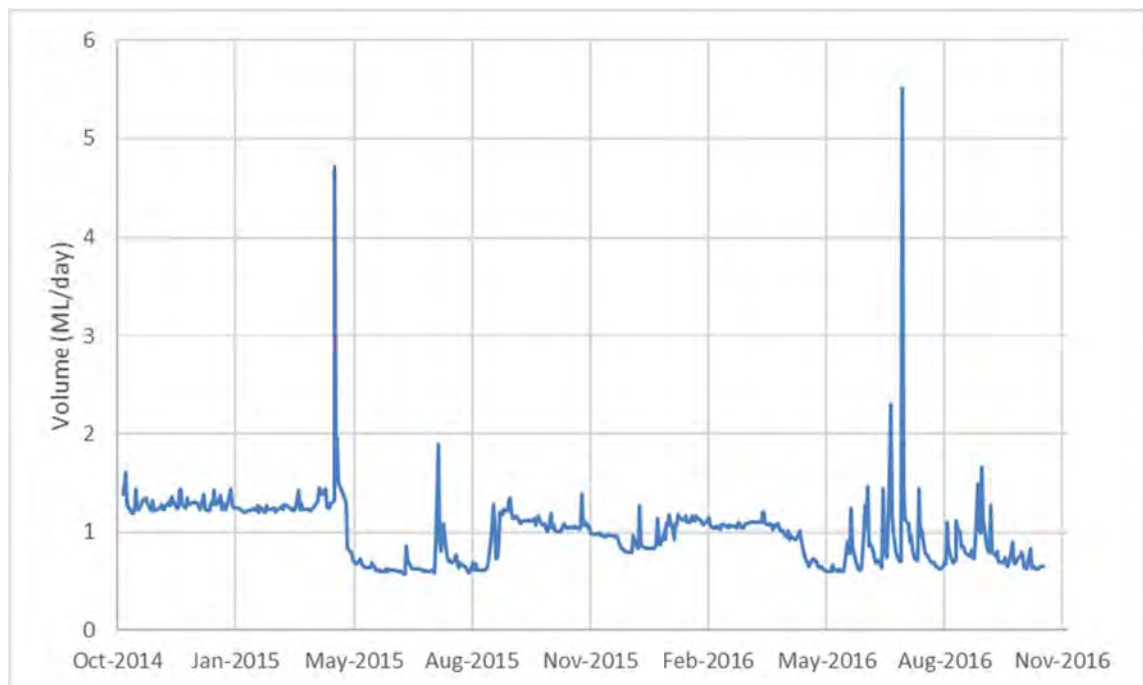


Figure 5-1 Environmental flow releases from Thompsons Creek Reservoir

The monitoring indicated in Figure 5-1 show three predominate discharge rates from the releases during 2014 to 2016. There was no clear correlation between water level within the reservoir and release rate, with some of the flow monitoring equipment influenced by rainfall (as shown with the spikes in Figure 5-1). A value of 1.0 ML/day was adopted for daily contribution to

Thompsons Creek via riparian releases from the reservoir wall as part of this assessment. This is above the minimum regulatory requirements set within the Statement of Approval 10CA117220.

Aeration

Aeration is undertaken on TCR from March to November. The reservoir is provided with an air bubble de-stratification system that effectively achieves vertical mixing of the water near the outlet of TCR. A small brick building on the crest of the storage houses a compressor which supplies air to an underwater perforated pipe. The bubbles released effectively de-stratify the water near the outlet of TCR.

Management of large rainfall events

TCR has not overtopped via its spillway historically. This is due to the active management of the water level within the reservoir and typically high water demands at MPPS over the last six years.

5.1.2 Lake Lyell

Overview

Lake Lyell (also known as Lilyvale Dam) is a concrete faced rock-fill dam located on the Coxs River, downstream of Lake Wallace. Key points for the dam include (Aurecon 2016b):

- Constructed in 1982 to supply cooling water for Wallerawang Power Station. Augmented in 1995 to increase storage capacity by 7,500 ML. Fusegate upgrade completed in 2002.
- Dam height of 50 m with a FSL of 785.41 m AHD (allows for approximately 33,836 ML of storage).
- Spillway from the dam is a concrete ogee crest approximately 40 m wide.
- The 2016 Lake Lyell dam surveillance report (Aurecon 2016b) assessed Lake Lyell as having a 'HIGH C' consequence category for both sunny day and flood conditions.
- Discharge from the dam is via an outlet tower fitted with five vertical openings allowing for level regulation within the dam. From the outlet water is either transferred to the MPPS water supply system or two riparian release pipelines.

Environmental flows

Statement of Approval 10CA117220 specifies the minimum release of water from Lake Lyell, depending on the total storage of Lake Wallace, Lake Lyell and TCR and on the daily inflows to Lake Lyell. Environmental flow releases over the last two years from Lake Lyell are presented in Figure 5-2.

Environmental flow releases from 2014 to 2016 have varied from 0 ML/day to 667 ML/day with an average of 21.7 ML/day. Three spikes observed within 2016 indicate periods of significant rainfall where the dam was being drawn down to reduce the operating level.

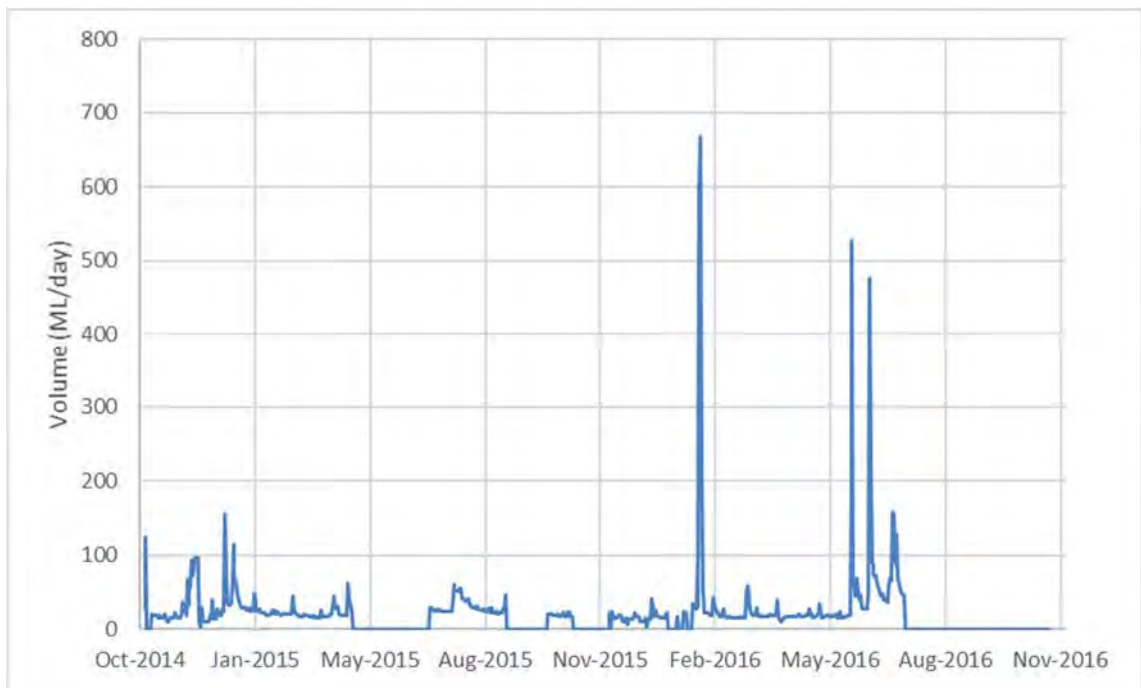


Figure 5-2 Environmental flow releases from Lake Lyell

Storage volume within Lake Lyell was extracted from weekly reporting undertaken by EnergyAustralia (2016). The results are presented in Figure 5-3 along with environmental inflow contribution also monitored by EnergyAustralia.

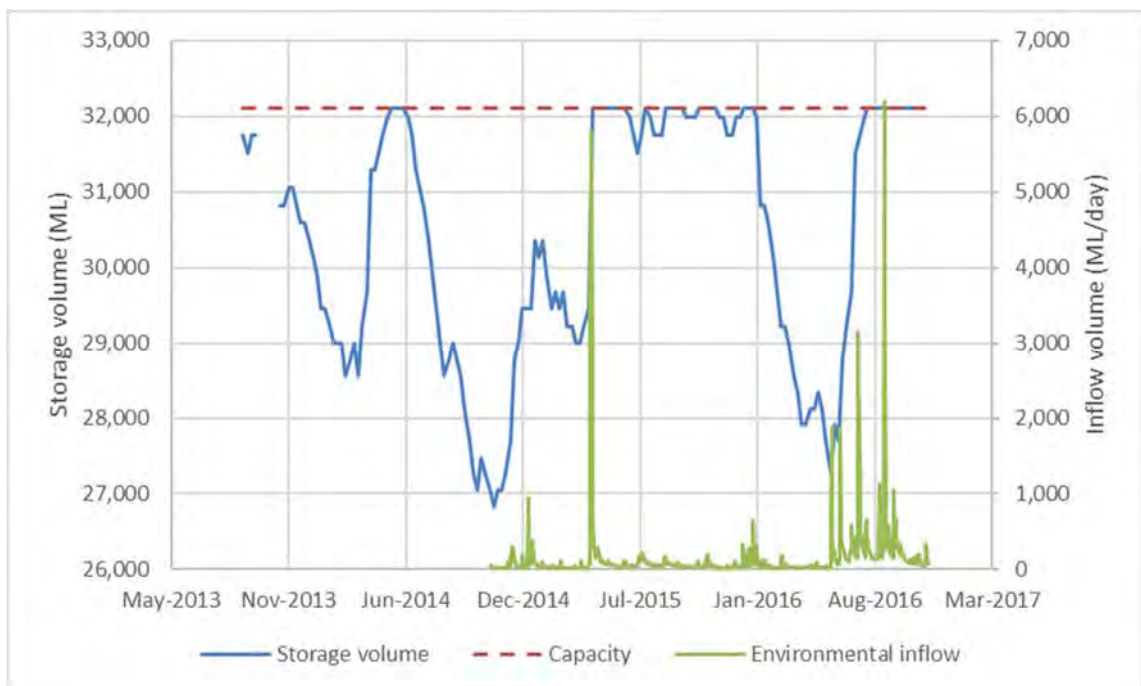


Figure 5-3 Lake Lyell storage volume and environmental inflows

5.1.3 Lake Wallace

Lake Wallace was constructed in the late 1970s and was built as part of the water supply system for power generation at Wallerawang Power Station. The lake has not been actively managed within the last two years of monitoring by EnergyAustralia (2016), as shown in Figure 5-4. This suggests that the storage is managed as a 'fill and spill' operation with no drawdown of the storage. With the closure of Wallerawang Power Station, the need to extract water from the lake has ceased and therefore the storage is maintained at levels above the full supply level of 2,206 ML.

Statement of Approval 10CA117220 specifies the daily release of water from Lake Wallace equal to or greater than 0.7 ML/day. This requirement, is being met currently as the operating level rarely fails below 100%.

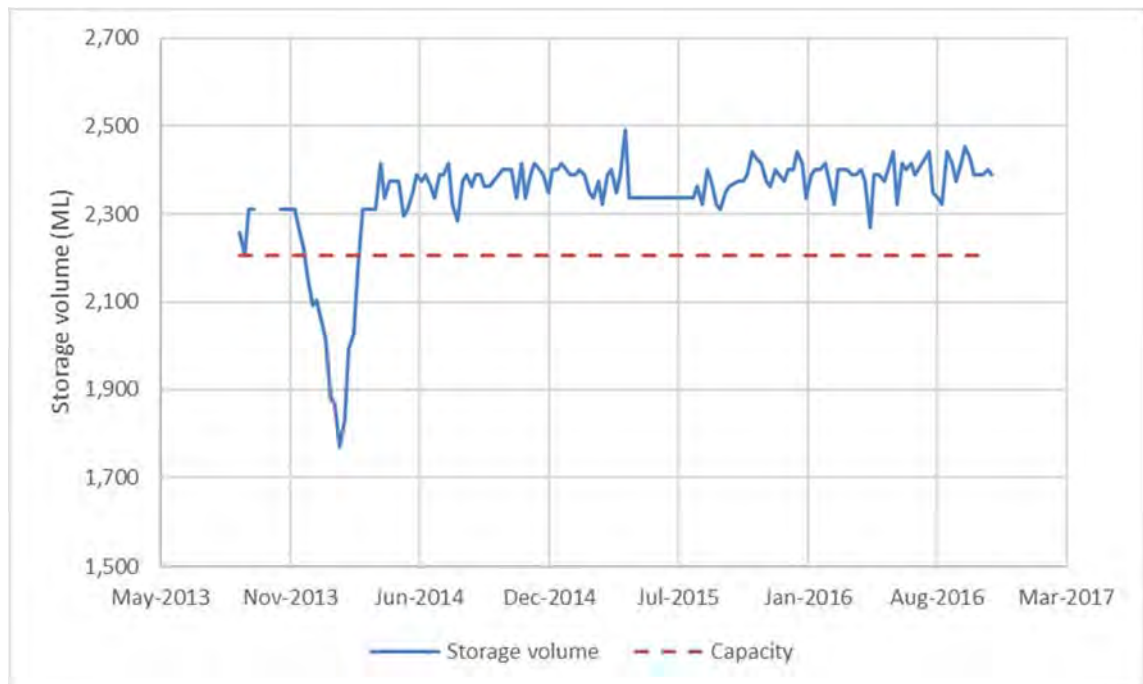


Figure 5-4 Lake Wallace storage volume

5.2 Water and salt balance assessment

5.2.1 Water balance results

The water cycle for the Cocks River catchment was modelled based on the current conditions in 2016, using a historical time series of daily rainfall data extending over 127 years. A total of 127 simulations were applied with each simulation modelling a different rainfall pattern (refer Section 4.2; GHD 2016a). As a result, 127 annual totals were available for each element within the water balance model, thereby representing a wide range of possible rainfall conditions.

Water balance modelling estimated the annual volumetric transfers between the water cycle components under existing conditions, as shown in Figure 5-5. These results are based on a 50% power generation requirement at MPPS. The results present the average annual transfers between water management elements as well as the 10th percentile and 90th percentile values. The purpose of displaying the three results for each water transfer is to show the average transfer volume and an indication of the range of values expected due to possible variation in rainfall.

The 10th percentile represents the value at which 10% of the modelled outputs were less than this value. Similarly, the 90th percentile represents the value at which 90% of the modelled outputs were less than this value. The 10th and 90th percentile values have been used (rather than minimum and maximum values) to remove the impact of skewing by infrequent to extreme wet and dry conditions.

From the results provided in Figure 5-5, average inputs and outputs were assessed for Wangcol Creek at the confluence with the Coxs River and for the Coxs River upstream of Lake Burragorang.

Wangcol Creek catchment

A summary of the average annual inputs and outputs for the water balance for the Wangcol Creek catchment under existing conditions in 2016 is presented in Table 5-1.

Table 5-1 Summary of average annual water inputs and outputs for Wangcol Creek catchment under existing conditions in 2016

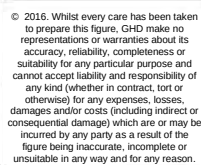
	Existing conditions (ML/year)
	50% power generation
INPUTS	
Catchment runoff	2,180.0
LDP discharge from SCSS (LDP006)	847.5
TOTAL INPUTS (rounded)	3,028
OUTPUTS	
Contribution to Coxs River	3,027.5
TOTAL OUTPUTS (rounded)	3,028
BALANCE	
Inputs – outputs	0

As seen in Table 5-1, the discharge from Wangcol Creek into the Coxs River was modelled to be approximately 3,028 ML/year on average. Catchment runoff into Wangcol Creek was estimated to be approximately 2,180 ML/year on average, which equates to 72% of the total flow to the confluence with the Coxs River. Discharges from the SCSS was estimated to contribute approximately 848 ML/year on average to the creek, equating to 28% of the total flow modelled.

Coxs River catchment

A summary of the average annual inputs and outputs for the water balance for the Coxs River catchment under existing conditions in 2016 is presented in Table 5-2.

As seen in Table 5-2, the largest source of water into the Coxs River catchment was rainfall onto surface water storages and catchment runoff, which accounted for approximately 131,923 ML/year on average, equating to 92% of the total inflows to the system. The second largest input under existing conditions was modelled to be associated with the mine water from Angus Place Colliery and Springvale Mine dewatered to the SDWTS. The inflow from the SDWTS of 7,968 ML/year, which was modelled to be discharged to Sawyers Swamp Creek via Springvale Mine's LDP009 under existing conditions, contributed approximately 6% of the total inflows to the system.



Annual water transfers
Existing conditions (2016)



Figure 5-5

Table 5-2 Summary of average annual water inputs and outputs for the Coxs River catchment under existing conditions in 2016

	Existing conditions (ML/year)
	50% power generation
INPUTS	
Direct rainfall onto storages and catchment runoff	131,923.2
Supply from Fish River water supply scheme to MPPS	0.0
Transfer from Clarence Colliery to Farmers Creek Dam	1,668.1
LDP discharge from Angus Place Colliery (LDP001)	732.7
LDP discharge from Angus Place Colliery (LDP002)	94.5
LDP discharge from Lidsdale Siding (LDP004)	9.2
LDP discharge from SCSS (LDP006)	847.5
LDP discharge from Springvale Mine (LDP001)	579.0
LDP discharge from Springvale Mine (LDP009)	7,968.3
TOTAL INPUTS (rounded)	143,822
OUTPUTS	
Evaporation	7,789.5
Additional make-up water used at MPPS*	10,156.5
Oakey Park WTP use	2,050.1
Contribution to Lake Burragorang	123,915.2
TOTAL OUTPUTS (rounded)	143,911
CHANGE IN STORAGE	
Farmers Creek Dam	0.8
Lake Lyell	-100.2
Lake Wallace	1.0
TCR	64.3
Sawyers Swamp Creek Ash Dam	-53.9
TOTAL CHANGE IN STORAGE (rounded)	-88
BALANCE	
Inputs –outputs – change in storage	-1

* Additional make-up water sourced from Coxs River via Lake Lyell and TCR.

The volume of make-up water used by MPPS in the cooling water system was modelled under existing conditions to be 10,157 ML/year with a 50% power generation requirement. This water was modelled to be supplied by the Coxs River via Lake Lyell and TCR and equates to 7% of the total inflows into the Coxs River catchment.

Under the existing conditions modelled, the total annual flow within the Coxs River upstream of Lake Burragorang was estimated to be approximately 123,915 ML/year on average. Of this, 7% on average was contributed by site-based discharges from Angus Place Colliery, Lidsdale Siding, the SCSS and Springvale Mine.

5.2.2 Salt balance results

Similar to the water balance, salt balance modelling provided 127 possible annual totals of salt transfers between the water cycle components of the Coxs River catchment under existing conditions, as shown in Figure 5-6. As with the water balance results, the salt balance results are based on a 50% power generation requirement at MPPS. The results present the average annual salt transfers as well as the 10th percentile and 90th percentile values to provide an indication of the range of values expected due to possible variation in rainfall. In addition to the salt transfer quantities, the average salinity of each transfer is also displayed on the figure.

Wangcol Creek catchment

A summary of the average annual inputs and outputs for the salt balance for the Wangcol Creek catchment under existing conditions in 2016 is presented in Table 5-3.

Table 5-3 Summary of average annual salt inputs and outputs for Wangcol Creek catchment under existing conditions in 2016

	Existing conditions (t/year) 50% power generation
INPUTS	
Catchment runoff	317.1
LDP discharge from SCSS (LDP006)	1,520.6
TOTAL INPUTS (rounded)	1,838
OUTPUTS	
Contribution to Coxs River	1,837.7
TOTAL OUTPUTS (rounded)	1,838
BALANCE	
Inputs – outputs	0

As shown in Table 5-3, the discharge from Wangcol Creek into the Coxs River was modelled to contribute approximately 1,838 t/year of salt on average. Although catchment runoff was the largest source of water into Wangcol Creek, it did not contribute a significant salt load. Salt associated with catchment runoff was estimated to be approximately 317 t/year on average, which equates to 17% of the total salt load of Wangcol Creek.

The major source of salt into Wangcol Creek was associated with the discharge from the SCSS via LDP006, which was predicted to contribute approximately 1,521 t/year on average, equating to 83% of the total salt load.

Coxs River catchment

A summary of the average annual inputs and outputs for the salt balance for the Coxs River catchment under existing conditions in 2016 is presented in Table 5-4.

Table 5-4 Summary of average annual salt inputs and outputs for the Coxs River catchment under existing conditions in 2016

	Existing conditions (t/year)
	50% power generation
INPUTS	
Direct rainfall onto storages and catchment runoff	9,521.3
Supply from Fish River water supply scheme to MPPS	0.0
Transfer from Clarence Colliery to Farmers Creek Dam	290.6
LDP discharge from Angus Place Colliery (LDP001)	387.6
LDP discharge from Angus Place Colliery (LDP002)	51.1
LDP discharge from Lidsdale Siding (LDP004)	4.8
LDP discharge from SCSS (LDP006)	1,520.6
LDP discharge from Springvale Mine (LDP001)	584.3
LDP discharge from Springvale Mine (LDP009)	6,246.3
TOTAL INPUTS (rounded)	18,607
OUTPUTS	
Additional make-up water used at MPPS*	4,010.8
Oakey Park WTP use	291.7
Contribution to Lake Burragorang	14,443.0
TOTAL OUTPUTS (rounded)	18,746
CHANGE IN STORAGE	
Farmers Creek Dam	0.1
Lake Lyell	-117.0
Lake Wallace	0.3
TCR	24.0
Sawyers Swamp Creek Ash Dam	-46.2
TOTAL CHANGE IN STORAGE (rounded)	-139
BALANCE	
Inputs – outputs – change in storage	0

* Additional make-up water sourced from Coxs River via Lake Lyell and TCR.

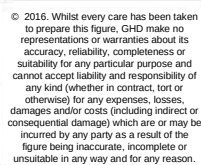


Figure 5-6

As shown in Table 5-4, the sources and sinks for the salt balance were broadly similar to the water balance. The largest source of salt into the Coxs River catchment was rainfall onto surface water storages and catchment runoff, which accounted for approximately 9,521 t/year on average. This equates to 51% of the total salt load input to the system. The average salinity of the total contribution of rainfall and runoff to the catchment was estimated to be approximately 110 $\mu\text{S}/\text{cm}$.

The second largest annual salt input under existing conditions was modelled to be associated with the mine water dewatered to the SDWTS that is currently discharged to Sawyers Swamp Creek via LDP009. This transfer was estimated to input 6,246 t/year of salt on average to the Coxs River catchment, which equates to 34% of the total salt inflows to the system. The average salinity of the discharge was estimated to be 1,170 $\mu\text{S}/\text{cm}$.

The salt load associated with make-up water used by MPPS with a 50% power generation requirement was predicted by the model to be approximately 4,011 t/year on average. This equates to 22% of the total salt inflows into the Coxs River catchment, which is essentially removed from the catchment. The average salinity of extractions from the Coxs River catchment to supply MPPS were modelled to be 590 $\mu\text{S}/\text{cm}$.

Salt associated with the total annual flow within the Coxs River upstream of Lake Burragorang was estimated to be approximately 14,443 t/year on average under existing conditions. Site-based discharges from Angus Place Colliery, Lidsdale Siding, the SCSS and Springvale Mine were modelled to contribute 61% of this total salt load on average.

5.3 Surface water quality

5.3.1 Thompsons Creek Reservoir

Surface water quality for TCR is presented in Table 5-5, including results from a site visit on 8 November 2016 and a statistical summary of the results of routine monitoring of TCR undertaken by EnergyAustralia. The DGVs recommended by ANZECC (2000) presented in Table 4-3 are also provided in Table 5-5 for comparative purposes. Time series graphs for selected water quality parameters are provided in Appendix C.

As Table 5-5 shows, the water stored in TCR is typically slightly alkaline, with a median pH of 8.4, with all pH results within the ANZECC (2000) DGVs. EC recorded within TCR consistently exceeded the ANZECC (2000) DGV of 350 $\mu\text{S}/\text{cm}$, with a median EC of 540 $\mu\text{S}/\text{cm}$. Results for TSS were generally below the ANZECC (2000) DGV of 25 mg/L, with two results exceeding the DGV. No exceedances of the ANZECC (2000) DGVs for nutrients, dissolved metals or total selenium were observed over the monitoring period between April 2014 and September 2016.

Table 5-5 Surface water quality in Thompsons Creek Reservoir

Parameter	Units	DGV (ANZECC 2000)	8 November 2016	Routine TCR monitoring			
				Count	Minimum	Median	Maximum
Physicochemical parameters							
EC	µS/cm	350	528	27	521	540	570
pH	pH unit	6.5–9.0	8.1	16	8.0	8.4	8.5
TSS	mg/L	25	<5	46	2	5	33
Nutrients							
Ammonia	mg/L	0.9	<0.01	46	0.01	0.01	0.03
Nitrate	mg/L	0.7	0.01	–	–	–	–
Nitrite	mg/L	–	0.02	–	–	–	–
Nitrite + nitrate	mg/L	–	0.03	–	–	–	–
Reactive phosphorus	mg/L	–	<0.01	–	–	–	–
Total Kjeldahl nitrogen (TKN)	mg/L	–	0.2	46	0.1	0.3	1.0
Total nitrogen	mg/L	0.25	0.2	46	0.1	0.3	1.0
Total phosphorus	mg/L	0.02	<0.01	46	0.01	0.01	0.02
Anions							
Alkalinity (total as CaCO ₃)	mg/L	–	115	27	97	124	159
Chloride	mg/L	–	16	27	17	18	20

Parameter	Units	DGV (ANZECC 2000)	8 November 2016	Routine TCR monitoring			
				Count	Minimum	Median	Maximum
Sulfate	mg/L	–	106	27	110	120	139
Cations							
Calcium	mg/L	–	16	27	15.4	17.2	20.6
Magnesium	mg/L	–	9	27	8.2	9.1	11.1
Potassium	mg/L	–	7	27	7.3	8.2	11.2
Sodium	mg/L	–	72	27	63.2	75.3	98.4
Hardness (total as CaCO ₃)	mg/L	–	77	27	70.8	77.0	86.5
Dissolved metals							
Aluminium	mg/L	0.055	<0.01	21	0.01	0.01	0.02
Arsenic	mg/L	0.024	<0.001	21	0.001	0.001	0.001
Boron	mg/L	0.37	0.08	21	0.07	0.09	0.12
Cadmium	mg/L	0.0002	<0.001	–	–	–	–
Chromium	mg/L	0.001	<0.001	–	–	–	–
Copper	mg/L	0.0014	<0.001	21	0.001	0.001	0.001
Iron	mg/L	0.3	<0.001	21	0.002	0.007	0.014
Lead	mg/L	0.0034	<0.001	–	–	–	–

Parameter	Units	DGV (ANZECC 2000)	8 November 2016	Routine TCR monitoring			
				Count	Minimum	Median	Maximum
Manganese	mg/L	1.9	<0.001	21	0.001	0.001	0.002
Mercury	mg/L	0.0006	<0.0001	–	–	–	–
Nickel	mg/L	0.011	0.001	21	0.001	0.001	0.002
Selenium	mg/L	–	<0.01	–	–	–	–
Vanadium	mg/L	–	<0.01	21	0.01	0.01	0.01
Zinc	mg/L	0.008	<0.005	21	0.005	0.005	0.007
Total metals							
Aluminium	mg/L	–	0.02	27	0.01	0.03	0.13
Arsenic	mg/L	–	<0.001	27	0.001	0.001	0.001
Barium	mg/L	–	–	27	0.021	0.023	0.026
Beryllium	mg/L	–	–	27	0.001	0.001	0.001
Boron	mg/L	–	0.11	27	0.08	0.10	0.12
Cadmium	mg/L	–	<0.001	27	0.0001	0.0001	0.0001
Chromium	mg/L	–	<0.001	27	0.001	0.001	0.001
Copper	mg/L	–	<0.001	27	0.001	0.001	0.005
Iron	mg/L	–	<0.05	27	0.008	0.023	0.079

Parameter	Units	DGV (ANZECC 2000)	8 November 2016	Routine TCR monitoring			
				Count	Minimum	Median	Maximum
Lead	mg/L	–	<0.001	27	0.001	0.001	0.001
Manganese	mg/L	–	0.003	27	0.001	0.003	0.061
Mercury	mg/L	–	<0.0001	–	–	–	–
Molybdenum	mg/L	–	–	27	0.004	0.005	0.007
Nickel	mg/L	–	0.001	27	0.001	0.001	0.003
Selenium	mg/L	0.11	<0.01	27	0.0002	0.0002	0.0006
Silver	mg/L	–	–	27	0.001	0.001	0.001
Vanadium	mg/L	–	<0.01	27	0.01	0.01	0.01
Zinc	mg/L	–	0.008	27	0.005	0.005	0.019
Other							
Dissolved organic carbon	mg/L	–	4	–	–	–	–
Fluoride	mg/L	–	–	27	0.244	0.320	0.488
Silica	mg/L	–	–	27	0.1	0.3	1.0

5.3.2 Thompsons Creek and Pipers Flat Creek

The surface water quality results obtained from the sampling of Thompsons Creek on 18 August 2016 and a statistical summary of the results of monitoring at Pipers Flat Creek are provided in Table 5-6. The DGVs recommended by ANZECC (2000) presented in Table 4-3 are also provided in Table 5-6 for comparative purposes. Time series graphs for selected water quality parameters for Pipers Flat Creek are provided in Appendix C.

As shown in Table 5-6, the EC recorded in Thompsons Creek indicates the influence of riparian flow from TCR on the water quality of the creek. It is evident that the natural contributions to Thompsons Creek are less saline than the water in TCR, with different dominant ion chemistry. Chloride, which is the most conservative of the major ions, was observed at a higher concentration in Thompsons Creek than in TCR, which indicates that a higher concentration of chloride is present in the surface water of Thompsons Creek catchment, despite the water being more chemically dilute. Other assumptions that can be drawn about the quality of Thompsons Creek water prior to mixing with riparian releases from TCR are that it has lower sulfate, sodium and potassium concentrations, and higher calcium and magnesium concentrations. No elevated concentrations of metals or nutrients were observed in the Thompsons Creek sample, however it is noted that concentrations of iron and manganese were observed to be significantly higher than those in TCR.

Both Thompsons Creek and Pipers Flat Creek are relatively saline for upland creeks in NSW, with EC results exceeding the ANZECC (2000) DGV of 350 $\mu\text{S}/\text{cm}$. Thompsons Creek is less saline due to lower concentrations of sodium and sulfate, however it has a higher pH due to its higher alkalinity. Thompsons Creek did not have metal or nutrient concentrations which exceeded the ANZECC (2000) DGVs. In the historical record for Pipers Flat Creek, occasional exceedances of the ANZECC (2000) DGVs were observed for manganese and iron.

Table 5-6 Surface water quality in Thompsons Creek and Pipers Flat Creek

Parameter	Units	DGV (ANZECC 2000)	Thompsons Creek 18 August 2016	Pipers Flat Creek			
				Count	Minimum	Median	Maximum
Physicochemical parameters							
EC	µS/cm	350	420	51	239	549	1,560
pH	pH unit	6.5–9.0	7.9	50	6.6	7.2	7.9
TSS	mg/L	25	–	49	1	5	16
Turbidity	NTU	25	–	34	2	5	48
Nutrients							
Ammonia	mg/L	0.9	0.01	–	–	–	–
Nitrate	mg/L	0.7	0.12	48	0.01	0.18	2.04
Nitrite	mg/L	–	–	47	0.01	0.01	0.3
Nitrite + nitrate	mg/L	–	–	47	0.01	0.19	2.04
Anions							
Alkalinity (total as CaCO ₃)	mg/L	–	120	49	50	100	275
Chloride	mg/L	–	27	49	10	35	97
Sulfate	mg/L	–	69	49	50	136	424
Cations							
Calcium	mg/L	–	36	49	23	38	64

Parameter	Units	DGV (ANZECC 2000)	Thompsons Creek 18 August 2016	Pipers Flat Creek			
				Count	Minimum	Median	Maximum
Magnesium	mg/L	–	17	48	11	21	37
Potassium	mg/L	–	3	49	4	6	19
Sodium	mg/L	–	22	49	13	47	274
Hardness (total as CaCO ₃)	mg/L	–	160	–	–	–	–
Dissolved metals							
Aluminium	mg/L	0.055	<0.05	–	–	–	–
Arsenic	mg/L	0.024	<0.001	–	–	–	–
Barium	mg/L	–	0.04	–	–	–	–
Beryllium	mg/L	–	<0.001	–	–	–	–
Boron	mg/L	0.37	<0.05	–	–	–	–
Cadmium	mg/L	0.0002	<0.0002	3	0.0001	0.0001	0.0001
Chromium	mg/L	0.001	<0.001	–	–	–	–
Cobalt	mg/L	0.0025	<0.001	–	–	–	–
Copper	mg/L	0.0014	<0.001	3	0.001	0.001	0.001
Iron	mg/L	0.3	0.13	47	0.05	0.15	2.05
Lead	mg/L	0.0034	<0.001	–	–	–	–

Parameter	Units	DGV (ANZECC 2000)	Thompsons Creek 18 August 2016	Pipers Flat Creek			
				Count	Minimum	Median	Maximum
Manganese	mg/L	1.9	0.058	47	0.001	0.169	3.39
Mercury	mg/L	0.0006	<0.0001	–	–	–	–
Molybdenum	mg/L	–	<0.005	–	–	–	–
Nickel	mg/L	0.011	<0.001	2	0.001	–	0.002
Selenium	mg/L	–	<0.001	–	–	–	–
Silver	mg/L	0.00005	<0.005	–	–	–	–
Strontium	mg/L	–	0.13	–	–	–	–
Vanadium	mg/L	–	<0.005	–	–	–	–
Zinc	mg/L	0.008	<0.001	–	–	–	–
Total metals							
Aluminium	mg/L	–	0.13	–	–	–	–
Arsenic	mg/L	–	<0.001	–	–	–	–
Barium	mg/L	–	0.05	–	–	–	–
Beryllium	mg/L	–	<0.001	–	–	–	–
Boron	mg/L	–	<0.05	–	–	–	–
Cadmium	mg/L	–	<0.0002	46	0.0001	0.0001	0.0062

Parameter	Units	DGV (ANZECC 2000)	Thompsons Creek 18 August 2016	Pipers Flat Creek			
				Count	Minimum	Median	Maximum
Chromium	mg/L	–	<0.001	–	–	–	–
Copper	mg/L	–	<0.001	46	0.001	0.002	0.022
Iron	mg/L	–	0.49	–	–	–	–
Lead	mg/L	–	<0.001	–	–	–	–
Manganese	mg/L	–	0.13	–	–	–	–
Mercury	mg/L	–	<0.0001	–	–	–	–
Molybdenum	mg/L	–	<0.005	–	–	–	–
Nickel	mg/L	–	<0.001	46	0.001	0.003	0.008
Selenium	mg/L	0.11	<0.001	–	–	–	–
Silver	mg/L	–	<0.005	–	–	–	–
Strontium	mg/L	–	0.13	–	–	–	–
Vanadium	mg/L	–	<0.005	–	–	–	–
Zinc	mg/L	–	<0.001	–	–	–	–

5.4 Fish community

Boat-mounted electrofishing was conducted successfully at each of the six transects on TCR. The transects in which each species was recorded are presented in Table 5-7 and a full list of species counts and measurements is presented in Appendix C. Three fish species were caught during the surveys including one native, as shown in Figure 5-7, and two exotic species, as shown in Figure 5-8 and Figure 5-9. As trout are stocked within the dam for recreational purposes, they were returned to the water after being identified and measured. There were no mortalities as a result of electrofishing activities.

Fish habitat within the dam was considered best for trout species along the eastern shore, as shown in Figure 5-10, where a shallow edge dropped off sharply to water around 3 m deep. Rocky outcrops were also prevalent along the eastern shore. On the western shore trout habitat was restricted to deeper sections where steep, rocky drop-offs were also present. The quarry, a deeper pool surrounded by shallow mud, standing timber and overhanging vegetation provided cover and potential food for trout species. Flathead gudgeons were found in greater numbers around large boulders (such as along the dam wall) and in trailing vegetation. They were found in every transect except Transect 3 (the quarry), where little habitat existed for evading feeding trout.

Table 5-7 Fish species collected in Thompsons Creek Reservoir during survey

Scientific name	Common name	Collected in transect					
		1	2	3	4	5	6
Native species							
<i>Philypnodon grandiceps</i>	Flathead gudgeon	✓	✓		✓	✓	✓
Exotic species							
<i>Oncorhynchus mykiss</i>	Rainbow trout			✓		✓	
<i>Salmo trutta</i>	Brown trout			✓	✓	✓	



Figure 5-7 Flathead Gudgeon (*Philypnodon grandiceps*)



Figure 5-8 Brown Trout (*Salmo trutta*)



Figure 5-9 Rainbow Trout (*Oncorhynchus mykiss*)



Figure 5-10 Eastern shore of Thompsons Creek Reservoir

5.5 Stream health

MPR (2015) and MPR (2016) reported that Pipers Flat Creek upstream (PFup) had fair habitat condition due to the continuity of the riparian corridor and the sequencing of pools and riffles in the creek. However, the riparian vegetation at the site was dominated by exotic species including willows (*Salix* spp.) and blackberry (*Rubus fruticosus* agg.). The average SIGNAL-2 (Stream Invertebrate Grade Number Average Level) (Chessman 2003) scores for the site were 3.39 in autumn 2015 and 3.13 in spring 2015, indicating that the macroinvertebrate community at the site was impaired, with the species present tolerant of pollution.

The fish species flathead gudgeon and eastern gambusia (*Gambusia holbrooki*) have been observed in Pipers Flat Creek by MPR.

5.6 Downstream water users

Land use surrounding the Project includes rural residential, grazing land, coal mining, power generation, commercial forestry, recreation activities and nature conservation. Water to supply these various activities is drawn from a range of sources, including extraction from watercourses. The major surface resource in the region surrounding the Project is the Coxs River. Surface water use in the Coxs River catchment also includes supply for power generation activities at MPPS.

The Coxs River ultimately flows into Lake Burragorang which is impounded by Warragamba Dam. This dam is the primary reservoir for drinking water in Sydney, supplying more than 3.7 million people living in Sydney and the lower Blue Mountains. WaterNSW is responsible for the management of the drinking water catchment, including the Coxs River catchment, to ensure a reliable supply of raw water of suitable quality.

Licensed surface water users were identified by searching the *NSW Water Register* (DPI Water 2016) within the Coxs River catchment that may potentially be impacted by the amended Project. Based on the search of allotments, WALs were identified for surface water use, with details provided in Table 5-8 and locations presented in Figure 5-11. Note that Figure 5-11 does not show Lake Burragorang, which is located approximately 70 km from the amended Project.

WAL 25659 was identified within the upstream catchment of Pipers Flat Creek, believed to be associated with Pipers Flat Dam, which is owned by Centennial. This is understood to be connected with the Ivanhoe Operations which components are no longer operational or are in care and maintenance. As this allocation and infrastructure is located upstream of any potential influence from the amended Project it was not considered.

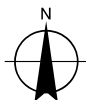
Table 5-8 Identified downstream water users

Licence number	Location	Use category	Share component
WAL 25607	Coxs River upstream of Lake Wallace	Irrigation	10 ML/year
WAL 27428	Lake Wallace, Lake Lyell and TCR	Major utility (power generation)	25,000 ML/year
WAL 27431	Lake Burragorang	Major utility (urban water)	620,000 ML/year



Service Layer Credits: © Land and Property Information 2015

Paper Size A4
0 1,050 2,100 4,200
Metres
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

- Project application area (representative)
- Waterbody
- Watercourse - Non Perennial
- Watercourse - Perennial
- Surface water licenses



Centennial Coal
Amended EAVCEY Water Treatment Project
Water Resources Impact Assessment

Job Number 21-25109
Revision A
Date 16 Nov 2016

Licensed surface water users

Figure 5-11

6. Impact assessment

6.1 Proposed water management

6.1.1 Overview

The amended Project proposes to utilise TCR for the transfer of any excess treated water not immediately required for use within the MPPS cooling water system. The existing water supply infrastructure allows for excess water to be transferred from MPPS to TCR as required. The existing system is proposed to be upgraded as part of the amended Project, supported by increased pumping capacity.

The amended Project also proposes to utilise the existing Valve House to regulate flows between MPPS, Lake Lyell and TCR. A new transfer pipeline will be required between the proposed WTP and the existing TCR supply pipeline. Infrastructure at the pipeline junction would comprise of a flow meter, a tap point for sampling and a series of in-line water quality monitoring devices for field parameters such as pH and EC.

Figure 6-1 presents the existing water supply system with the proposed amended Project shown as orange. The amended Project seeks to implement a closed loop for reuse of treated water.

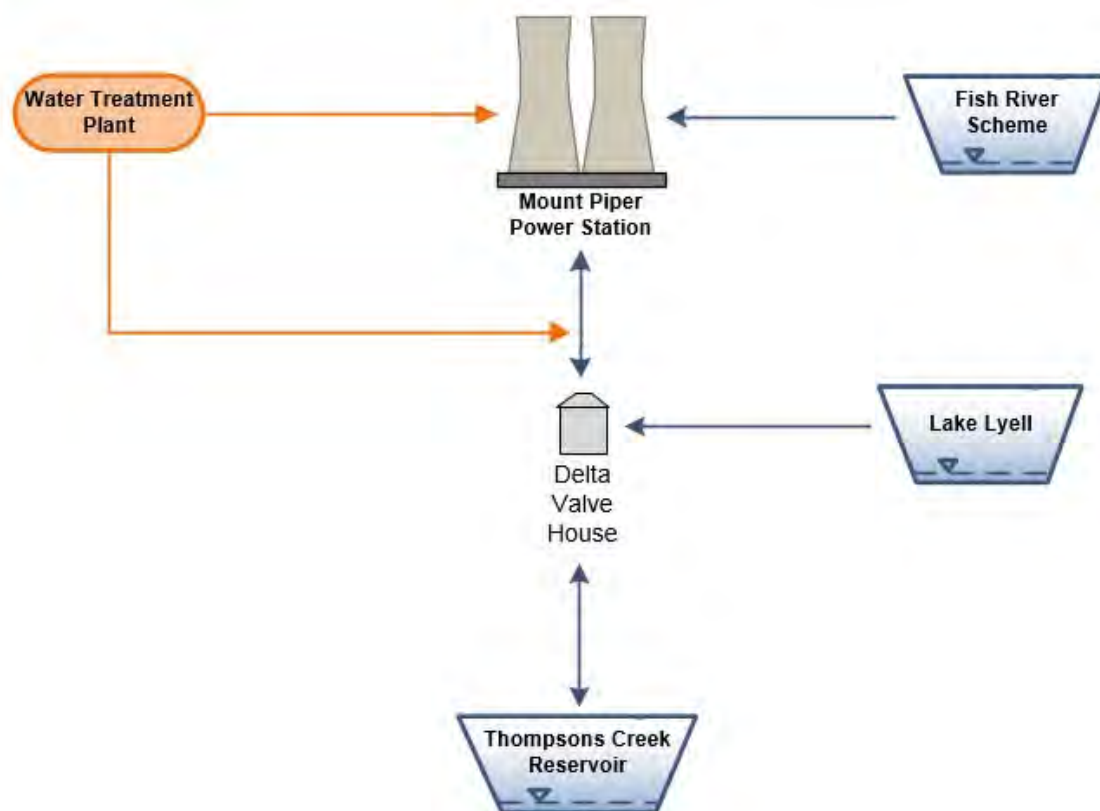


Figure 6-1 Proposed modifications to the water supply system of Thompsons Creek Reservoir

The proposed WTP has a design capacity of 42 ML/day; however, the supply from the SDWTS is predicted to be up to approximately 36.1 ML/day (refer Section 4.2.1). The increase in capacity at the proposed WTP will provide additional contingency to ensure the treatment of all incoming flow volumes.

6.1.2 Modification in operating level of Thompsons Creek Reservoir

In order to determine the potential change in the operating level of TCR, an assessment was undertaken for both an environmental and operational assessment. Environmental assessment modelling (considering supply of up to 36.1 ML/day from the SDWTS, as discussed in Section 4.2.1) as well as operational assessment modelling (considering MPPS shutdown periods of five and ten days and emergency storage of the maximum treatment capacity of 42 ML/day) was undertaken.

As discussed in Section 5.1.1, TCR is currently managed with an operating level of 1,032.7 m AHD, 0.3 m below the FSL. The amended Project proposes to lower the operating level to manage:

- Periods of reduced water demand from MPPS coinciding with increased treatment volumes from the SDWTS and proposed WTP (the assessment of 0% to 100% power generation scenarios).
- Emergency disposal of excess treated water, which may happen on any given day with minimal notice (the assessment of five and ten day shutdown periods for MPPS).

The proposed approach for drawing down TCR to ensure there is sufficient storage capacity within the reservoir include make-up water supplied to MPPS, seepage through the dam wall, riparian release, evaporation from the surface of TCR, release to Pipers Flat Creek via a discharge valve.

Seepage, riparian flow and evaporation from TCR are not significant outputs from the reservoir. During periods of low to zero water demand from MPPS, either discharges via the Pipers Flat Creek or transfers to Lake Wallace may be required. A contingency measure for the operation of the amended Project is have excess water volumes transferred to Lake Wallace. This is primarily due to minimal use of the Pipers Flat Creek relief discharge valve from TCR historically. If the Project is expected to increase discharges from Lake Wallace to the Coxs River, both the infrastructure for releases from the lake and the river itself has sufficient capacity to manage the potential volume of water directed to the lake by the Project. The amended Project estimates an available lead time of at least two years before this would be required.

6.2 Water and salt balance assessment

The water balance model was developed to represent the water cycle under proposed conditions based on the water management strategy presented in Section 6.1. Annual transfers and monthly average time series results from the water and salt balance model are presented in the following sections for the do nothing scenario (50% power generation requirement) and Scenario 3 (50% power generation requirement). Results for the remaining proposed scenarios modelled are presented in Appendix B. Note that results are indicative only as water demands at MPPS vary daily with power generation requirements.

It should be noted that the groundwater inflows into the active underground workings of Angus Place Colliery and Springvale Mine, which are transferred to the SDWTS, are predicted to vary over time, as shown in Figure 4-2. The results are presented for the proposed conditions are based on the predicted conditions in 2031. This year was chosen as it is when groundwater inflows, and the inflows to the SDWTS, are predicted to peak (refer Section 4.2.1) and the Coxs River catchment system will be the most different compared to the existing conditions.

Slight differences in some components of the modelling output between the existing conditions in 2016 and the proposed conditions in 2031 are attributed to 2016 being a leap year (i.e. 366 days available) and 2031 not being a leap year (i.e. 365 days available). Therefore, an extra day of simulation is represented in the results for existing conditions compared to proposed conditions.

6.2.1 Water balance results

Annual results

The predicted annual values for each of the water transfers within the Coxs River catchment for proposed conditions in 2031 are provided in Figure 6-2 and Figure 6-3 for the do nothing scenario (50% power generation requirement) and Scenario 3 (50% power generation requirement) respectively. The results present the average annual transfers between the elements of the water cycle as well as an indication of the range of values expected due to possible variations in rainfall.

Wangcol Creek catchment

A summary of the average annual inputs and outputs for the water balance for the Wangcol Creek catchment under proposed conditions in 2031 for all scenarios is presented in Table 6-1

As shown in Table 6-1, the Project was predicted to result in an increase in the discharge from Wangcol Creek into the Coxs River due to discharges from LDP006 for all of the modelled Project scenarios. The increase in LDP006 discharge from the SCSS was associated with the transfer of residual material from the Project to the existing reject emplacement area (REA) at the SCSS at a rate of 0.43 ML/day. This transfer was predicted to increase discharges to Wangcol Creek by approximately 128 ML/year on average, compared to the do nothing scenario.

Previously, the increase in LDP006 discharges as a result of the Project was predicted to be approximately 63 ML/year (GHD 2016a). The change in this value has occurred as a result of the updated detailed water and salt balance model for SCSS (refer Section 4.2.1). Further refinement of this model, in particular modelling of the high connectivity between the REA and groundwater system, has resulted in additional water contributing to LDP006 via Cooks Dam with less opportunity for water entrained in the residuals and tailings to be evaporated.

The total annual flow from Wangcol Creek to the Coxs River was modelled to be approximately 3,093 ML/year for all Project scenarios on average, compared to a flow of approximately 2,965 ML/year on average for the do nothing scenario. Discharges from the SCSS via LDP006 as a result of the Project were predicted to contribute approximately 18% of the total flow within Wangcol Creek.

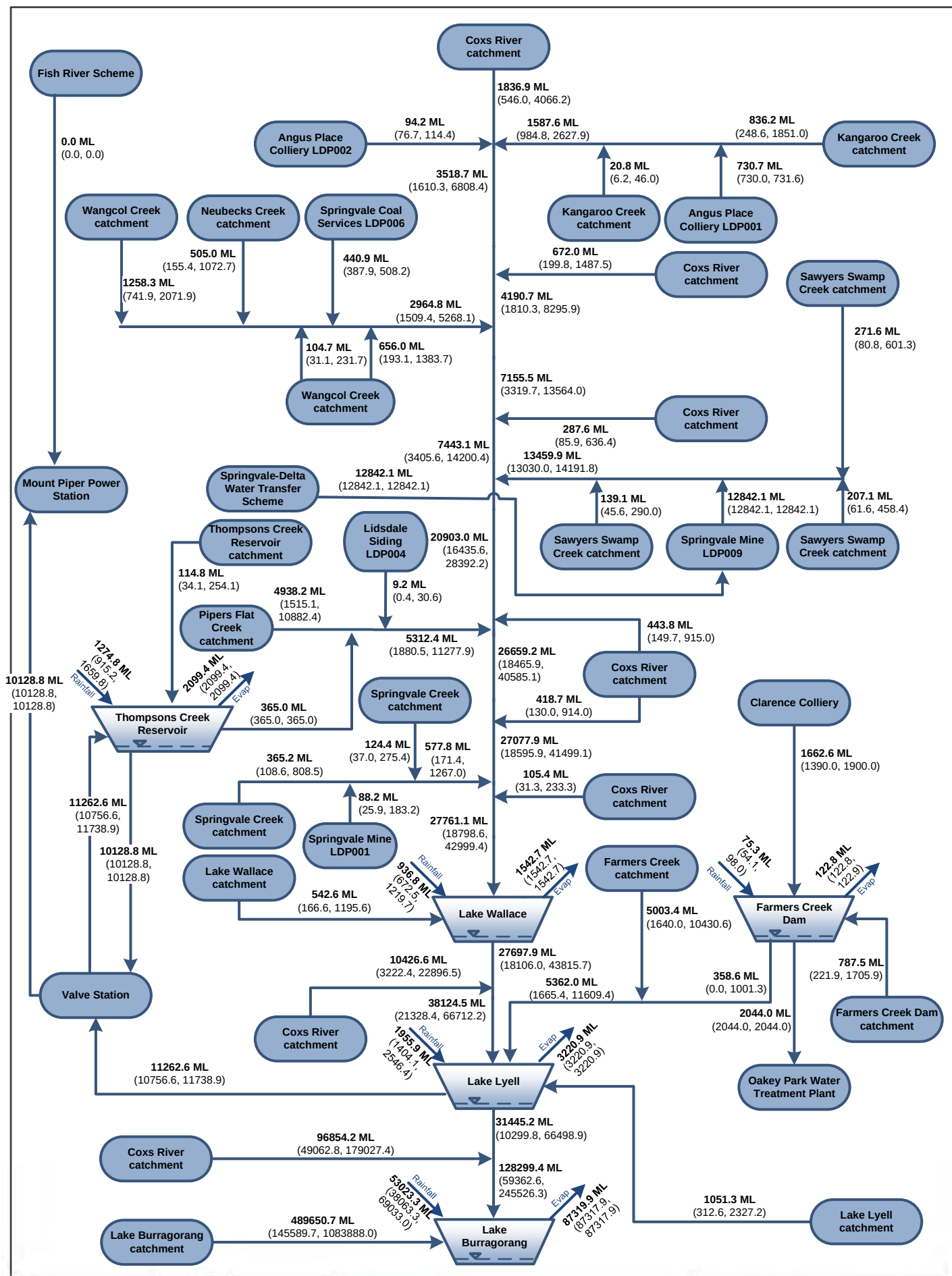
Coxs River catchment

A summary of the average annual inputs and outputs for the water balance for the Coxs River catchment under proposed conditions in 2031 for all scenarios is presented in Table 6-2.

As with existing conditions, the largest source of water into the Coxs River catchment was associated with rainfall onto surface water storages and catchment runoff, which accounted for approximately 132,214 ML/year on average, equating to between 89% (do nothing scenario) and 98% (scenarios 4 and 5) of the total inflows to the system. The second largest input was modelled to be associated with the transfer from MPPS to TCR for scenarios 1 and 2; transfers from Clarence Colliery into the catchment for scenarios 3, 4 and 5; and discharges from LDP009 for the do nothing scenario.

The volume of make-up water used by MPPS in the cooling water system, in addition to the water supplied by the Project, varied with scenario modelled. No additional water was required

for scenarios 1, 2 and 3, with all make-up water required at MPPS supplied by the Project. A volume of 3,898 ML/year was modelled to be supplied from the Coxs River in Scenario 4, which increased to 8,962 ML/year for Scenario 5 supplied from the Coxs River catchment.



© 2016. Whilst every care has been taken to prepare this figure, GHD make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the figure being inaccurate, incomplete or unsuitable in any way and for any reason.

LOCATION	Cocks River
SEAM	NA
DRAWN	SM
CHECKED	TD
APPROVED	LH
SCALE	NTS



Amended Springvale Water Treatment Project
Water Resources Impact Assessment

Annual water transfers
Proposed conditions (2031)
Do nothing scenario



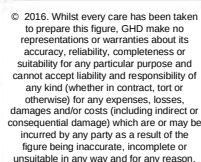
Centennial Coal



EnergyAustralia

DATE Dec 2016

Figure 6-2



Annual water transfers
Proposed conditions (2031)
Scenario 3



Figure 6-3

Table 6-1 Summary of average water inputs and outputs for Wangcol Creek catchment under proposed conditions in 2031

	Scenario 1 (ML/year)	Scenario 2 (ML/year)	Scenario 3 (ML/year)	Scenario 4 (ML/year)	Scenario 5 (ML/year)	Do nothing scenario (ML/year)
	0% power generation	25% power generation	50% power generation	75% power generation	100% power generation	50% power generation
INPUTS						
Catchment runoff	2,524.0	2,524.0	2,524.0	2,524.0	2,524.0	2,524.0
LDP discharge from SCSS (LDP006)	568.6	568.6	568.6	568.6	568.6	440.9
TOTAL INPUTS (rounded)	3,093	3,093	3,093	3,093	3,093	2,965
OUTPUTS						
Contribution to Coxs River	3,092.6	3,092.6	3,092.6	3,092.6	3,092.6	2,964.8
TOTAL OUTPUTS (rounded)	3,093	3,093	3,093	3,093	3,093	2,965
BALANCE						
Inputs – outputs	0	0	0	0	0	0

Table 6-2 Summary of average water inputs and outputs for Coxs River catchment under proposed conditions in 2031

	Scenario 1 (ML/year)	Scenario 2 (ML/year)	Scenario 3 (ML/year)	Scenario 4 (ML/year)	Scenario 5 (ML/year)	Do nothing scenario ^a (ML/year)
	0% power generation	25% power generation	50% power generation	75% power generation	100% power generation	50% power generation
INPUTS						
Direct rainfall onto storages and catchment runoff	132,214.2	132,214.2	132,214.2	132,214.2	132,214.2	132,214.2
Supply from Fish River water supply scheme to MPPS	0.0	0.0	0.0	0.0	0.0	0.0
Transfer from Clarence Colliery to Farmers Creek Dam	1,662.6	1,662.6	1,662.6	1,662.6	1,662.6	1,662.6
LDP discharge from Angus Place Colliery (LDP001)	730.7	730.7	730.7	730.7	730.7	730.7
LDP discharge from Angus Place Colliery (LDP002)	94.2	94.2	94.2	94.2	94.2	94.2
LDP discharge from Lidsdale Siding (LDP004)	9.2	9.2	9.2	9.2	9.2	9.2
LDP discharge from SCSS (LDP006)	568.6	568.6	568.6	568.6	568.6	440.9
LDP discharge from Springvale Mine (LDP001)	88.2	88.2	88.2	88.2	88.2	88.2
LDP discharge from Springvale Mine (LDP009)	0.0	0.0	0.0	0.0	0.0	12,842.1
Transfer from MPPS to TCR	11,295.5	6,231.1	1,166.8	0.0	0.0	0.0
TOTAL INPUTS (rounded)	146,663	141,599	136,535	135,368	135,368	148,082
OUTPUTS						
Evaporation	6,985.9	6,985.9	6,985.9	6,985.9	6,985.9	6,985.9

	Scenario 1 (ML/year)	Scenario 2 (ML/year)	Scenario 3 (ML/year)	Scenario 4 (ML/year)	Scenario 5 (ML/year)	Do nothing scenario ^a (ML/year)
	0% power generation	25% power generation	50% power generation	75% power generation	100% power generation	50% power generation
Additional make-up water used at MPPS ^b	0.0	0.0	0.0	3,897.6	8,962.0	10,128.8
Oakey Park WTP use	2,044.0	2,044.0	2,044.0	2,044.0	2,044.0	2,044.0
Contribution to Lake Burragorang	137,625.2	127,150.6	126,818.6	121,089.5	115,409.8	128,299.4
TOTAL OUTPUTS (rounded)	146,655	136,181	135,849	134,017	133,402	147,458
CHANGE IN STORAGE						
Farmers Creek Dam	0.0	0.0	0.0	0.0	0.0	0.0
Lake Lyell	-13.9	262.0	315.1	1,292.0	1,689.0	565.0
Lake Wallace	-7.1	-0.1	-0.1	-0.2	-0.1	-0.1
TCR	29.1	5,156.3	370.9	58.9	277.1	59.0
TOTAL CHANGE IN STORAGE (rounded)	8	5,418	686	1,351	1,966	624
BALANCE						
Inputs – outputs – change in storage	0	0	-1	0	0	0

^a In the do nothing scenario, inputs from the SDWTS are discharged to Sawyers Swamp Creek via Springvale Mine's LDP009.

^b Additional make-up water required in addition to the supply from the Project.

Under the proposed conditions, the total annual flow within the Coxs River upstream of Lake Burragorang varied with the power generation requirement at MPPS modelled, with additional flow available for lower power generation scenarios. Flow was estimated to range from approximately 115,410 ML/year for Scenario 5 to 137,625 ML/year for Scenario 1 on average. For the do nothing scenario, with a 50% power generation requirement and all water within the SDWTS modelled to be discharged via LDP009, the flow within the Coxs River was predicted to be approximately 128,299 ML/year on average.

Site-based discharges from Angus Place Colliery, Lidsdale Siding, the SCSS and Springvale Mine as well as Project transfers from MPPS to TCR, were estimated to contribute between approximately 1,491 ML/year, for scenarios 4 and 5, and approximately 12,786 ML/year, for Scenario 1, to the Coxs River catchment on average. This equates to between 1%, for scenarios 4 and 5, and 9%, for Scenario 1, of the total annual inflow to the Coxs River catchment.

The change in storage modelled for Lake Lyell and TCR was less than 20% of the total capacity for all scenarios. It should be noted that a simple linear correlation cannot be inferred between scenarios modelled and the change in storage presented in Table 6-2. This is due to the complex relationship between the power generation requirement at MPPS, the operation of Lake Lyell and TCR (particularly the operational level of TCR) and discharges via LDP009. Further detail on the annual transfers between modelled components is provided within Appendix B. How releases to TCR are managed with respect to each scenario are further discussed within Section 6.2.3.

Time series results

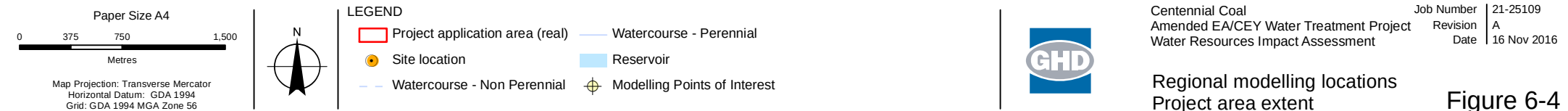
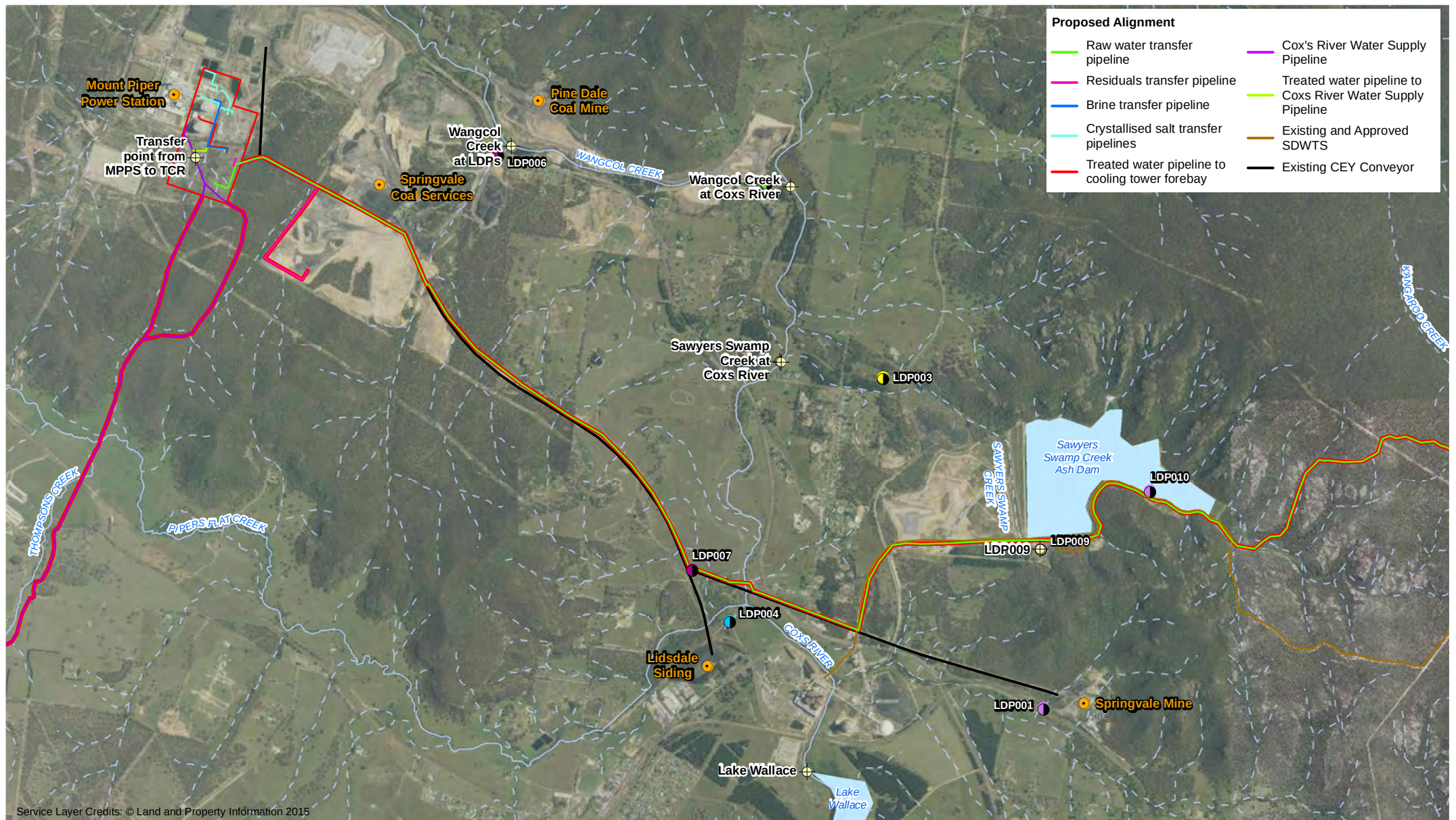
Monthly average time series results of flow are presented for the do nothing scenario (50% power generation requirement) and Scenario 3 (50% power generation requirement) for the following locations in the Coxs River catchment, as shown in Figure 6-4 and Figure 6-5. Note that the results for LDP009 discharges to Sawyers Swamp Creek and for Sawyers Swamp Creek at the confluence with the Coxs River have not changed as a result of the amended Project. Refer to the original WRIA (GHD 2016a) for these results.

- Wangcol Creek at the confluence with the discharge from LDP006 from the SCSS.
- Wangcol Creek at the confluence with the Coxs River.
- Transfers from MPPS to TCR (Scenario 3 only).
- Coxs River at the inflow to Lake Wallace.
- Coxs River at the inflow to Lake Lyell.
- Coxs River at the inflow to Lake Burragorang.

Note that for the do nothing scenario, it was assumed in the water balance model that the Project would not be developed. As such, there were no transfers predicted from MPPS to TCR.

A seasonal pattern can be seen in the time series results, corresponding to the pattern found in the rainfall and evaporation data used as inputs into the water and salt balance.

Time series results for scenarios 1, 2, 4 and 5 are provided in Appendix B.

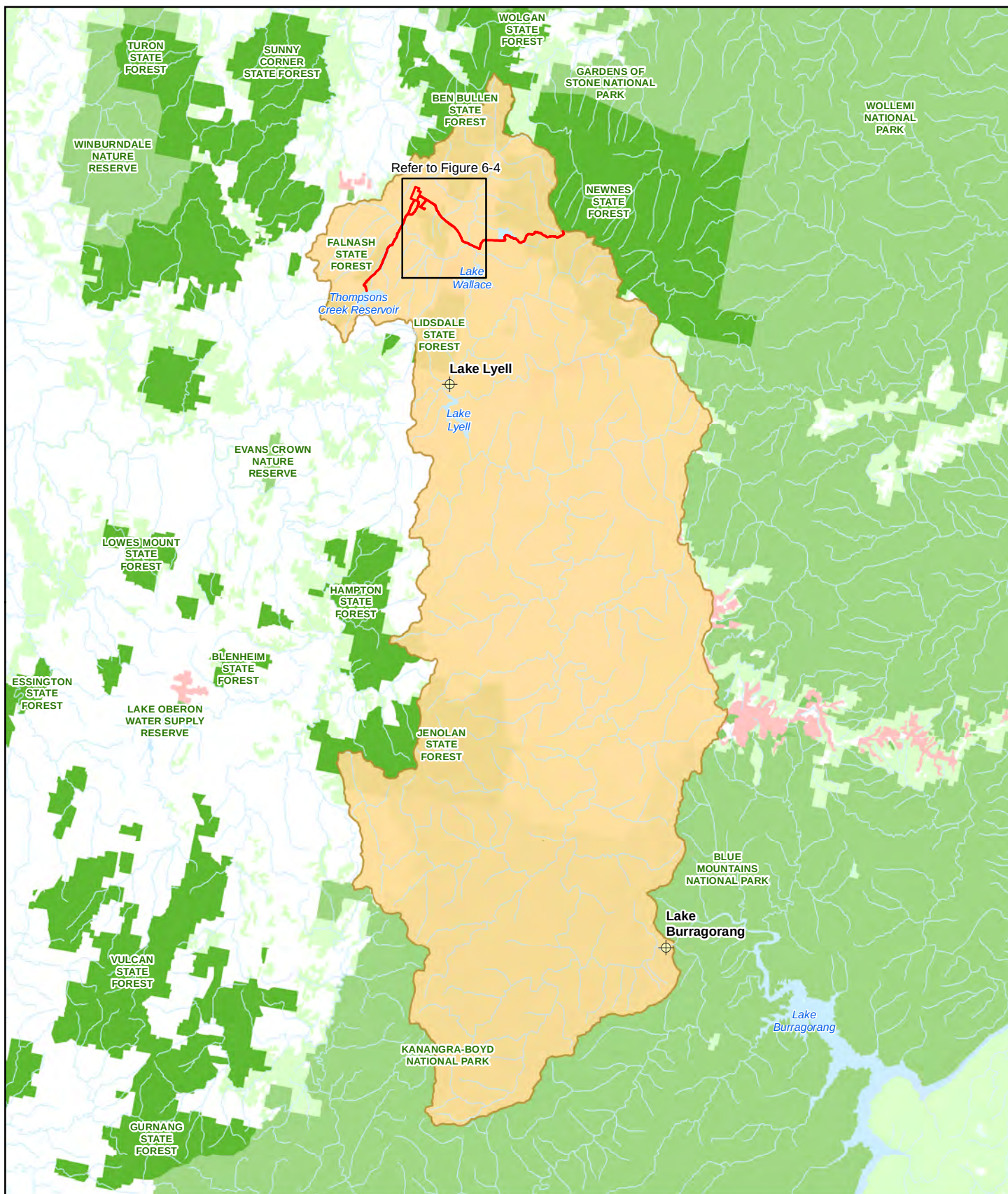


G:\22\0105001\GIS\Maps\Deliverables\Western\Springvale\2125109\TCR_Options\2125109_TCR007_Regionalmodelling_projectextent_A.mxd

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 T 61 2 4979 9999 F 61 2 4979 9988 E ntlmail@ghd.com W www.ghd.com.au

© 2016. Whilst every care has been taken to prepare this map, GHD, NSW Land and Property Information, and Commonwealth of Australia (Geoscience Australia) make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

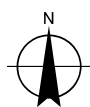
Data source: Aerial Imagery: Sixmaps (2016) NSW LPI, General Topo: NSW LPI DTDB 2012 and Geoscience Australia 250K Topo; Centennial: Site location, boundaries, monitoring, alignment, imagery, 2016. Created by: tmorton



LEGEND

- | | | |
|---|---|--|
| Project application area | Waterway | Recreation area |
| Cocks River Catchment | Waterbody | Nature Conservation |
| Modelling Points of Interest | Built up area | State Forest |
| | | Forest or shrub |

Paper Size A4
 0 4 8 16
 Kilometres
 Map Projection: Transverse Mercator
 Horizontal Datum: GDA 1994
 Grid: GDA 1994 MGA Zone 55



Centennial Coal
 Amended EA/CEY Water Treatment Project
 Water Resources Impact Assessment

Job Number 21-25109
 Revision A
 Date 16 Nov 2016

Regional modelling locations
 Regional extent

Figure 6-5

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 T 61 2 4979 9999 F 61 2 4979 9988 E ntlmail@ghd.com W www.ghd.com.au
 G:\22\10105001\GIS\Maps\Deliverables\Western\Springvale\2125109\TCR_Options\2125109_TCR006_Regionalmodelling_Regionalextent_A.mxd

© 2016. Whilst every care has been taken to prepare this map, GHD and Geoscience Australia make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: Commonwealth of Australia (Geoscience Australia); 250K Topographic Data Series, 2006; Centennial: Boundaries, monitoring, 2016. Created by: tmorton

Do nothing scenario

The modelled flow of Wangcol Creek at the confluence with the discharge from the SCSS via LDP006 is presented in Figure 6-6. Site-based discharges from the SCSS as well as upstream catchment runoff in Wangcol Creek were estimated to be an average of approximately 4 ML/day to 12 ML/day. The flow ranged between approximately 2 ML/day (10th percentile) and 33 ML/day (90th percentile) due to the variation in rainfall contributing to catchment runoff. Changes to the water management system at the SCSS to reduce the volume of clean water discharged through LDP006 were modelled to commence in 2017. Following this, the peak average flow volume in Wangcol Creek at LDP006 was predicted to reduce to approximately 10 ML/day.

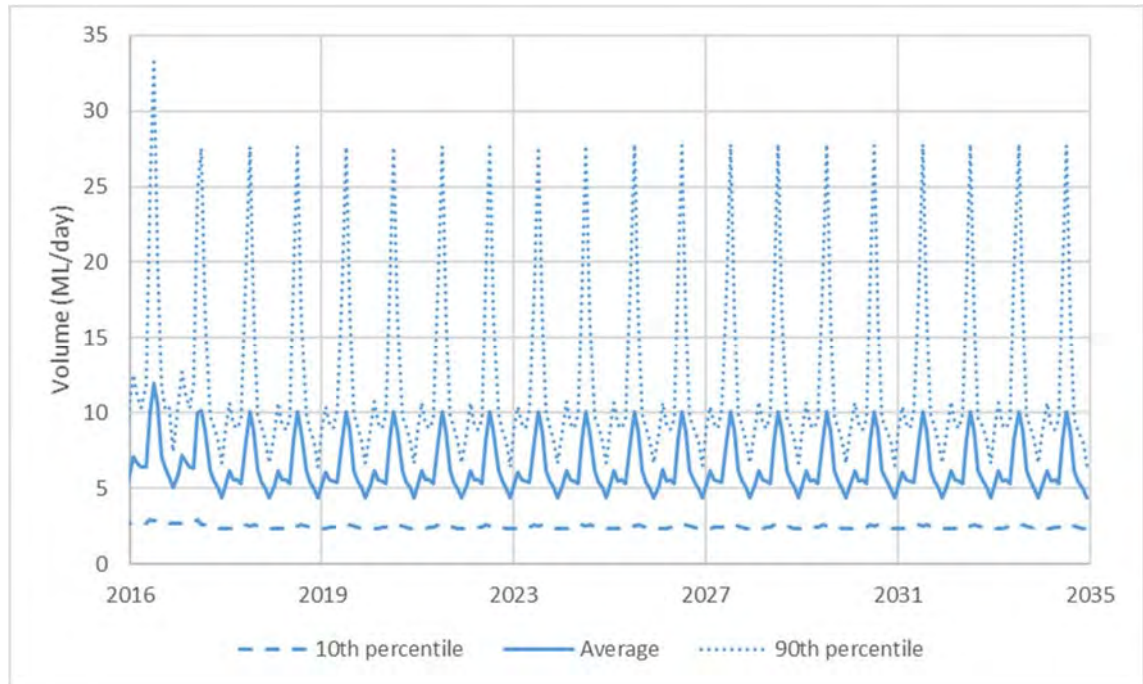


Figure 6-6 Do nothing scenario – Predicted flow of Wangcol Creek at LDP006

Wangcol Creek flow at the confluence with the Cocks River is shown in Figure 6-7. Catchment runoff downstream of LDP006 discharges from the SCSS provides up to an additional 1 ML/day to 3 ML/day to Wangcol Creek on average.

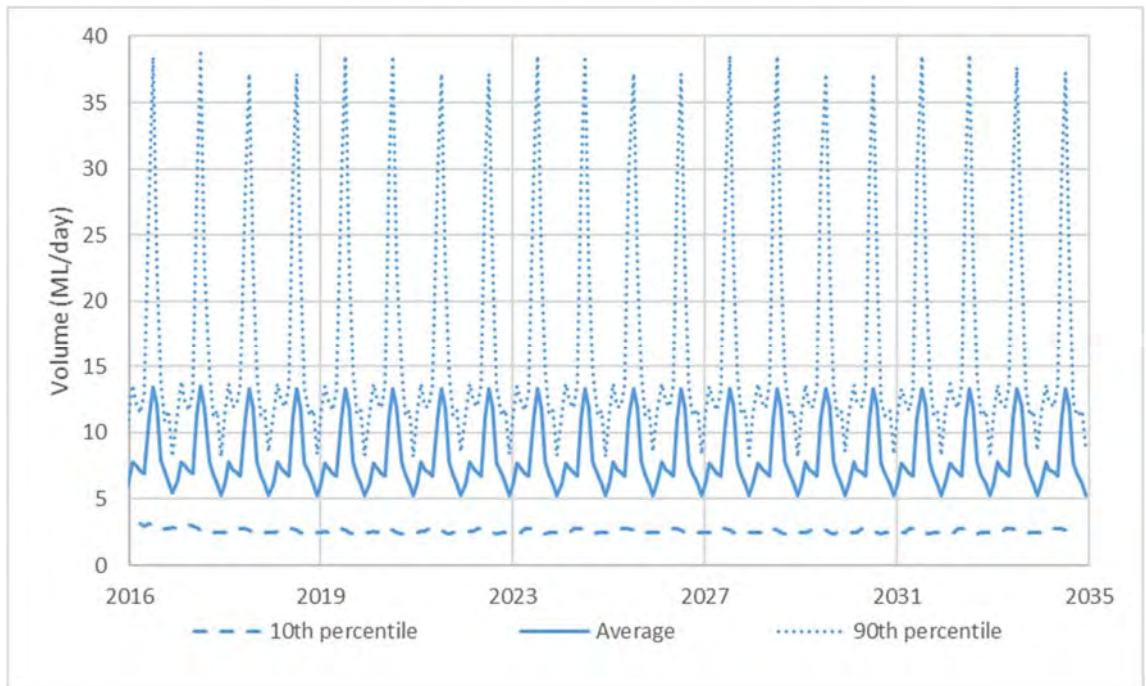


Figure 6-7 Do nothing scenario – Predicted flow of Wangcol Creek at the confluence with the Coxs River

The modelled inflow to Lake Wallace is presented in Figure 6-8. The flow is dominated by catchment runoff, with a small variation over time due to the SDWTS discharges to the Coxs River catchment via LDP009. The average inflow to the lake was found to vary between approximately 38 ML/day to 105 ML/day. The flow ranged between approximately 21 ML/day (10th percentile) and 229 ML/day (90th percentile) due to the variation in rainfall contributing to catchment runoff.

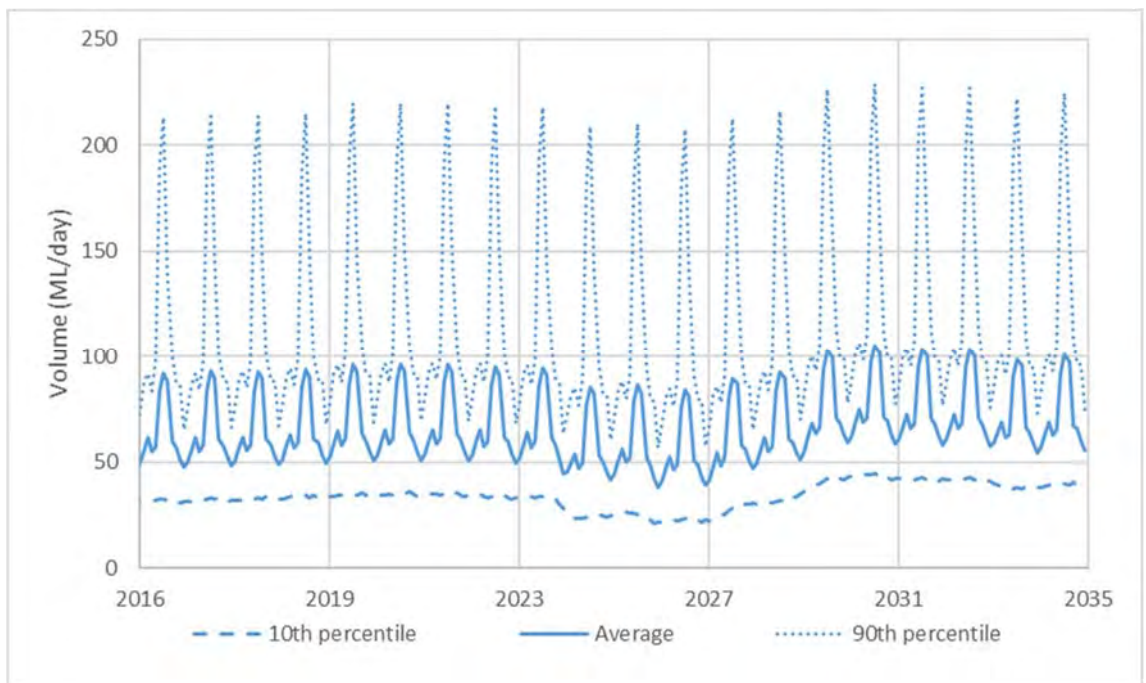


Figure 6-8 Do nothing scenario – Predicted flow from Coxs River to Lake Wallace

Inflows to Lake Lyell were predicted to range between approximately 50 ML/day and 160 ML/day on average, as shown in Figure 6-9. The flow was modelled to range between 18 ML/day (10th percentile) and 400 ML/day (90th percentile) due to the variation in rainfall contributing to catchment runoff.

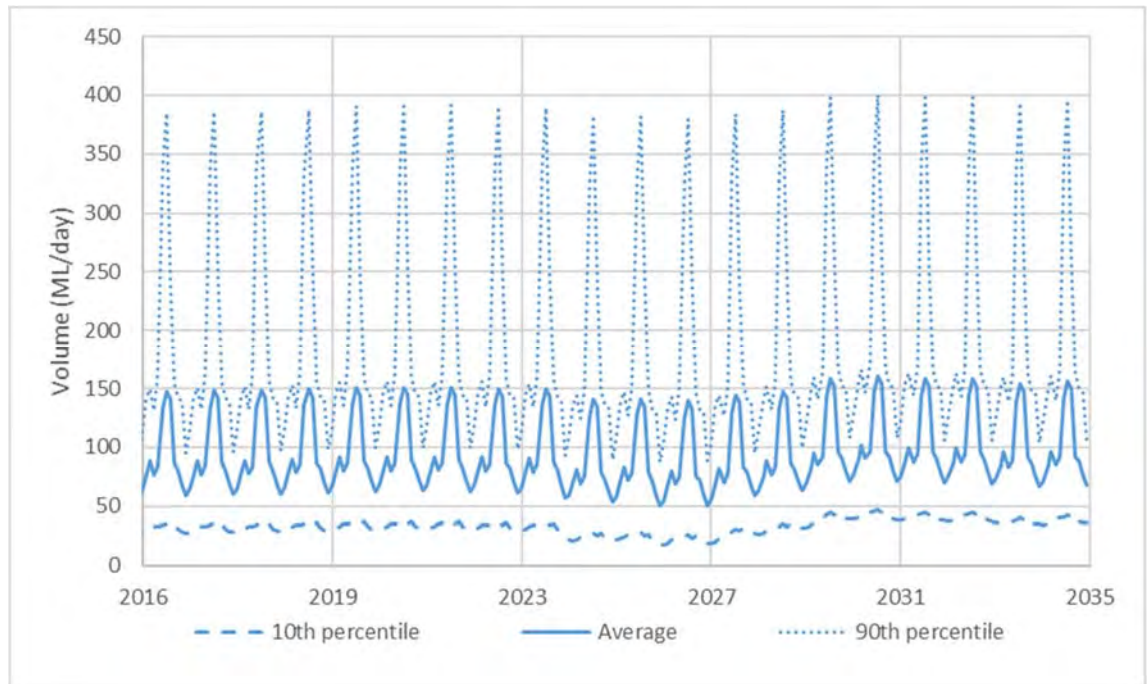


Figure 6-9 Do nothing scenario – Predicted flow from Coxs River to Lake Lyell

Figure 6-10 provides the modelled flow from the Coxs River catchment into Lake Burragorang, which was found to vary between approximately 151 ML/day and 507 ML/day on average. The flow ranged from approximately 30 ML/day (10th percentile) and 1,263 ML/day (90th percentile) due to the variation in rainfall contributing to catchment runoff.

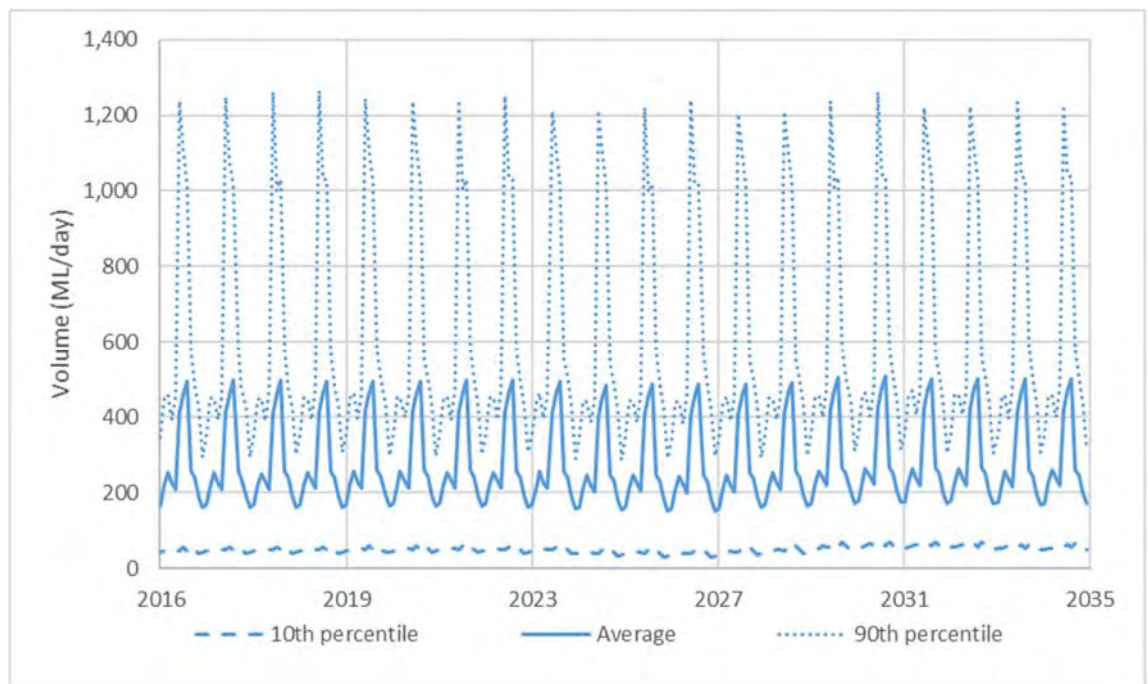


Figure 6-10 Do nothing scenario – Predicted flow from Coxs River to Lake Burragorang

Scenario 3

The proposed Project was modelled to result in an increase of less than 1 ML/day on average in the flow of Wangcol Creek at the confluence with LDP006, as shown in Figure 6-11, and at the confluence with the Cocks River, as shown in Figure 6-12, compared to the do nothing scenario.

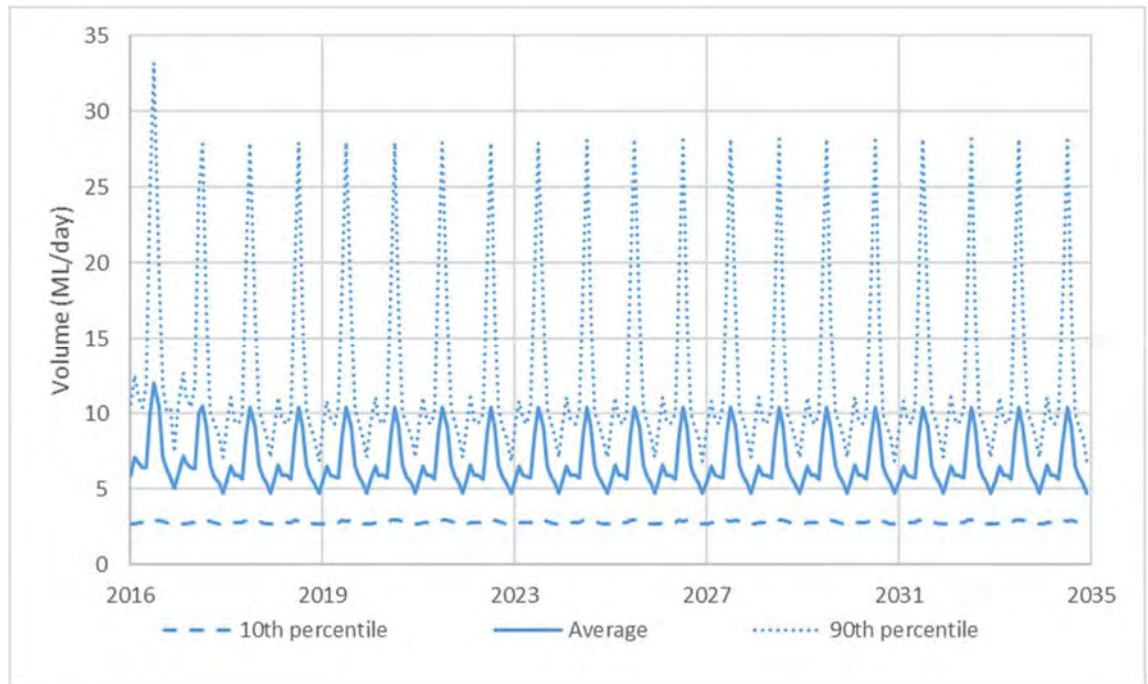


Figure 6-11 Scenario 3 – Predicted flow of Wangcol Creek at LDP006

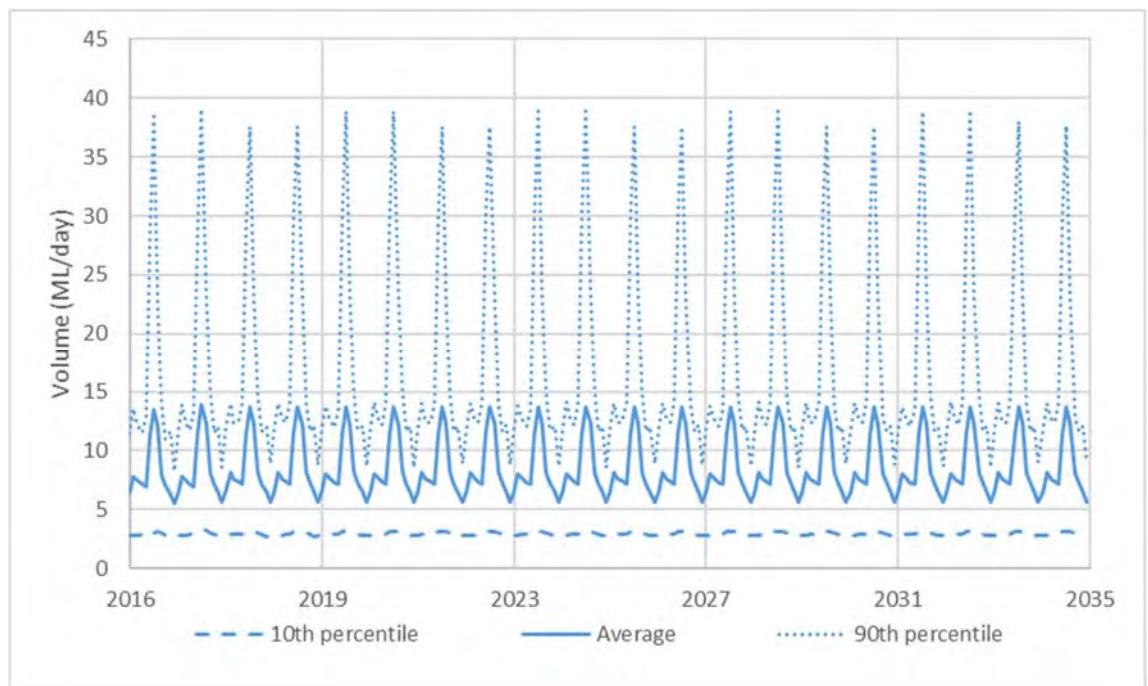


Figure 6-12 Scenario 3 – Predicted flow of Wangcol Creek at the confluence with the Cocks River

The predicted transfer of excess water from MPPS to TCR is presented in Figure 6-13. For Scenario 3, the 50% power generation requirement modelled at MPPS results in the majority of water transferred to the SDWTS used within the cooling water system. The proposed releases of excess treated water were predicted to occur from May 2030 to January 2034, peaking at approximately 3.9 ML/day in March 2031. As discussed, the results are indicative only as water demands at MPPS vary daily with power generation requirements.

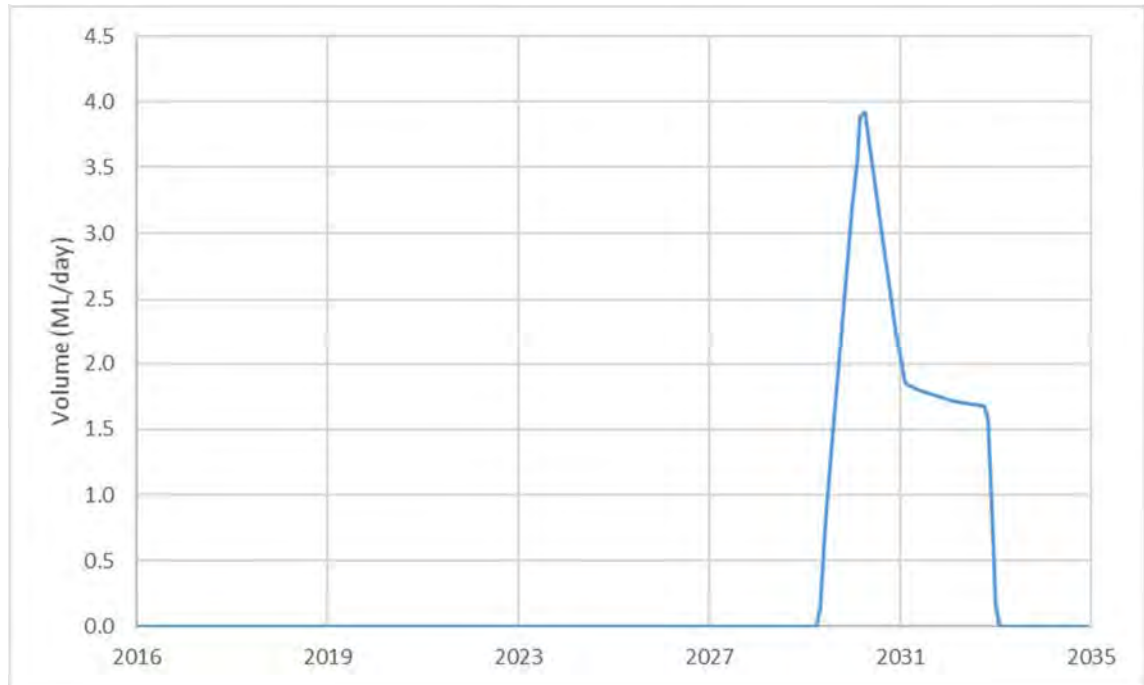


Figure 6-13 Scenario 3 – Predicted transfer from Mount Piper Power Station to Thompsons Creek Reservoir

Figure 6-14 presents the modelled inflow to Lake Wallace. As with the do nothing scenario, the flow is dominated by catchment runoff. The inflow to Lake Wallace was slightly reduced compared to the do nothing scenario, due to the cessation of discharges from LDP009 following the commencement of the Project. The average inflow to Lake Wallace was found to vary between approximately 25 ML/day and 92 ML/day. The flow ranged between approximately 8 ML/day (10th percentile) and 213 ML/day (90th percentile) due to the variation in rainfall contributing to catchment runoff.

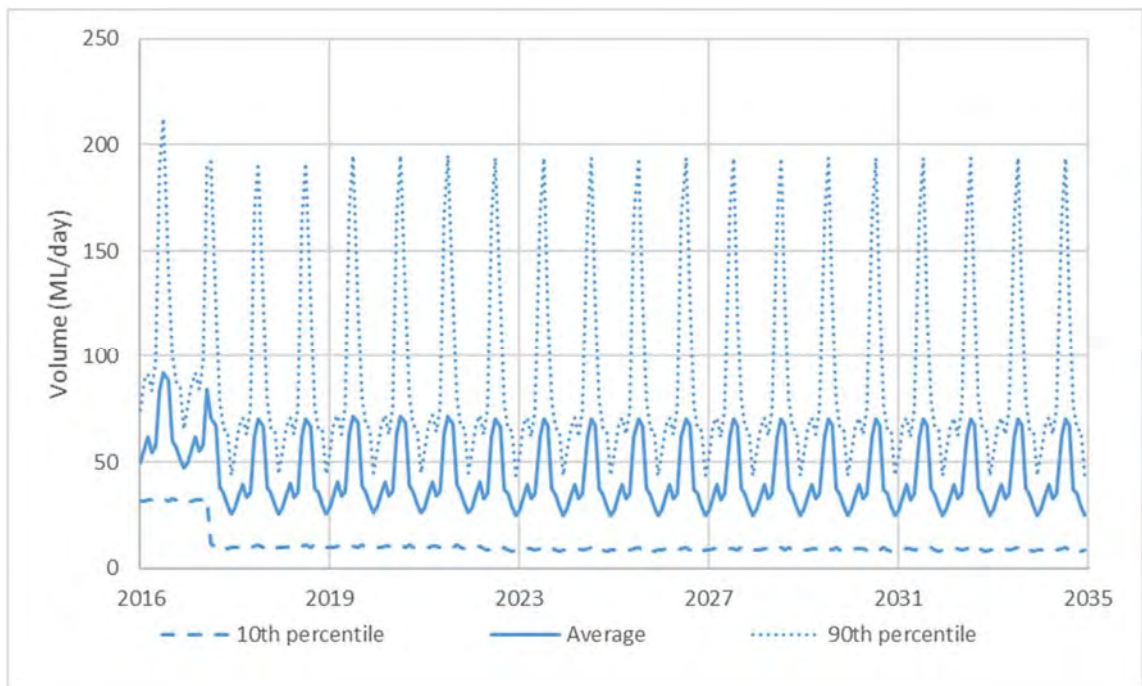


Figure 6-14 Scenario 3 – Predicted flow from Coxs River to Lake Wallace

Inflows to Lake Lyell were predicted to range between approximately 37 ML/day and 147 ML/day on average, as shown in Figure 6-15. The flow was modelled to range between 5 ML/day (10th percentile) and 385 ML/day (90th percentile) due to the variation in rainfall contributing to catchment runoff. Flows are slightly decreased compared to the do nothing scenario, due to the absence of LDP009 discharges within the Coxs River catchment after the commencement of the Project.

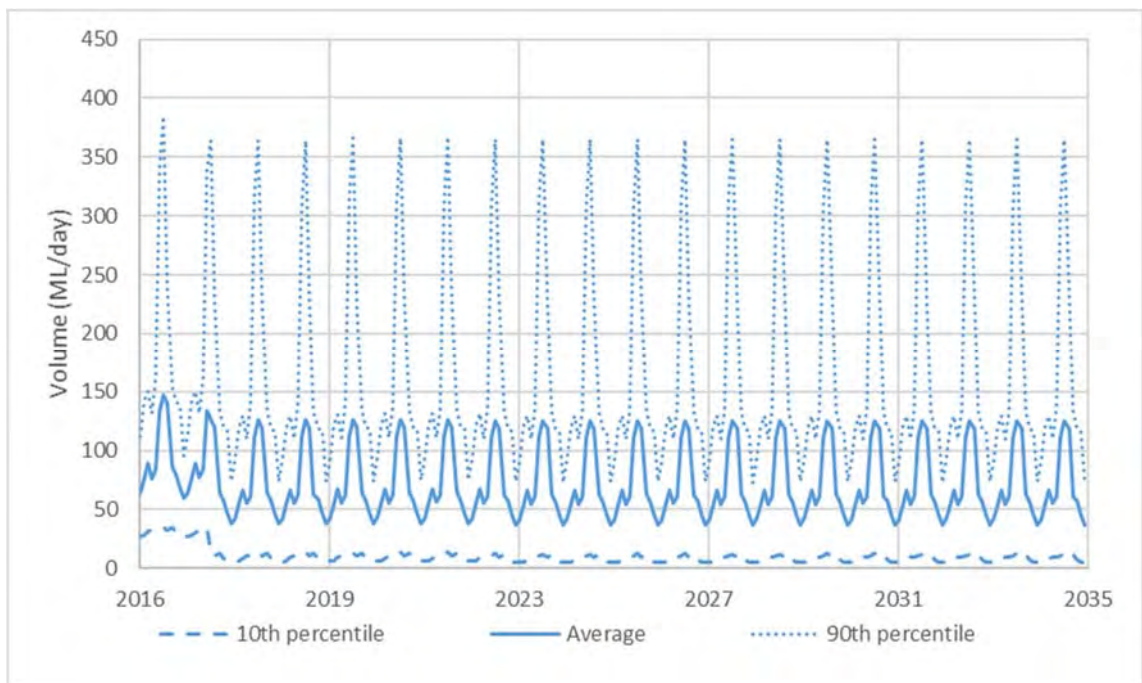


Figure 6-15 Scenario 3 – Predicted flow from Coxs River to Lake Lyell

Figure 6-16 provides the modelled flow from the Coxs River catchment into Lake Burragorang, which was found to vary between approximately 138 ML/day and 493 ML/day on average. The flow ranged from approximately 16 ML/day (10th percentile) and 1,248 ML/day (90th percentile) due to the variation in rainfall contributing to catchment runoff. The cessation of LDP009 discharges associated with the Project resulted in a slight decrease in the upper ranges of Coxs River flow into Lake Burragorang.

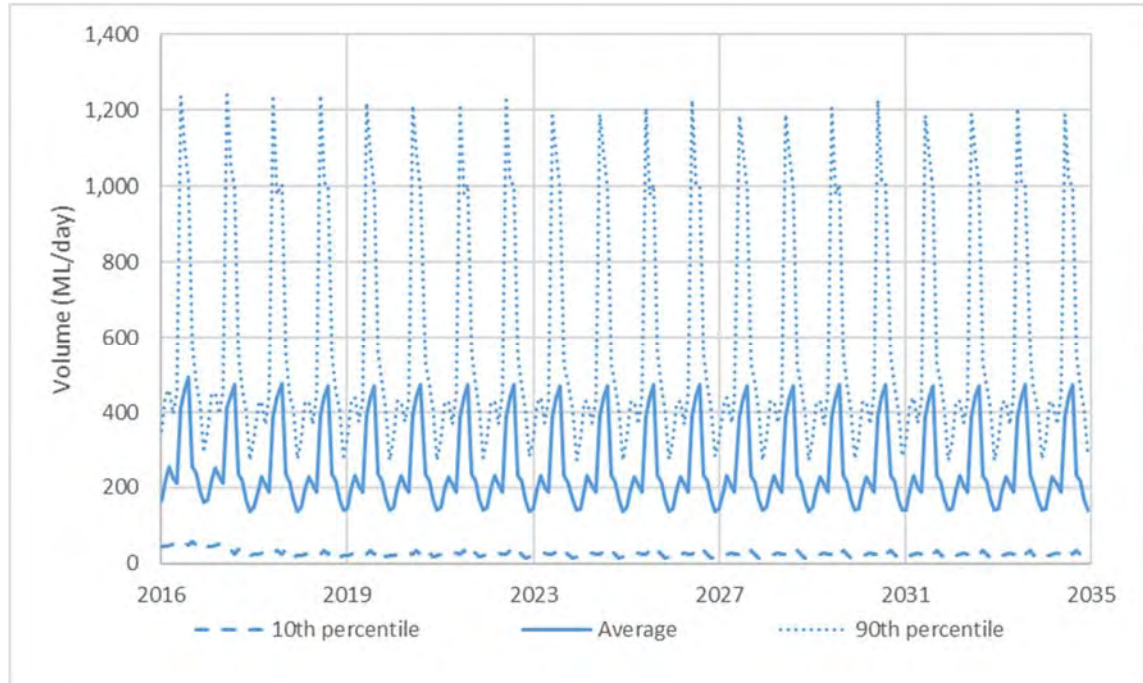


Figure 6-16 Scenario 3 – Predicted flow from Coxs River to Lake Burragorang

6.2.2 Salt balance results

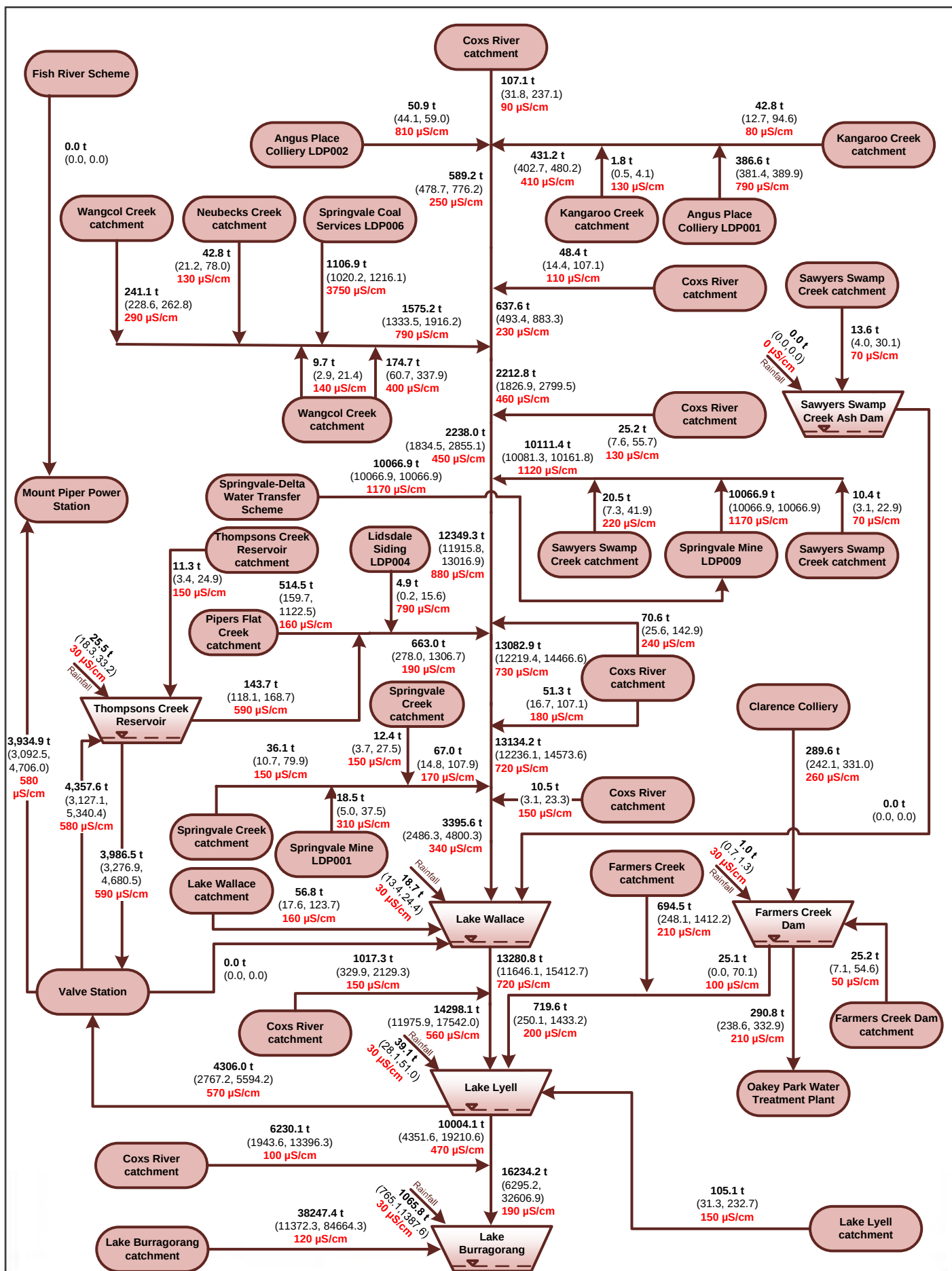
Annual results

The predicted values for each of the salt transfers within the Coxs River catchment for proposed conditions in 2031 are provided in Figure 6-17 and Figure 6-18 for the do nothing scenario (50% power generation requirement) and Scenario 3 (50% power generation requirement) respectively. The results present the average annual salt transfers between the elements of the water cycle as well as an indication of the range of values expected due to possible variations in rainfall and the predicted average salt concentrations.

Wangcol Creek catchment

A summary of the average annual inputs and outputs for the salt balance for the Wangcol Creek catchment under proposed conditions in 2031 for all scenarios is presented in Table 6-3.

Similar to the water balance results for proposed conditions, the Project was predicted to result in an increase in the salt load of discharges from Wangcol Creek into the Coxs River due to discharges from LDP006 for all of the proposed Project scenarios. The increase in LDP006 discharge associated with the disposal of residual material from the Project within the REA at the SCSS was found to be approximately 335 t/year on average, compared to the do nothing scenario.



© 2016. Whilst every care has been taken to prepare this figure, GHD make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the figure being inaccurate, incomplete or unsuitable in any way and for any reason.



Amended Springvale Water Treatment Project
Water Resources Impact Assessment

Annual salt transfers
Proposed conditions (2031)
Do nothing scenario



Centennial Coal



EnergyAustralia

DATE Dec 2016

Figure 6-17

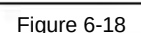


Table 6-3 Summary of average salt inputs and outputs for Wangcol Creek catchment under proposed conditions in 2031

	Scenario 1 (t/year)	Scenario 2 (t/year)	Scenario 3 (t/year)	Scenario 4 (t/year)	Scenario 5 (t/year)	Do nothing scenario (t/year)
	0% power generation	25% power generation	50% power generation	75% power generation	100% power generation	50% power generation
INPUTS						
Catchment runoff	468.3	468.3	468.3	468.3	468.3	468.3
LDP discharge from SCSS (LDP006)	1,442.3	1,442.3	1,442.3	1,442.3	1,442.3	1,106.9
TOTAL INPUTS (rounded)	1,911	1,911	1,911	1,911	1,911	1,575
OUTPUTS						
Contribution to Coxs River	1,910.6	1,910.6	1,910.6	1,910.6	1,910.6	1,575.2
TOTAL OUTPUTS (rounded)	1,911	1,911	1,911	1,911	1,911	1,575
BALANCE						
Inputs – outputs	0	0	0	0	0	0

The salt load associated with the discharge from Wangcol Creek was modelled to contribute from approximately 1,687 t/year into the Coxs River on average for all of the proposed Project scenarios. For the do nothing scenario, the salt load associated with Wangcol Creek flow was estimated to be 1,352 t/year on average. Increased discharges from LDP006 as a result of residuals transferred to the REA at SCSS were modelled to contribute approximately 20% of the total salt load within Wangcol Creek.

Coxs River catchment

A summary of the average annual inputs and outputs for the salt balance for the Coxs River catchment under proposed conditions in 2031 for all scenarios is presented in Table 6-4.

As shown in Table 6-4, the sources and sinks for the salt balance were broadly similar to the water balance. The largest source of salt into the Coxs River catchment under proposed conditions was associated with rainfall onto surface water storages and catchment runoff, which accounted for 9,658 t/year on average, equating to between 45% (do nothing scenario) and 81% (scenarios 4 and 5) of the total salt input to the system. The average salinity of the total contribution of rainfall and runoff to the catchment was estimated to be approximately 110 $\mu\text{S}/\text{cm}$.

Similar to the water balance results, the second largest input of salt to the system was modelled to be associated with proposed releases to TCR for scenarios 1 and 2; discharges through LDP006 to Wangcol Creek for scenarios 3, 4 and 5; and discharges from LDP009 for the do nothing scenario.

The salt load associated with make-up water supplied to MPPS, in addition to the supply from the Project, varied with scenario modelled. No additional make-up water was required for scenarios 1, 2 and 3. MPPS was predicted to act as a sink for salt in the catchment for scenarios 4 and 5, with 927 t/year and 1,951 t/year supplied to the power station respectively on average.

Under the proposed conditions, the total annual salt load of the Coxs River upstream of Lake Burragorang was estimated to range from approximately 9,149 t/year for Scenario 5 to 14,643 t/year for Scenario 1 on average. For the do nothing scenario, with a 50% power generation requirement and all salt associated with water within the SDWTS modelled to be discharged via LDP009, the salt load of the Coxs River was predicted to be approximately 16,234 t/year on average.

Site-based discharges from Angus Place Colliery, Lidsdale Siding, the SCSS and Springvale Mine as well as Project transfers from MPPS to TCR were estimated to contribute between approximately 1,903 t/year, for scenarios 4 and 5, and approximately 5,442 t/year, for Scenario 1, to the Coxs River catchment on average. This equates to between 16%, for scenarios 4 and 5, and 35%, for Scenario 1, of the total annual salt load input to the Coxs River catchment. This is a reduction in salt load associated with mine water discharges compared to the do nothing scenario, which was predicted to discharge 11,635 t/year of salt on average, equating to 54% of the total salt load input to the catchment.

Table 6-4 Summary of average salt inputs and outputs for Coss River catchment under proposed conditions in 2031

	Scenario 1 (t/year)	Scenario 2 (t/year)	Scenario 3 (t/year)	Scenario 4 (t/year)	Scenario 5 (t/year)	Do nothing scenario ^a (t/year)
	0% power generation	25% power generation	50% power generation	75% power generation	100% power generation	50% power generation
INPUTS						
Direct rainfall onto storages and catchment runoff	9,658.2	9,658.2	9,658.2	9,658.2	9,658.2	9,658.2
Supply from Fish River water supply scheme to MPPS	0.0	0.0	0.0	0.0	0.0	0.0
Transfer from Clarence Colliery to Farmers Creek Dam	289.6	289.6	289.6	289.6	289.6	289.6
LDP discharge from Angus Place Colliery (LDP001)	386.6	386.6	386.6	386.6	386.6	386.6
LDP discharge from Angus Place Colliery (LDP002)	50.9	50.9	50.9	50.9	50.9	50.9
LDP discharge from Lidsdale Siding (LDP004)	4.9	4.9	4.9	4.9	4.9	4.9
LDP discharge from SCSS (LDP006)	1,442.3	1,442.3	1,442.3	1,442.3	1,442.3	1,106.9
LDP discharge from Springvale Mine (LDP001)	18.5	18.5	18.5	18.5	18.5	18.5
LDP discharge from Springvale Mine (LDP009)	0.0	0.0	0.0	0.0	0.0	10,066.9
Transfers from MPPS to TCR	3,538.4	1,953.1	367.8	0.0	0.0	0.0
TOTAL INPUTS (rounded)	15,389	13,804	12,219	11,851	11,851	21,583
OUTPUTS						
Additional make-up water used at MPPS ^b	0.0	0.0	0.0	926.7	1,950.5	3,934.9

	Scenario 1 (t/year)	Scenario 2 (t/year)	Scenario 3 (t/year)	Scenario 4 (t/year)	Scenario 5 (t/year)	Do nothing scenario ^a (t/year)
	0% power generation	25% power generation	50% power generation	75% power generation	100% power generation	50% power generation
Oakey Park WTP use	290.8	290.8	290.8	290.8	290.8	290.8
Contribution to Lake Burragorang	14,642.7	11,933.6	11,540.2	10,313.8	9,148.7	16,234.2
TOTAL OUTPUTS (rounded)	14,934	12,224	11,831	11,531	11,390	20,460
CHANGE IN STORAGE						
Farmers Creek Dam	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1
Lake Lyell	91.0	-71.2	53.0	292.7	395.2	851.9
Lake Wallace	25.6	-24.0	0.8	-0.6	-0.2	6.6
TCR	340.3	1,675.6	334.4	27.7	66.4	264.2
TOTAL CHANGE IN STORAGE (rounded)	457	1,580	388	320	461	1,123
BALANCE						
Inputs – outputs – change in storage	-2	0	0	0	0	0

^a In the do nothing scenario, inputs from the SDWTS are discharged to Sawyers Swamp Creek via Springvale Mine's LDP009.

^b Additional make-up water required in addition to the supply from the Project.

Time series results

Monthly average time series results of EC associated with flows at the locations shown in Figure 6-4 and Figure 6-5 are presented for the do nothing scenario (50% power generation requirement) and Scenario 3 (50% power generation requirement) in the following sections.

Note that for the do nothing scenario, it was assumed in the water balance model that the Project would not be developed. As such, there were no releases predicted into TCR as a result of the amended Project.

Do nothing scenario

The predicted EC of Wangcol Creek at the confluence with the discharge from the SCSS via LDP006 is presented in Figure 6-19. Site-based discharges from the SCSS dominate the EC of Wangcol Creek at this location, with EC predicted to be an average of approximately 1,480 $\mu\text{S}/\text{cm}$ and 1,900 $\mu\text{S}/\text{cm}$. The flow EC ranged between approximately 870 $\mu\text{S}/\text{cm}$ (10th percentile) and 2,290 $\mu\text{S}/\text{cm}$ (90th percentile) due to the variation in rainfall contributing to catchment runoff. Following changes to the water management system at SCSS in 2017, the average EC of flow in Wangcol Creek at LDP006 was estimated to reduce by up to approximately 200 $\mu\text{S}/\text{cm}$.

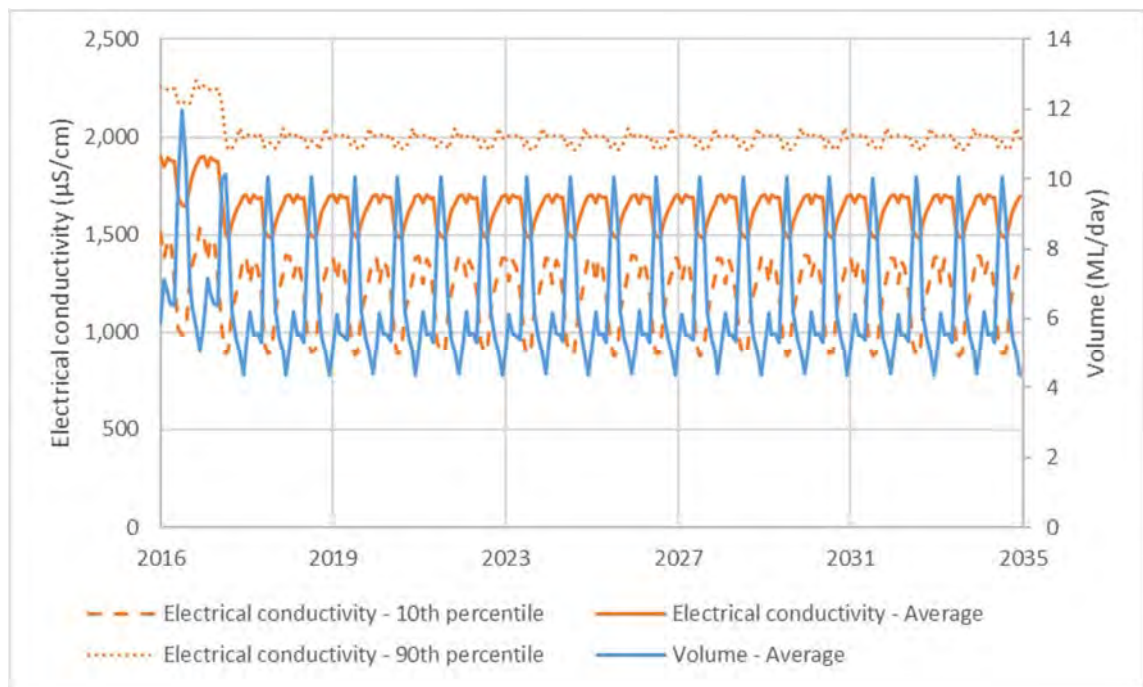


Figure 6-19 Do nothing scenario – Predicted EC of Wangcol Creek at LDP006

The EC of Wangcol Creek at the confluence with the Cocks River predicted by the salt balance model is shown in Figure 6-20. The relatively low EC of catchment runoff downstream of LDP006 discharges provides a slight dilution of the flow of up to approximately 150 $\mu\text{S}/\text{cm}$ on average.

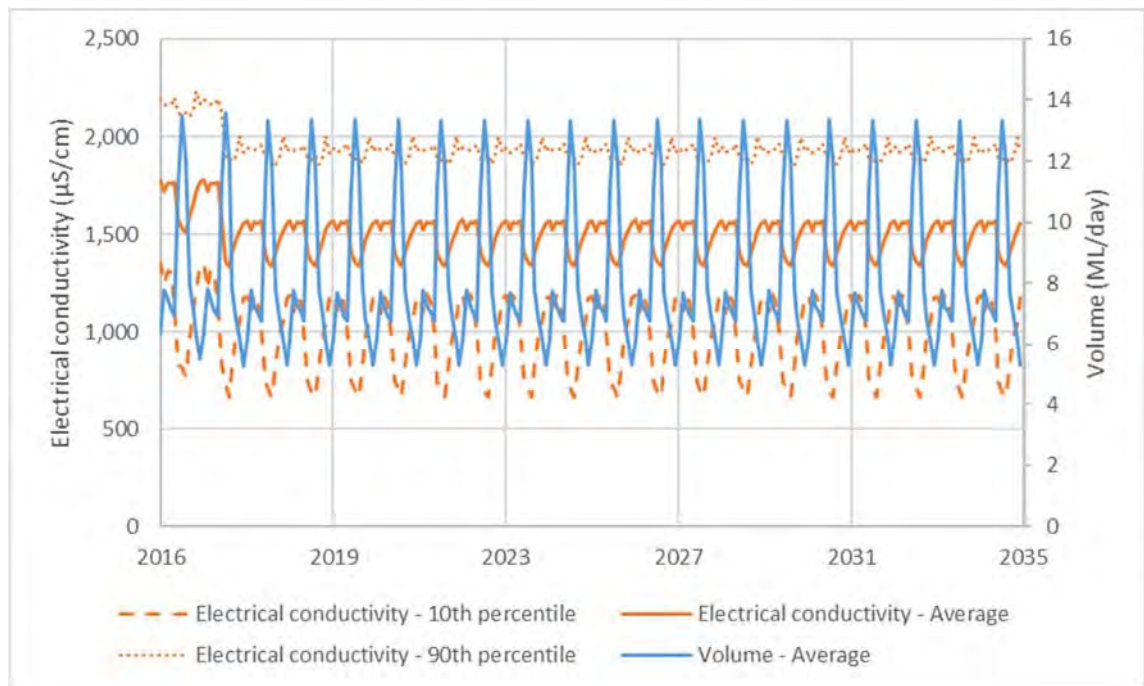


Figure 6-20 Do nothing scenario – Predicted EC of Wangcol Creek at the confluence with the Coxs River

The modelled EC of the inflow to Lake Wallace is shown in Figure 6-21. The EC is dominated by the relatively high EC of mine water discharges via LDP009, with the average EC found to vary between 750 $\mu\text{S/cm}$ and 970 $\mu\text{S/cm}$. The flow ranged in EC between approximately 350 $\mu\text{S/cm}$ (10th percentile) and 1,180 $\mu\text{S/cm}$ (90th percentile) due to the variation in rainfall contributing to catchment runoff.

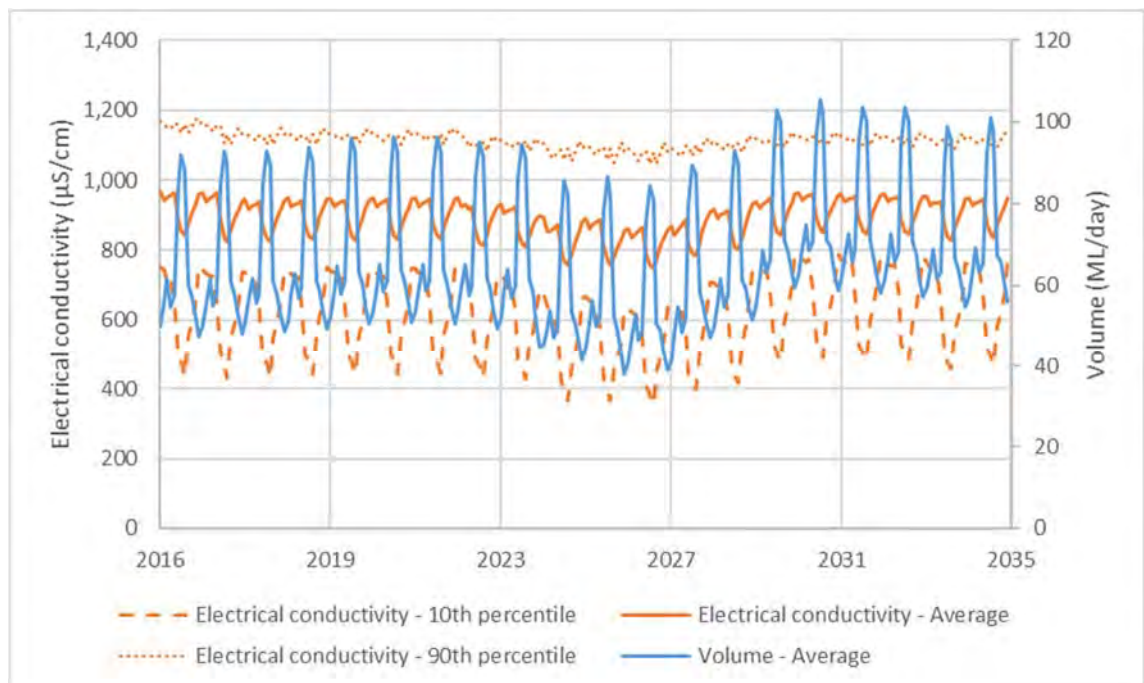


Figure 6-21 Do nothing scenario – Predicted EC of flow from the Coxs River to Lake Wallace

The EC of inflows to Lake Lyell was predicted to range between approximately 530 $\mu\text{S/cm}$ and 800 $\mu\text{S/cm}$ on average, as shown in Figure 6-22. The flow was modelled to range in EC between 220 $\mu\text{S/cm}$ (10th percentile) and 1,050 $\mu\text{S/cm}$ (90th percentile) due to the variation in rainfall contributing to catchment runoff.

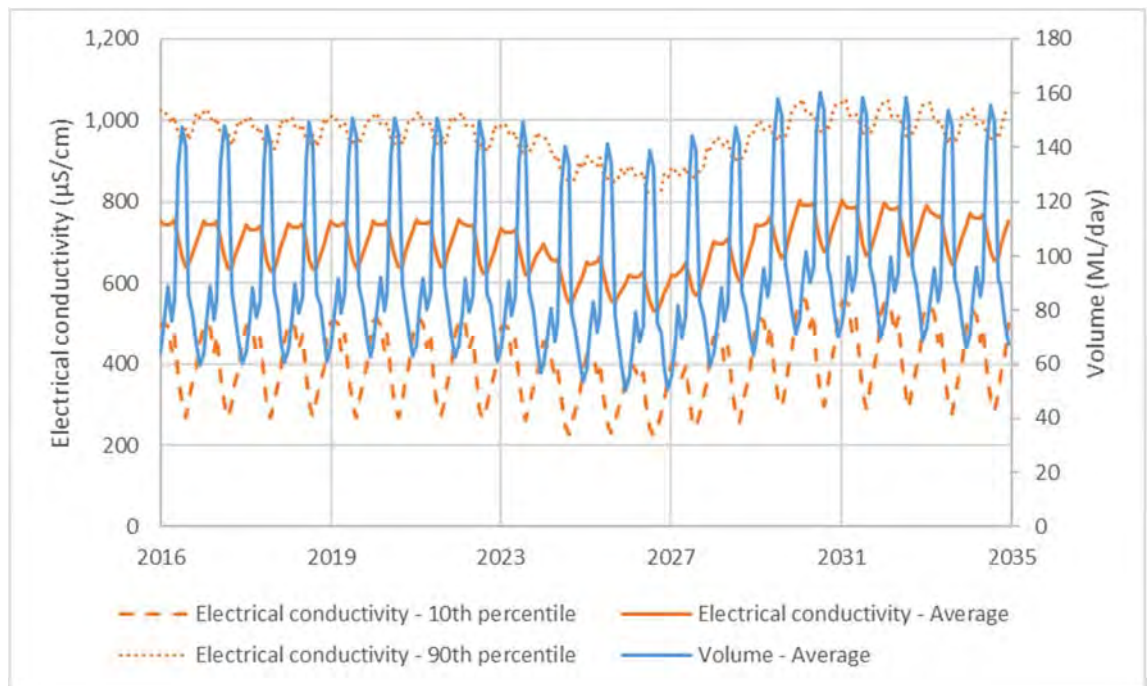


Figure 6-22 Do nothing scenario – Predicted EC of flow from the Coxs River to Lake Lyell

Figure 6-23 provides the modelled EC of flows from the Coxs River catchment into Lake Burragorang, which was found to vary between approximately 200 $\mu\text{S}/\text{cm}$ and 270 $\mu\text{S}/\text{cm}$ on average. The EC of the flow ranged from approximately 140 $\mu\text{S}/\text{cm}$ (10th percentile) and 360 $\mu\text{S}/\text{cm}$ (90th percentile) due to the variation in rainfall contributing to catchment runoff. The relatively low EC indicates that the flows into Lake Burragorang are heavily dominated by the large volume of catchment runoff compared to the higher EC of mine water discharges within the Coxs River catchment.

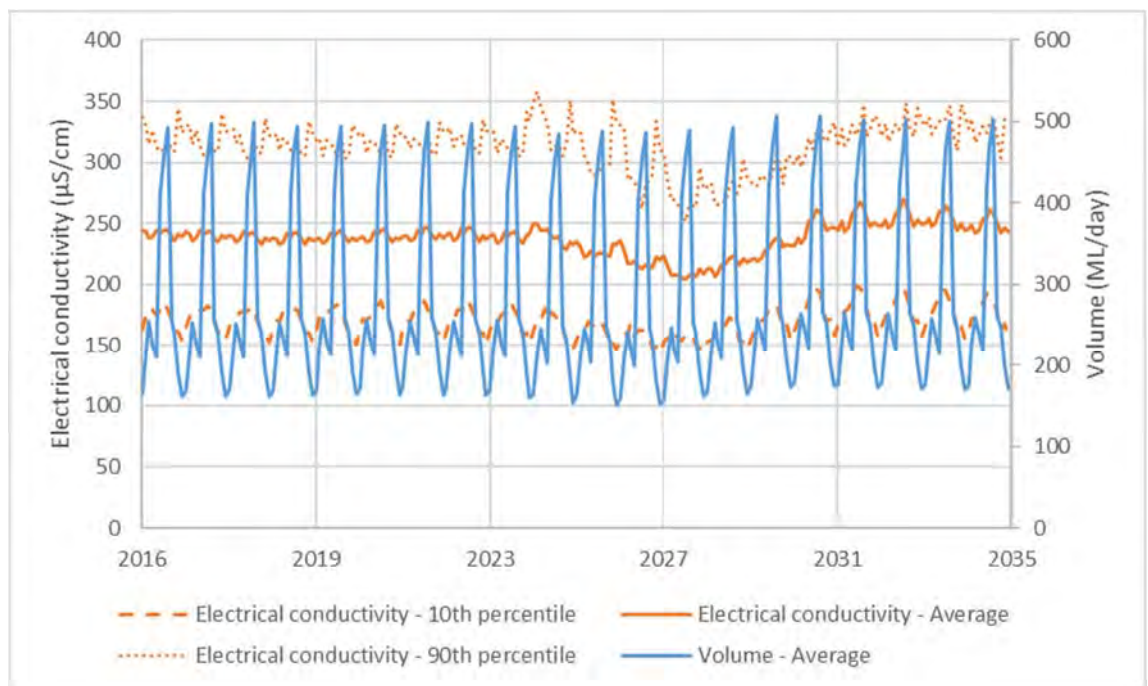


Figure 6-23 Do nothing scenario – Predicted EC of flow from the Coxs River to Lake Burragorang

Scenario 3

The predicted EC of Wangcol Creek at the confluence with LDP006 discharges is presented in Figure 6-24 and at the confluence with the Coxs River is presented in Figure 6-25. The predicted increase in discharges from LDP006 associated with the disposal of residual material from the Project within the REA at the SCSS was estimated to increase the average EC of Wangcol Creek by up to approximately 200 $\mu\text{S}/\text{cm}$.

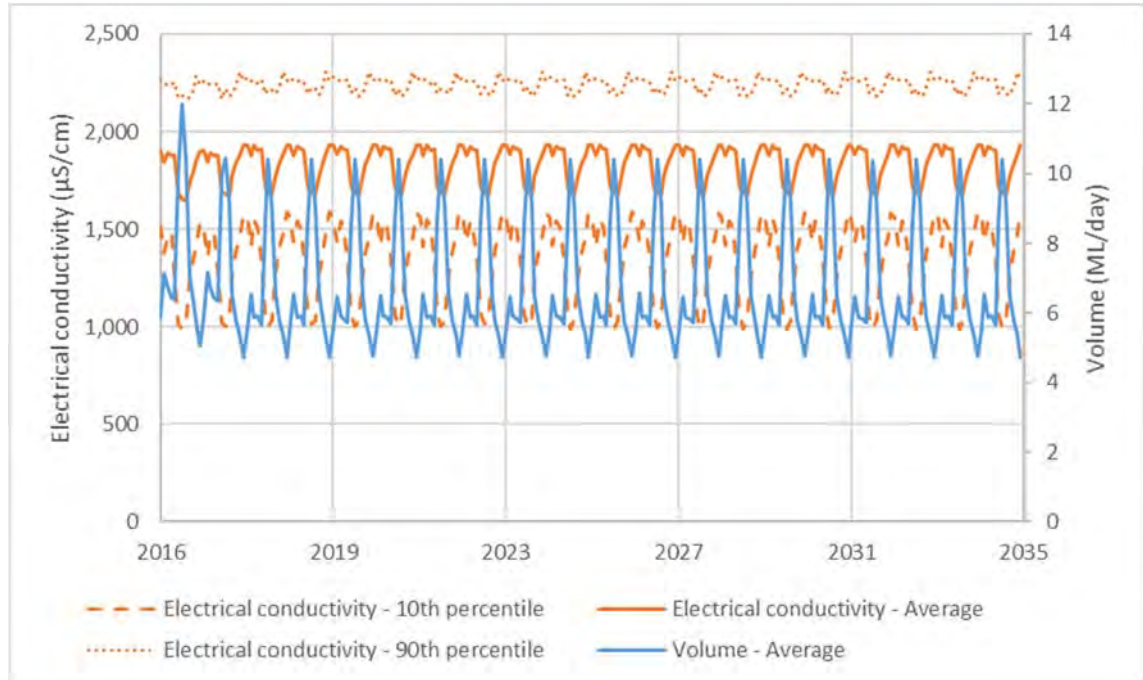


Figure 6-24 Scenario 3 – Predicted EC of Wangcol Creek at LDP006

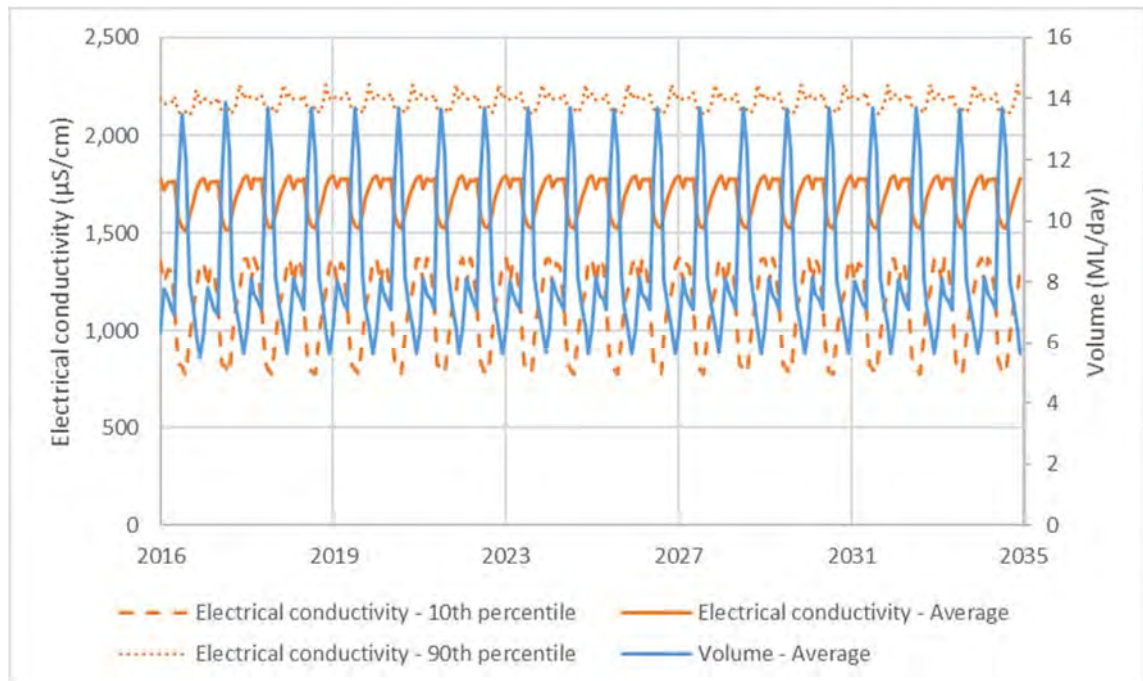


Figure 6-25 Scenario 3 – Predicted EC of Wangcol Creek at the confluence with the Coxs River

The EC of the predicted transfer of excess water from MPPS to TCR is presented in Figure 6-26. For Scenario 3, the 50% power generation requirement modelled at MPPS results in the majority of water transferred to the SDWTS used within the cooling water system. The treated water was modelled to have a maximum EC of approximately 490 $\mu\text{S}/\text{cm}$.

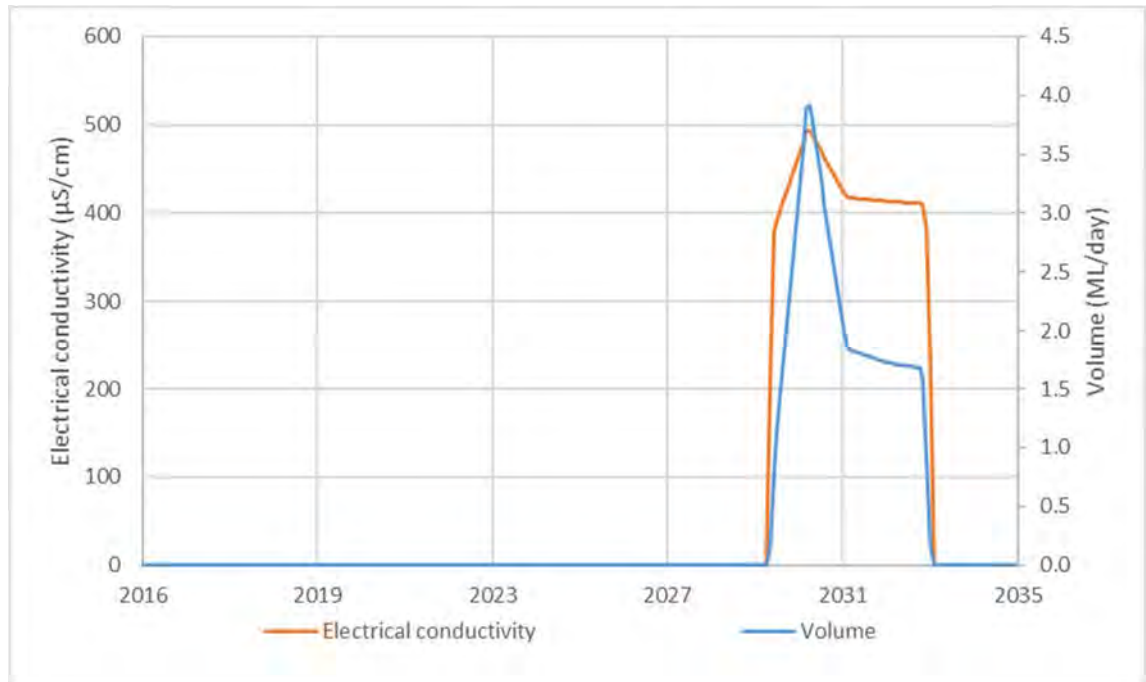


Figure 6-26 Scenario 3 – Predicted EC of transfer from Mount Piper Power Station to Thompsons Creek Reservoir

Figure 6-27 presents the modelled EC of inflows to Lake Wallace. The downward trend in the EC of inflows to the lake is attributed to the cessation of discharges at LDP009, which allows the contribution of relatively low EC catchment runoff to have a greater influence on the EC. The average EC of inflows to Lake Wallace was found to range from approximately 620 $\mu\text{S}/\text{cm}$ to 800 $\mu\text{S}/\text{cm}$ following the commencement of the Project.

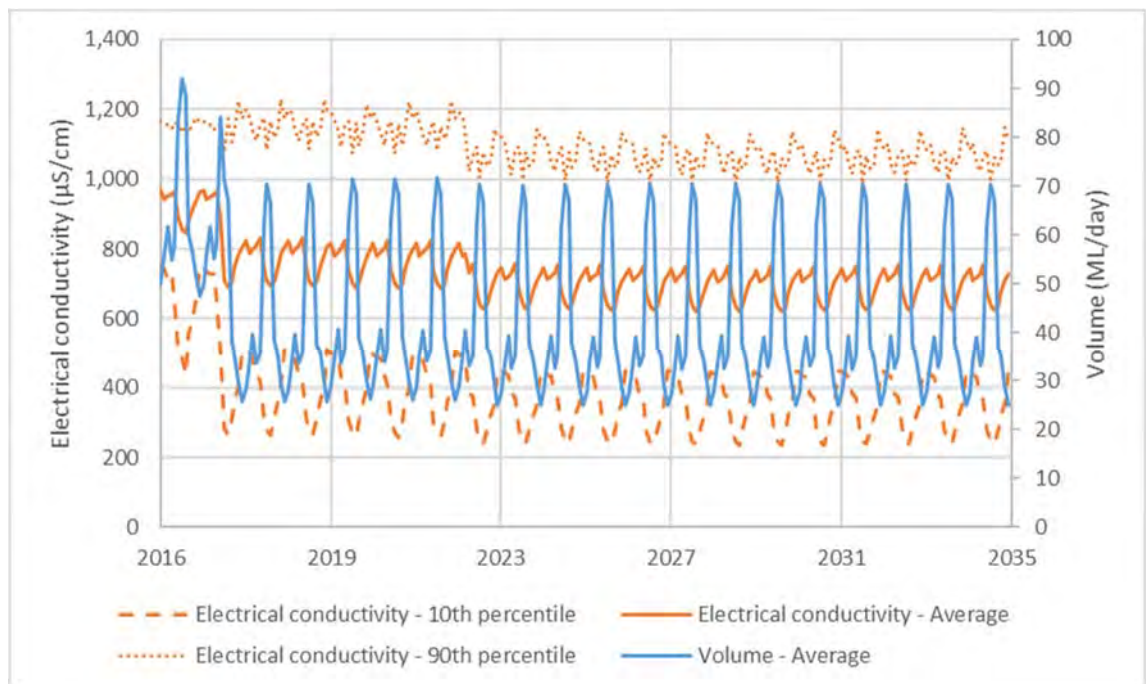


Figure 6-27 Scenario 3 – Predicted EC of flow from the Coxs River to Lake Wallace

The EC of inflows to Lake Lyell presented in Figure 6-28 modelled the same downward trend as the EC of Coxs River flows into Lake Wallace. The average EC of inflows to Lake Lyell following the commencement of the Project was found vary between approximately 320 $\mu\text{S}/\text{cm}$ to 450 $\mu\text{S}/\text{cm}$. The EC is slightly decreased compared to the do nothing scenario, due to the absence of LDP009 discharges within the system following the commencement of the Project.

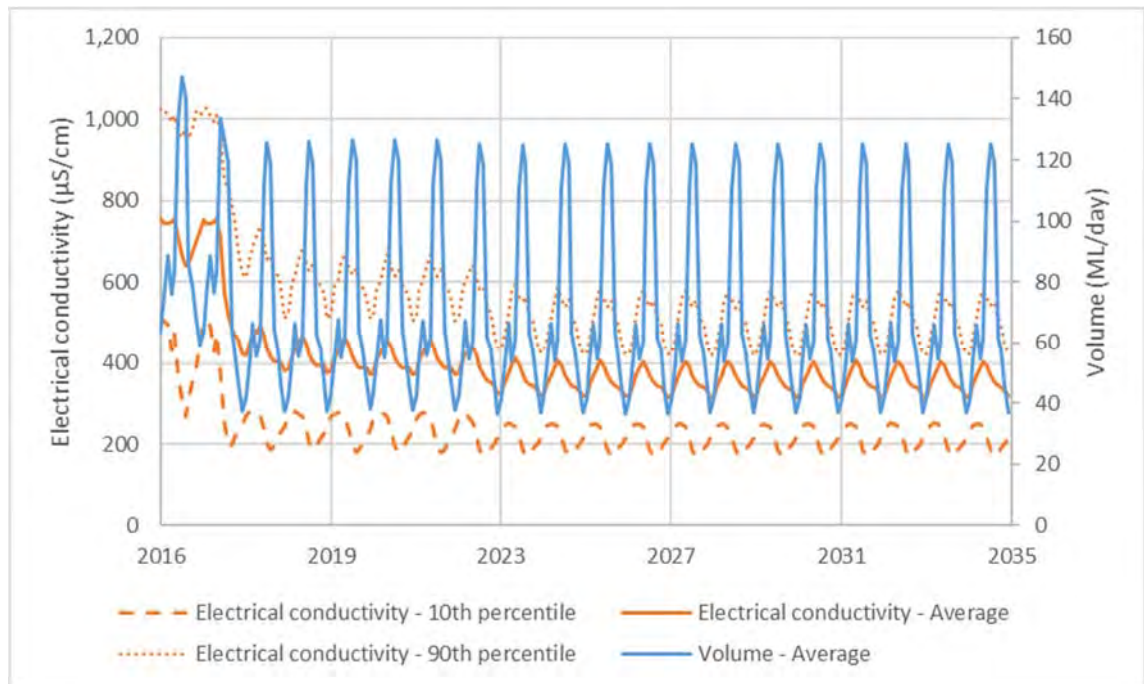


Figure 6-28 Scenario 3 – Predicted EC of flow from the Coxs River to Lake Lyell

The cessation of LDP009 discharges associated with the Project resulted in a decrease in the EC of Coxs River flow into Lake Burragarang over time. Figure 6-29 provides the modelled EC of the inflow from the Coxs River catchment to Lake Burragarang, which was found vary from approximately 180 $\mu\text{S}/\text{cm}$ to 280 $\mu\text{S}/\text{cm}$ on average. The modelled EC ranged from approximately 140 $\mu\text{S}/\text{cm}$ (10th percentile) and 390 $\mu\text{S}/\text{cm}$ (90th percentile) due to the variation in rainfall contributing to catchment runoff.

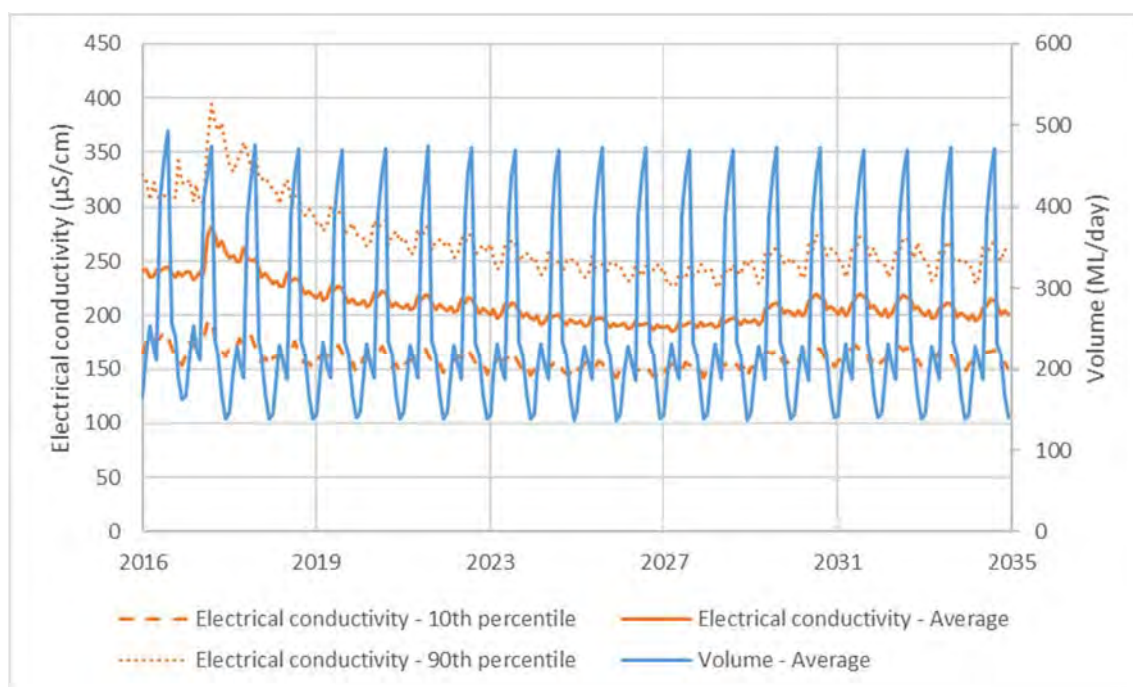


Figure 6-29 Scenario 3 – Predicted EC of flow from the Coxs River to Lake Burragorang

6.2.3 Impact of amended Project on operating water level

The water balance modelling for the amended Project indicated the following outcomes, provided in Table 6-5 and graphically in Figure 6-30, for the environmental and operational assessment scenarios that have been considered.

Table 6-5 Changes to operating water level

Scenario		Outcome
Operational	Scenario A (five day emergency disposal of treated water from proposed WTP operating at 42 ML/day)	Drawdown – Reduce current operating level down 0.1 m below current operating level (1,032.6 m AHD – 0.4 m below FSL). No transfer to Lake Wallace required.
	Scenario B (ten day emergency disposal of treated water from proposed WTP operating at 42 ML/day)	Drawdown – Reduce current operating level down 0.3 m below current operating level (1,032.4 m AHD – 0.6 m below FSL). No transfer to Lake Wallace required.
Environmental	Scenario 1 – 0% power generation at MPPS	Excess treated water transferred to Lake Wallace via Wallerawang Pipeline.
	Scenario 2 – 25% power generation at MPPS	Excess treated water transferred to Lake Wallace via Wallerawang Pipeline.
	Scenario 3 – 50% power generation at MPPS	Drawdown – Reduce current operating level down 1.2 m below current operating level (1,031.4 m AHD – 1.6 m below FSL). No transfer to Lake Wallace required.

Scenario	Outcome
Scenario 4 – 75% power generation at MPPS	Maintain/drawdown – Maintain current operating level at 1,032.6 m AHD (± 0.1 m from existing operating level). No transfer to Lake Wallace required.
Scenario 5 – 100% power generation at MPPS	Maintain/drawdown – Maintain current operating level at 1,032.6 m AHD (± 0.1 m from existing operating level). No transfer to Lake Wallace required.

Operational decisions affecting day-to-day management requirements of the TCR are likely to form a key component in revisions to water management plans and operational manuals following the approval of the amended Project. For a ten day shutdown period at MPPS (Scenario B), it was predicted that a reduction in the operation level of TCR to 0.6 m below the FSL and 0.3 m below the current operating level would be sufficient to manage emergency disposal of excess treated water at a rate of 42 ML/day.

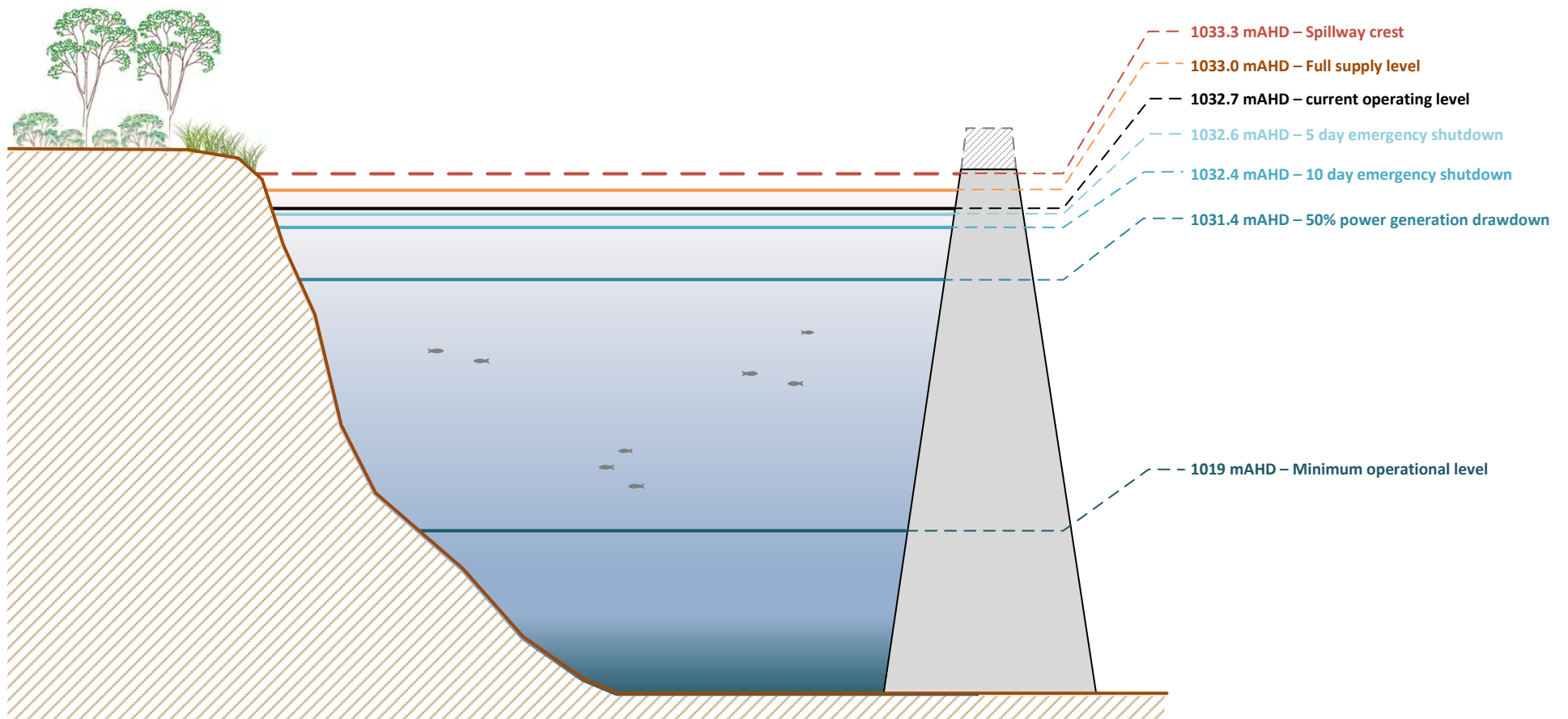
Outcomes of the environmental assessment scenarios indicated that the current operational level of TCR (± 0.1 m) could be maintained for scenarios 4 and 5, with drawdown required for Scenario 3 and transfer to Lake Wallace required for scenarios 1 and 2.

The results for scenarios 4 and 5 (75% and 100% power generation requirement at MPPS respectively) indicated that the current operational level of TCR (± 0.1 m) could be maintained with no water required to be transferred to Lake Wallace. This is primarily due to the make-up water demand at MPPS exceeding the supply of treated water from the proposed WTP, which is consistent with the outcomes of the original EIS (where no discharges to Wangcol Creek were predicted). A power generation requirement at MPPS of 61% was predicted to be the lower limit to maintain the current operating level of TCR (± 0.1 m).

For Scenario 3 (50% power generation requirement), the operating level of TCR was required to be lower than the current operating level to sustainably store excess treated water from the proposed WTP. The results of the water balance modelling indicate that a reduction in operating level to 1.6 m below the FSL and 1.3 m below the current operating level would be required. This level is within the historical storage level of TCR over the past two years and is expected to be sustainable. The reduction in operating level is considered to be essential during periods when water supply from the SDWTS exceeds the make-up water demand at MPPS. For Scenario 3, this was modelled to occur between 2029 and 2035.

A power generation requirement of 32% at MPPS was predicted by the water balance modelling to be the upper limit for the sustainable use of TCR to store excess treated water (assuming an operational level at the minimum operating level for TCR of 1,019 m AHD). Sustained power generation at levels lower than 32% were predicted to result in excess water required to be transferred to Lake Wallace.

The results for scenarios 1 and 2 (0% and 25% power generation requirement at MPPS respectively) indicated that the use of TCR to store excess treated water is not sustainable over the life of the Project. Modelling for these scenarios assumed a minimum operating level of 1,019 m AHD, with the volume held within the reservoir predicted to exceed the FSL after approximately 3.7 years (in February 2021) for Scenario 1 and approximately 18 years (in August 2035) for Scenario 2 on average.

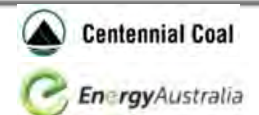


© 2016. Whilst every care has been taken to prepare this figure, GHD make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the figure being inaccurate, incomplete or unsuitable in any way and for any reason.

LOCATION		Springvale
SEAM		NA
DRAWN		SM
CHECKED		LH
APPROVED		SG
SCALE		NTS

Amended Springvale Water Treatment Plant Water Resources Impact Assessment

Changes to operational water level



DATE Dec 2016 Figure 6-30

As discussed in Section 6.1.2, there are two options for the disposal for excess water from TCR available to manage water levels with the reservoir. TCR has an outlet on Pipers Flat Creek which is a valve system off the main supply line to MPPS. As environmental flow requirements for TCR are currently met by riparian releases, the use of the Pipers Flat Creek outlet has not been used over the life of the dam. MPPS has been able to manage water levels in TCR predominately through regulating Lake Lyell supply and MPPS demands.

Not considering the Pipers Flat Creek outlet point as an option for disposal of excess water from TCR, the alternative is the use of existing transfer infrastructure to supply treated water to Lake Wallace. This forms a contingency measure for the Project as the likelihood of this ever being required is low. The lead time in scenarios such as this are likely to be in the order of at least two years (depending on the level within TCR). The transfer pathway is highlighted with orange arrows on Figure 6-31.

The predicted excess water required to be transferred to Lake Wallace for scenarios 1 and 2 are summarised in Table 6-6.

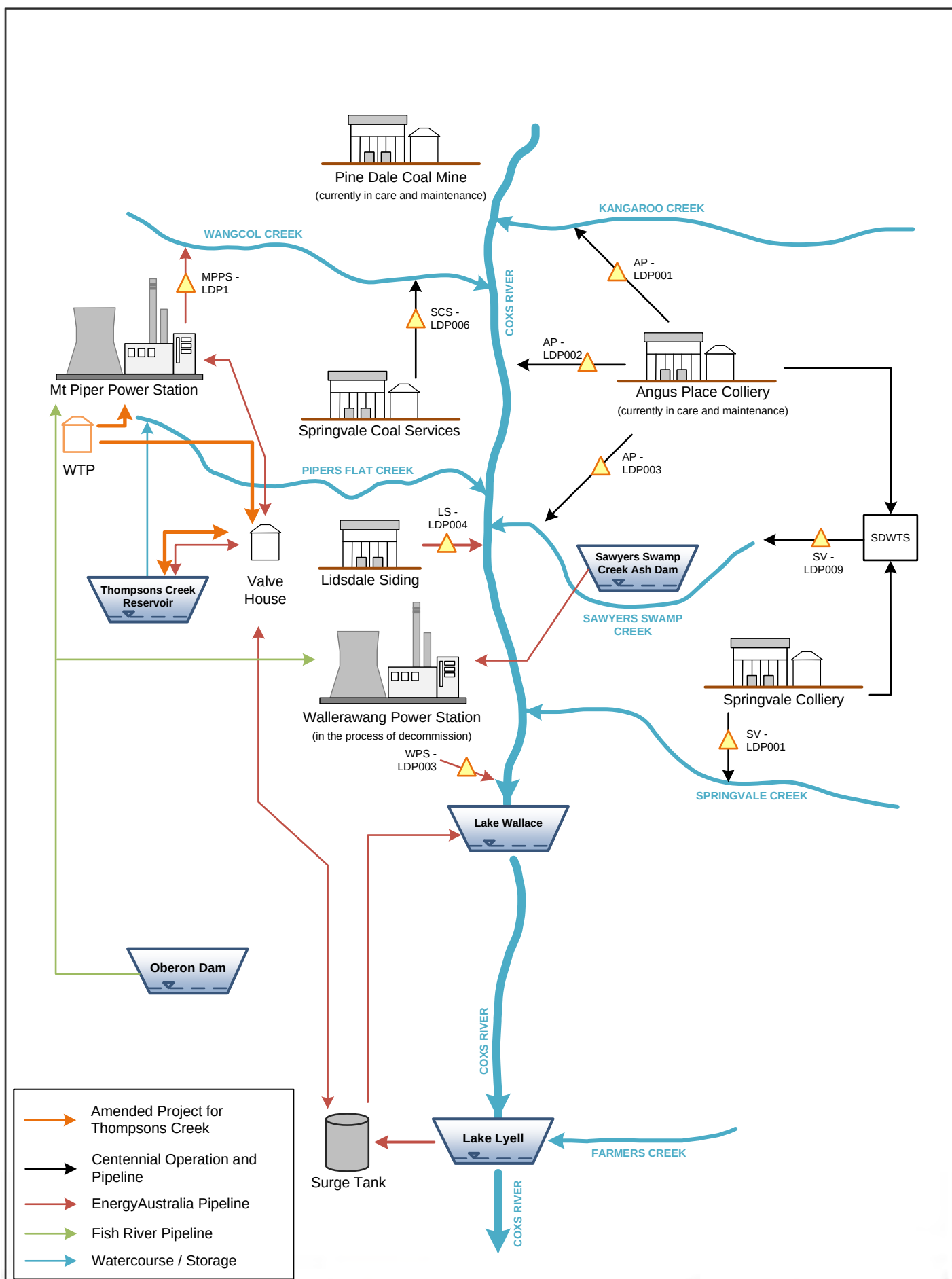
Table 6-6 Predicted excess water required to be managed (scenarios 1 and 2)

Scenario	10th percentile (ML/day)	Average (ML/day)	90th percentile (ML/day)	Corresponding year peak occurs
Scenario 1 – 0% power generation at MPPS	26.8	27.9	29.4	2031 – peak groundwater occurs this year
Scenario 2 – 25% power generation at MPPS	5.5	8.6	10.9	2035 – delay in peak due to reuse by power station demand

As Lake Wallace is currently maintained as full with excess water from the lake discharged downstream to the Coxs River, the increase of inflow volumes to the lake are unlikely to change the current operating conditions with respect to flow frequency however the flow volume is likely to increase. The WaterNSW Coxs River flow gauge site of “Coxs @ Bathurst Rd” (station number 212008) has been used as a point to estimate the contribution of discharges from Lake Wallace to the Coxs River. Figure 6-32 presents the daily flow volume from WaterNSW from January 2014 to March 2015 (limited by current data availability).

The monitoring data presented in Figure 6-32 indicates the previous regulation of Lake Wallace up to March 2014. Following this period, it is expected that the lake has been maintained as full with overflows contributing to Coxs River. During the period of regulation, flow within Coxs River in 2014 averaged 13.5 ML/day downstream of Lake Wallace. Following this period average flow increased in Coxs River to between 36.4 ML/day and 36.7 ML/day in 2015 (however limited to two months of available data in 2015).

The use of Lake Wallace as the disposal point for excess water from TCR is the preferred option compared to release to Pipers Flat Creek. The capacity to convey flow within Pipers Flat is likely to be less than that of the Coxs River downstream of Lake Wallace. In addition, from a visual assessment of the creek, the lack of riparian vegetation along much of its length also raises the potential risk of instabilities forming or to be exacerbated. As indicated in Figure 6-32, the flow volumes within Coxs River at the WaterNSW monitoring site has observed elevated flow volumes from time to time with a 95th percentile flow volume of 68 ML/day observed over the 15 month sample set.



© 2016. Whilst every care has been taken to prepare this figure, GHD make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the figure being inaccurate, incomplete or unsuitable in any way and for any reason.

LOCATION	Western Coalfield
SEAM	NA
DRAWN	SM
CHECKED	LH
APPROVED	SG
SCALE	NTS



Amended Springvale Water
Treatment Plant
Water Resources Impact Assessment

Transfer pathway of excess water to
Lake Wallace



Centennial Coal



EnergyAustralia

DATE Dec 2016

Figure 6-31

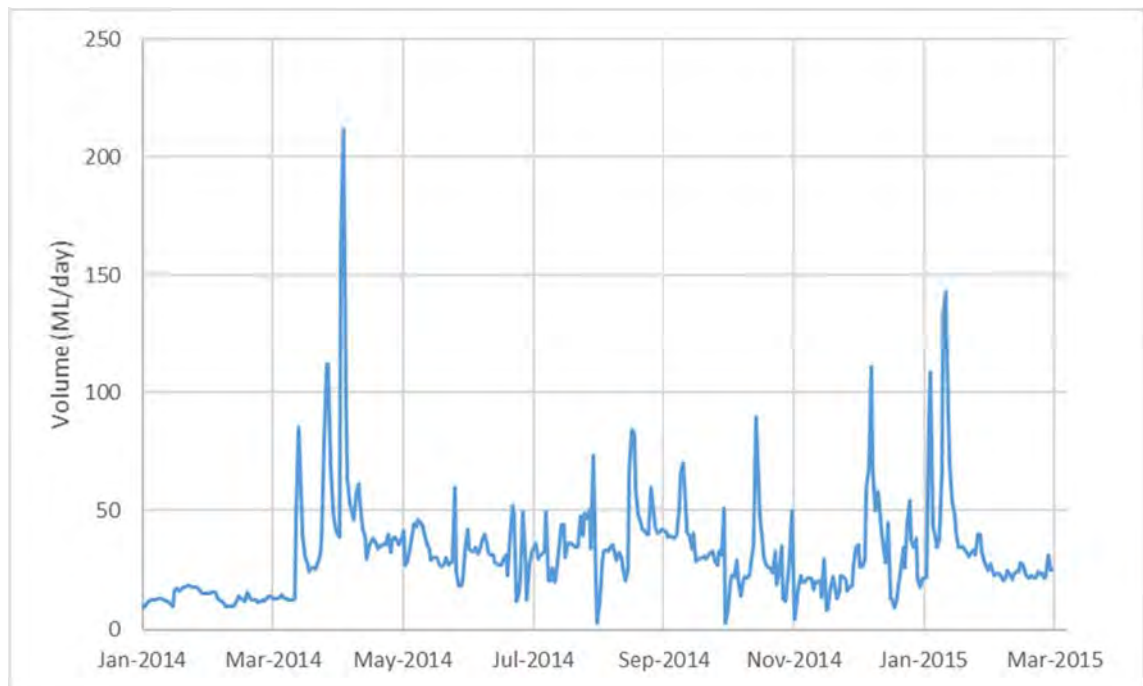


Figure 6-32 Daily flow volumes downstream of Lake Wallace

6.2.4 Summary

Summaries of the change in average results between existing conditions in 2016 and proposed conditions in 2031 for the water and salt balance are provided in Table 6-7 and Table 6-8 respectively. For the proposed conditions, results are presented for Scenario 3 and the do nothing scenario. All results are based on a 50% power generation requirement at MPPS. Note that slight differences in modelling results are attributed to an extra day of simulation represented under existing conditions compared to proposed conditions.

As shown in Table 6-7, the amended Project is proposed to increase the flow in Wangcol Creek at the confluence with the Coxs River by up to 2% on average compared to existing conditions and by up to 4% compared to the do nothing scenario. This is as a result of an increase in the discharge from LDP006 associated with the transfer of residual material from the Project to the SCSS. The EC in Wangcol Creek was predicted to increase as a result of the discharges from the SCSS via LDP006, by up to 16% compared to the do nothing scenario. However, the changes in the water management system at SCSS were found to mitigate this increase with only a 1% increase in EC compared to existing conditions.

For the results for proposed conditions modelled in Scenario 3, inflows to Lake Wallace, Lake Lyell and Lake Burragorang from the Coxs River were predicted to decrease, compared to existing conditions and the do nothing scenario. This is due to the increase in the mine water make transferred to the SDWTS under proposed conditions (Scenario 3 and do nothing scenario) compared to existing conditions, which is modelled to be used by MPPS in Scenario 3. The EC of the Coxs River at the inflow to the surface water storages is predicted to decrease for Scenario 3 compared to both existing conditions and the do nothing scenario, as shown in Table 6-8. This occurs as a result of the treatment of mine water make using reverse osmosis (RO) processes to decrease EC and reuse at MPPS as part of the Project, compared to the modelled discharge of LDP009 to Sawyers Swamp Creek.

Table 6-7 Summary of change in water volume results under proposed conditions

Location	Existing conditions (ML/year)	Do nothing scenario (ML/year)	Scenario 3 (ML/year)	Change between Scenario 3	
				Existing conditions	Do nothing scenario
Wangcol Creek at confluence with Coxs River	3,027.5	2,964.8	3,092.6	2%	4%
Coxs River flow to Lake Wallace	23,179.7	27,761.1	15,046.8	-35%	-46%
Coxs River flow to Lake Lyell	33,617.6	38,124.5	25,410.1	-24%	-33%
Coxs River flow to Lake Burragorang	123,915.2	128,299.4	126,818.6	2%	-1%

Table 6-8 Summary of change in electrical conductivity results under proposed conditions

Location	Existing conditions ($\mu\text{S/cm}$)	Do nothing scenario ($\mu\text{S/cm}$)	Scenario 3 ($\mu\text{S/cm}$)	Change between Scenario 3	
				Existing conditions	Do nothing scenario
Wangcol Creek at confluence with Coxs River	910	790	920	1%	16%
Coxs River flow to Lake Wallace	660	710	340	-48%	-52%
Coxs River flow to Lake Lyell	510	560	270	-47%	-52%
Coxs River flow to Lake Burragorang	170	190	140	-18%	-26%

6.3 Surface water quality

6.3.1 Predicted treated water quality

Water treated at the proposed WTP is to meet the treated water performance measures as prescribed by GHD (2016e), which are presented in Table 6-9. It is noted that Table 6-9 presents the metals concentrations as totals in order to provide definitive limiting concentrations, though it is most likely that following treatment these metals concentrations would comprise almost entirely of dissolved species.

The predicted typical (median) treated water quality was modelled by GHD as part of the tender design of WTP. The results of this modelling are also presented in Table 6-9. No exceedances of the ANZECC (2000) DGVs are predicted. Comparison with the historical water quality data for TCR (refer to Table 5-5) shows that the treated water is predicted to be considerably less saline, due to lower concentrations of all of the major ions. A neutral pH is predicted for the treated water, whereas the water in TCR is historically slightly alkaline.

The predicted treated water quality from the proposed WTP, summarised in Table 6-9, is to be confirmed as part of the commissioning phase of the Project. The water quality modelled and presented in Table 6-9 does not consider any regulation of the treated water quality to mitigate the potential for toxicity due to the treated water being stripped of ions. The water quality to be released to TCR is expected to resemble a water quality similar to that of TCR already regulated through the process systems by MPPS.

Table 6-9 Treated water quality

Parameter	Units	DGV (ANZECC 2000)	Required water quality (100th percentile)	Predicted typical water quality
Physicochemical parameters				
Dissolved oxygen (DO)	mg/L	–	–	8.7
EC	µS/cm	350	500	202
pH	pH units	6.5–9.0	6.5–8.5	7.1
Temperature	°C	–	–	24
TDS	mg/L	–	–	176
TSS	mg/L	25	10	<5
Nutrients				
Ammonia	mg/L	0.9	–	0.139
Nitrite	mg/L	–	–	0.002
Nitrate	mg/L	0.7	–	0.061
Total phosphorous	mg/L	0.02	–	0.001

Parameter	Units	DGV (ANZECC 2000)	Required water quality (100th percentile)	Predicted typical water quality
Anions				
Alkalinity (total as CaCO ₃)	mg/L	–	–	80
Chloride	mg/L	–	–	10
Sulfate	mg/L	–	–	6
Cations				
Calcium	mg/L	–	–	<1
Magnesium	mg/L	–	–	<1
Sodium	mg/L	–	–	44
Potassium	mg/L	–	–	2
Metals (total)				
Aluminium	mg/L	0.055	0.08	<0.001
Arsenic (III)	mg/L	0.024	0.1	0.002
Arsenic (IV)	mg/L	–	0.01	–
Barium	mg/L	–	–	0.006
Boron	mg/L	0.37	0.15	0.086
Cadmium	mg/L	0.0002	0.0004	<0.0001
Chromium	mg/L	0.001	0.0005	<0.001
Cobalt	mg/L	0.0025	0.0018	<0.001
Copper	mg/L	0.0014	0.0018	<0.001
Iron	mg/L	0.3	0.05	0.004
Lead	mg/L	0.0034	0.001	<0.001
Manganese	mg/L	1.9	0.5	<0.001
Mercury	mg/L	0.0006	0.0006	<0.0001
Molybdenum	mg/L	–	–	0.007
Nickel	mg/L	0.011	0.013	0.001
Selenium	mg/L	0.011	0.005	0.001
Zinc	mg/L	0.008	0.015	0.001

6.3.2 Thompsons Creek Reservoir

As the 100 percentile limiting value for salinity to be released to TCR is lower than the historical median of the reservoir (refer Table 5-5), any releases from the amended Project will have a diluting effect. This effect would be minor, as the release requirement will only be when MPPS is operating at approximately 50% or lower capacity. At 50% capacity (Scenario 3 in Section 6.2.1) the release is predicted to be up to approximately 4 ML/day. Even the highest predicted discharges of up to 36 ML/day are unlikely to result in significant dilution of the water in TCR, as these releases will only be required during total power shutdowns, which are predicted to occur a maximum of one to two days per year.

Due to the de-stratification system used at TCR, any treated water released to the reservoir is predicted to be well mixed with the water already present, and stratification due to salinity or temperature differences is unlikely. As such, any release of excess treated water from the amended Project is predicted to result in little change to the water quality in TCR (noting that it is monitored at the water surface), due to the considerable volume of the reservoir. However, from a simplistic mixing perspective, releases of treated water would result in the following changes to TCR water quality:

- Reduced pH.
- Reduced concentrations of all of the major ions.
- Negligible increases in the concentrations of ammonia and nitrate.

6.3.3 Thompsons Creek and Pipers Flat Creek

Any change to the water quality of TCR as a result of the amended Project is predicted to be negligible and diluting (in terms of ionic strength). As such, no adverse impact on the water quality of Thompsons Creek (which currently receives riparian releases from TCR) or Pipers Flat Creek (which Thompsons Creek reports to) is predicted. In the event that increased discharge from TCR to Pipers Flat Creek via the existing discharge valve is required, minor increases in the pH and the bicarbonate alkalinity concentration are predicted. No exceedances of the ANZECC (2000) DGVs or the derived SSGVs for Pipers Flat Creek (provided in Section 6.3.4) are predicted. The utilisation of the Pipers Flat Creek discharge valve is unlikely, with the preferred operation of the amended Project utilising the existing transfer infrastructure to allow water to flow under gravity to Lake Wallace, via the Wallerawang Pipeline.

6.3.4 Recommended site specific guideline values for the amended Project

SSGVs have been derived for the amended Project based on a review of the ANZECC (2000) DGVs and the 80th percentile values for water quality data collected at monitoring site PFup. Table 6-10 presents the recommended SSGV, as well as the DGVs and 80th percentile results for PFup.

The 80th percentile values for water quality data at PFup have been calculated using the data available between January 2014 and August 2016. As samples have been collected for over two years, the dataset covers a range of seasonal, climatic and flow conditions.

Table 6-10 Site-specific guideline values for the amended Project

Parameter	Units	Pipers Flat Creek 80th percentile	ANZECC (2000) DGV	Recommended SSGV
Physicochemical parameters				
EC	µS/cm	821	350	821

Parameter	Units	Pipers Flat Creek 80th percentile	ANZECC (2000) DGV	Recommended SSGV
pH	pH unit	7.1–7.4	6.5–9.0	6.5 – 9.0
Turbidity	NTU	9	25	25
TSS	mg/L	10	25	25
Nutrients				
Ammonia	mg/L	–	0.9	0.9
Nitrate	mg/L	0.37	0.7	0.7
Total nitrogen	mg/L	–	0.25	0.25
Total phosphorus	mg/L	–	0.02	0.02
Dissolved metals				
Aluminium	mg/L	–	0.055	0.055
Arsenic	mg/L	–	0.024	0.024
Boron	mg/L	–	0.37	0.37
Cadmium	mg/L	–	0.0002	0.0002
Chromium	mg/L	–	0.001	0.001
Cobalt	mg/L	–	0.0025	0.0025
Copper	mg/L	–	0.0014	0.0014
Iron	mg/L	0.21	0.3	0.3
Lead	mg/L	–	0.0034	0.0034
Manganese	mg/L	0.369	1.9	1.9
Mercury	mg/L	–	0.0006	0.0006
Nickel	mg/L	–	0.011	0.011
Selenium	mg/L	–	0.011 ^a	0.011 ^a
Silver	mg/L	–	0.00005	0.00005
Zinc	mg/L	–	0.008	0.008

^a Guideline value for total selenium.

SSGVs are applicable to future situations where discharges are required from TCR to Pipers Flat Creek. Discharges to Pipers Flat Creek may be undertaken in emergency situations to avoid the water level in TCR rising to the FSL. However, the amended Project proposes to transfer excess treated water to Lake Wallace via the existing Wallerawang Pipeline to avoid the requirement for any discharges to Pipers Flat Creek.

From the parameters assessed for background Pipers Flat Creek, EC was the only parameter that presented a result elevated above ANZECC (2000) DGVs. Whilst TCR does contribute some flow to Pipers Flat Creek via riparian releases into Thompsons Creek, it is expected that this flow would have sufficiently mixed with the contributing catchment before the PFup sampling location, which is located nearby the creeks confluence with Coxs River.

The quality of water transferred from TCR is expected to an improvement to what is already present within Lake Wallace and therefore will provide a diluting effect. It is expected that the water quality of the Coxs River catchment would gradually improve as water is either reused at MPPS or recirculated within the Coxs River water supply system.

6.4 Fish community

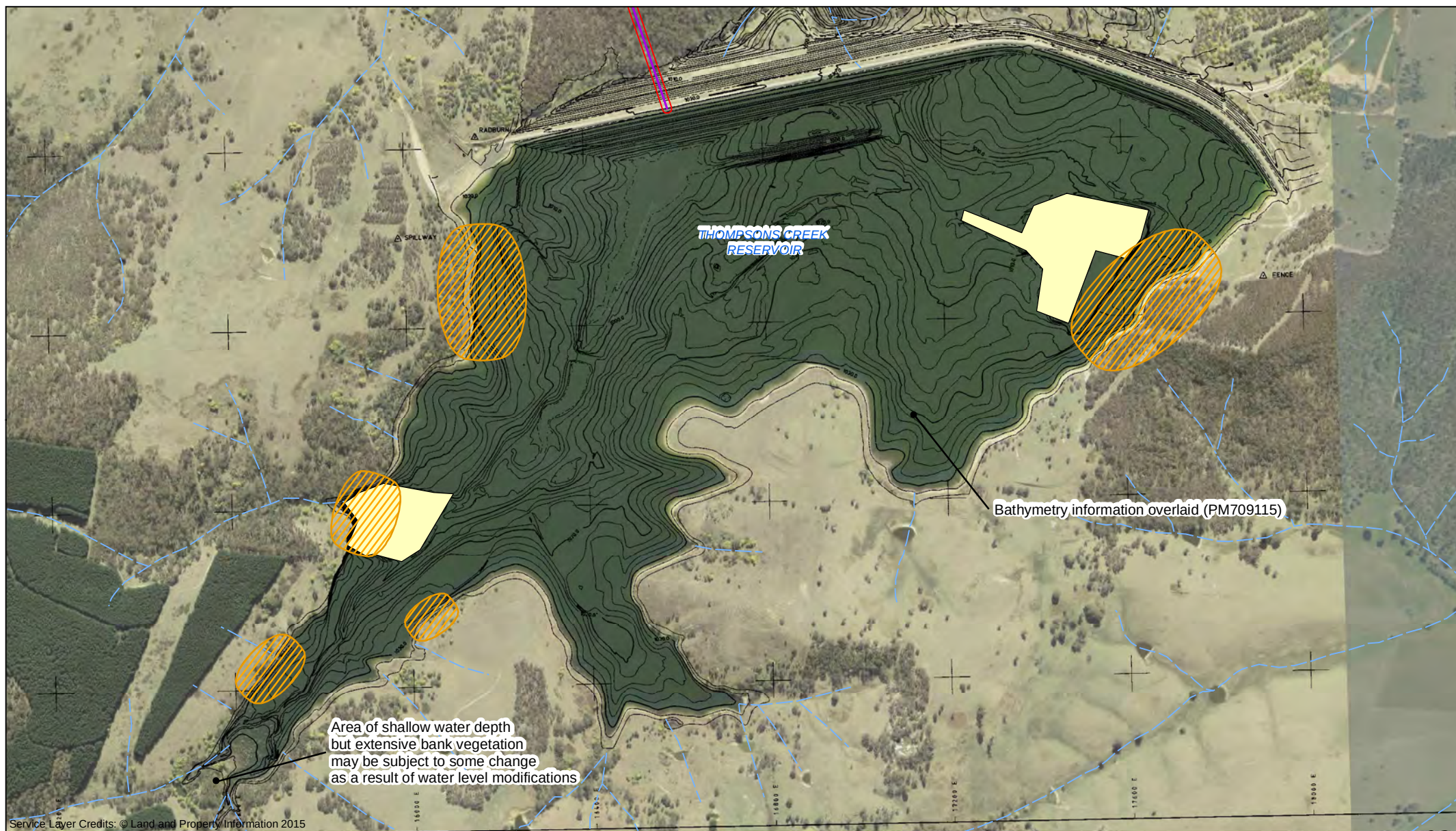
Given the minimal expected impact on water quality predicted in Section 6.3, and considering the environmental preferences and tolerances of the fish species present in TCR as shown in Table 6-11, it is unlikely that the amended Project would have an impact on the fish community. Thermal tolerances of trout species are close to or just under the modelled temperature of water to be released into TCR, which should not be an issue given the size and depth of the impoundment.

Table 6-11 Environmental tolerances of fish collected in Thompsons Creek Reservoir

Parameter	Units	<i>Oncorhynchus mykiss</i> Rainbow trout	<i>Philypnodon grandiceps</i> Flathead gudgeon	<i>Salmo trutta</i> Brown trout
Ammonia	mg/L	0–1.8	NI	0–1.8
DO	mg/L	2.6–13.0	2.8–12.0	2.6–13.0
EC	µS/cm	0–46,000	122.1–2,495	0–46,000
Hardness as CaCO ₃	mg/L	4–160	NI	4–160
Nitrate	mg/L	0–0.25	NI	0–0.25
pH	pH units	4.5–9.0	6.0–8.6	4.5–9.0
Temperature	°C	5–26	11–31	8–23.5
Turbidity	NTU	NI	0.7–38	NI
Zinc (dissolved)	mg/L	0–3.01	NI	0–3.01
Source of information		Molony (2001)	Pusey <i>et al.</i> (2004)	Molony (2001)

NI – no information

Preferred habitat for trout is steep, rocky drop-offs such as those found on the eastern shore and in the quarry sections of TCR. Should the water level change in those areas there may be some changes to the distribution of trout species within the reservoir, however this should not result in any mortality or reduction in survival of the species. Submerged features of the reservoir features are shown in Figure 6-33.

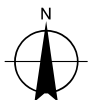


Paper Size A4

0 100 200 400

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56



LEGEND

- Cox's River Water Supply Pipeline
- Project application area
- Watercourse - Non Perennial
- Watercourse - Perennial
- Quarry and borrow pit areas
- Elevated bank risk



Centennial Coal
Amended EA/CEY Water Treatment Project
Water Resources Impact Assessment

Job Number | 21-25109
Revision | A
Date | 16 Nov 2016

Reservoir bathymetry

Figure 6-33

G:\22\0105001\GIS\Maps\Deliverables\Western\Springvale\2125109\TCR_Options\2125109_TCR008_TCRBatheo_A.mxd

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 T 61 2 4979 9999 F 61 2 4979 9988 E ntlmail@ghd.com W www.ghd.com.au

© 2016. Whilst every care has been taken to prepare this map, GHD, Centennial Coal and NSW LPI make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Data source: Aerial Imagery: Sixmaps (2016) - NSW LPI, General topo: NSW LPI DTD 2012. Centennial: Site location, boundaries, pipeline: EnergyAustralia: bathymetry imagery: 2016. Created by: tmorton

Metal and nutrient toxicant concentrations in the treated water are not predicted to exceed the relevant ANZECC (2000) DGVs and therefore no impact on the fish community in TCR is predicted due to toxicity. The treated water to be released to TCR is predicted to be soft (refer Table 6-9), due to low concentrations of calcium and magnesium. This low hardness is outside of the tolerance range for both species of trout, though is not predicted to have an impact due to the moderate salinity and hardness of the water in TCR. Based on the predicted treated water quality, presented in Table 6-9, and the historical TCR water quality, presented in Table 5-5, the mixing ratio of water from the two sources would have to exceed 39:1 respectively for the water hardness to be outside the tolerance of trout. This ratio is unlikely to occur as a result of the amended Project given the volumes maintained within TCR as part of existing operations. This indicates the risk to trout is low.

These assumptions do not account for any changes to the stocking regime undertaken by DPI. As TCR does not provide breeding habitat for brown or rainbow trout, the populations of these species are dependent on their stocking rates. The flathead gudgeon population is also strongly influenced by the trout stocking, as it is a likely prey species of both salmonids.

6.5 Stream health

As water levels in TCR are to be managed under the amended Project in order to prevent additional discharges from the reservoir, no change to the stream health of Thompsons Creek or Pipers Flat Creek is predicted. Potential risks associated with the discharge of excess water to Lake Wallace in periods of low power generation may potentially create or exacerbate existing instabilities if the waterway downstream of the lake cannot cater for the increased discharge. This would influence aquatic ecology habitats within Coxs River. Given the uncertainty of future power generation, it is likely that excess water management could be managed as part of a trigger action response plan (TARP) which is further discussed in Section 8.2.

6.6 Neutral or beneficial effect

The assessment of NorBE on water quality is undertaken through consultation between WaterNSW and the NSW Department of Planning and Environment (DPE). As the Minister for Planning is the consent authority for the amended Project, the assessment of NorBE is at the Minister's discretion. The NorBE guideline (WaterNSW 2015) provides some guidance to how various projects can be assessed. As the Project is a SSD, it falls under Module 5 of the guideline. Module 5, defined as 'other development', allows for a customised assessment approach that still achieves the overall objectives of the effect-based assessment and provides the framework for the consultation process between WaterNSW and DPE during the evaluation of a project.

The Project EIS considered NorBE at each of the points of interest required by WaterNSW (refer Figure 6-4 and Figure 6-5) and this has been updated for the amended Project, presented in Table 6-11. As with the EIS, the evaluation of EC was used as the measure of water quality change for the amended Project and compared the results of the water and salt balance modelling for Scenario 3 and the do nothing scenario (both based on a 50% power generation requirement at MPPS) in 2031.

It should be noted that the results for LDP009 discharges to Sawyers Swamp Creek and for Sawyers Swamp Creek at the confluence with the Coxs River have not changed as a result of the amended Project. Refer to the original WRIA (GHD 2016a) for these results.

Table 6-12 NorBE test outcomes for flow and water quality (based on electrical conductivity)

Point of interest	Outcome
Wangcol Creek at the confluence with discharge from LDP006	Increased EC and flow as a result of residuals – NO BENEFIT
Wangcol Creek at the confluence with the Coxs River	Increased EC and flow as a result of residuals – NO BENEFIT
Proposed point of release into TCR	Meets consent condition in SSD-5594
Coxs River at the inflow to Lake Wallace	Reduced EC and flow as a result of mine water used at MPPS – BENEFIT
Coxs River at the inflow to Lake Lyell	Reduced EC and flow as a result of mine water used at MPPS – BENEFIT
Coxs River at the inflow to Lake Burragorang	Reduced EC and flow as a result of mine water used at MPPS – BENEFIT

The results of Table 6-11 are generally consistent with those presented within the Project EIS downstream of Lake Wallace however there are some key differences of note, which are further discussed below.

Increased discharges from LDP006 to Wangcol Creek associated with the transfer of residual material from the Project to the SCSS on the water management system at that site will result in increases in EC within the creek. These increases are likely to be within historical ranges when considering annual average statistics. The residual material transferred to SCSS is likely to have a diluting effect on the quality of water already present at SCSS; however, due to the volumetric size of the introduced load and the inability of SCSS to regulate discharges from its current levels, and dominant EC sources from surface water storages within the site, EC is expected to increase. This increase was predicted to occur from LDP006 to the Coxs River confluence with the tributary of Sawyers Swamp Creek.

In the event that prolonged low power generation rates at MPPS (that is, less than approximately 32%), the need to discharge excess treated water to Lake Wallace in order to maintain operating levels within TCR will occur as a result of the amended Project. This transfer is likely to increase the flow volume occurring downstream of Lake Wallace to Lake Lyell. The water quality of TCR is representative of Lake Lyell and with the proposed WTP in operation, this is likely to be more dilute than existing conditions. It is therefore likely that, regardless of the increased flow rate from Lake Wallace, the EC at this location is to improve.

6.7 Downstream water users

Table 6-13 presents the predicted impacts to the identified licensed downstream water users.

Table 6-13 Impacts to downstream water users

Licence number	Location	Impacts to flow	Impacts to EC
WAL 25607	Coxs River upstream of Lake Wallace	Decrease	Decrease

Licence number	Location	Impacts to flow	Impacts to EC
WAL 27428	Lake Wallace	Potential increase in periods of low power generation	Decrease
	Lake Lyell	Potential increase in periods of low power generation	Decrease
WAL 27431	Lake Burragorang	Negligible change	Negligible change

The results from Table 6-13 indicate that greatest potential for change (although minimal) is the storages of Lake Wallace and Lake Lyell. This is likely to be in scenarios where the power generation rates are below 32% and excess treated water is required to be transferred to Lake Wallace from TCR. Generally, the amended Project will decrease catchment salinity through the treatment of water from the SDWTS.

WAL 25607 is located directly downstream of the Sawyers Swamp Creek tributary on the Coxs River and is predicted to observe a reduction in EC and flow from the cessation of LDP009 discharges, which contribute to Sawyers Swamp Creek. However, there will be some effects associated with the proposed WTP residual material being managed at SCSS resulting in increased discharges and EC from LDP006. The improvements from Sawyers Swamp Creek are likely to outweigh any impacts from the residuals at LDP006.

7. Licensing requirements

7.1 Protection of the Environment Operations Act 1997

The amended Project will require a new EPL due to the scheduled activity defined as groundwater treatment where over 100 ML/year will be treated. The EPL will define the applicant as the owner of the assets, to be Centennial, however the compliance for environment management will be a third party contractor.

7.1.1 Water quality limits

Water quality limits to be considered by NSW Environment Protection Authority (EPA) in the development of a new EPL for the amended Project are proposed to be representative of the SSGVs for Pipers Flat Creek (refer Table 6-10). These guideline values are proposed to provide a conservative approach for the Coxs River compared to Lake Lyell. The amended Project will supply treated water at concentrations below that of the Pipers Flat Creek SSGVs and hence the SSGVs will be an upper limit.

An alternative option to Pipers Flat Creek SSGVs is the adoption of baseline data from TCR itself, which have a correlation to water quality present within Lake Lyell. The development of the EPL will be subject to consultation with the EPA.

7.1.2 Excess water connection location

A connection will be required for the transfer of excess treated water to TCR. The connection point will be located at MPPS where the proposed WTP excess connects into the trunk water bi-directional pipeline between MPPS and TCR. This location is proposed not to be licensed as a discharge point within the proposed EPL to be developed for the amended Project. The connection point will allow for a volumetric limit up to 42 ML/day in line with the proposed treatment capacity of the WTP.

7.2 Water Management Act 2000

As a result of the amended Project and the focus on use of TCR as both a water supply storage and release point for excess treated water, the current WALs in place for the operation of the Coxs River water supply system were reviewed. The WAL conditions and combined approval issued to EnergyAustralia authorises the take and use of water from the Coxs River for power generation purposes and includes Lilyvale Dam (Lake Lyell), Wallerawang Dam (Lake Wallace) and TCR. These licence conditions define EnergyAustralia's water access rights and obligations and regulate the operation and management of its water management works. There is no proposed change to the current licence held by EnergyAustralia.

8. Avoidance, mitigation and management

8.1 Monitoring and management requirements

8.1.1 Thompsons Creek Reservoir

EnergyAustralia's monitoring of TCR water levels and quality is proposed to continue. The monitoring requirements are summarised in Table 8-1 below.

Table 8-1 Thompsons Creek Reservoir water quality monitoring

Frequency	Monitoring parameters
Weekly*	Physicochemical: EC, pH, TSS Metals (dissolved): Al, As, B, Cu, Fe, Mn, Ni, V, Zn Metals (total): Al, As, Ba, Be, B, Cd, Cr, Cu, Fe, Pb, Mn, Mo, Ni, Se, Ag, V, Zn Anions: Cl, F, SO₄, alkalinity Cations: Ca, Mg, Na, K, total hardness Nutrients: Ammonia, nitrite, nitrate, nitrite + nitrate, TKN, total nitrogen, total phosphorus Other: Silica

* Frequency increased in May 2016 after being monthly.

Following any change in operating water level of TCR made by MPPS following the approval of the amended Project, it is proposed that a revision of geotechnical models for the reservoir be undertaken to confirm the likely seepage rate through the dam wall. This is proposed to occur within 12 months of the Project's approval or as part of the next round of surveillance monitoring undertaken as part of Dam Safety NSW monitoring requirements.

8.1.2 Water treatment plant

Monitoring of the release volume and water quality of the proposed point of release into TCR will be performed by a third party contractor at the frequency and for the parameters shown in Table 8-2.

Table 8-2 Water quality monitoring for the proposed point of release to Thompsons Creek Reservoir

Frequency	Monitoring parameters
Daily during release	Physicochemical: pH, EC, DO, temperature, TSS, turbidity, oil and grease Metals (dissolved and totals): Al, As, Cd, Cu, Co, Ni, Zn, Fe, B, Mn, Pb, Hg, Cr, Se Other: F
Monthly during release	Physicochemical: pH, EC, temperature, turbidity, free chlorine, total chlorine, DO, TSS, TDS, oil and grease

Frequency	Monitoring parameters
	Anions: Cl, F, SO ₄ , alkalinity Cations: Ca, Mg, Na, K, total hardness Nutrients: Ammonia, nitrite, nitrate, nitrite + nitrate, TKN, total nitrogen, total phosphorus Metal (dissolved): Al, As, Cd, Cu, Co, Ni, Zn, Fe, B, Mn, Pb, Hg, Cr, Se, Ba, U, Sb, Li, Mo, Rb, Sr Semi-volatile organics: phenolic compounds Other: silica, silicon, total cyanide, total organic carbon

8.1.3 Downstream receiving environment of Lake Wallace

Centennial maintain a monitoring site for water quality downstream of Lake Wallace, referred to as part of Springvale Mine operations as Coxs River (Delta Site). This is proposed to be maintained and considered in any assessment of operational performance if transfers from TCR to Lake Wallace are required.

No watercourse stability or geomorphic assessment has been undertaken historically downstream of Lake Wallace to confirm the capacity of the natural system and the ability for the system manage flow volumes. In the event that discharge of excess treated water is required to be transferred to Lake Wallace, depending on the volume transferred, field condition assessments of the Coxs River for a length of 500 m to a 1 km should be undertaken.

Centennial undertake aquatic ecology monitoring as part of their Western Coal Services, Angus Place Colliery, Springvale Mine and Lidsdale Siding operations. Sites that should be considered as part of monitoring of aquatic ecology in the event that increased discharges to the environment as required are summarised in Table 8-3.

Table 8-3 Aquatic ecology monitoring downstream of potential discharge locations

Site location	Location	Eastings (m)	Northings (m)	Minimum monitoring frequency (historical data)
		MGA 56		
PFup	Upstream monitoring from Lidsdale Siding operation of Pipers Flat Creek	227,738	6,300,763	Spring and autumn (2013-2015)
CR5	Downstream monitoring from Springvale Mine of Coxs River	228,529	6,300,752	Spring and autumn (2013-2015)

8.2 Trigger action response plan

The development of a TARP is proposed for the amended Project for the operation of TCR. The TARP should consider triggers and responses to the following potential risks:

- Water level in TCR above/below defined operating levels.
- Surface water quality released to TCR.

- Environmental flow water quality from TCR.

The TARP presented in Table 8-4 indicates the typical responses to be undertaken as part of EnergyAustralia's operation as a result of three trigger levels.

8.3 Reporting

As discussed in the original WRIA (GHD 2016a), the completion of a WTP commission report will be required. As part of this commissioning phase the following will be undertaken:

- One hour composite sampling of treated water over the period over 24 hours and analysis of water quality.
- Ecotoxicology testing of treated water on standard suite of test species including fish bioassays.
- Development of a report summarising the final WTP specifications and results from commissioning testing.

The commissioning report will be developed in consultation with EnergyAustralia, WaterNSW, EPA, DPI Water and DPE.

8.4 Review

The review of the outcomes predicted within this WRIA will be required to validate the assumptions made concerning the impacts of the transfer of excess treated water to TCR on surface water.

At a minimum, a review of the impacts of the transfer of excess treated water to TCR is to be undertaken every year, or specifically as a result of:

- Any statutory or regulatory requirements.
- Any significant change to water management practices.
- Any incident that requires reporting.

Table 8-4 Trigger action response plan

Aspect	Normal	Level 1	Level 2	Response
Supply of water from WTP to TCR	Supply is within predicted range for period	Trigger: Supply is in excess of predicted range by 10% Action: Review water volumes for systems at the Centennial operations Estimate the necessary storage required for excess water within TCR and undertake actions to facilitate excess water storage	Trigger: Supply is in excess of predicted range by 30% Action: Review water volumes for systems at the Centennial operations Estimate the necessary storage required for excess water within TCR and undertake actions to facilitate excess water storage Utilise storage options at the Centennial operations to reduce the increased water supply	Trigger 1: Notify Springvale Mine Environmental Coordinator or Mine Manager Notify EnergyAustralia Environmental Coordinator or Operations Manager Trigger 2: Notify Springvale Mine Environmental Coordinator or Mine Manager Notify EnergyAustralia Environmental Coordinator or Operations Manager

Aspect	Normal	Level 1	Level 2	Response
TCR level	Storage at or below operational level	Trigger: Excess water to be released into TCR. Action: Ensure adequate holding volume is available within TCR Draw down storage via preferential reuse from TCR over supply from Lake Lyell Refer to predicted operational conditions within Section 6.2.3	Trigger: Excess water to be released into Dam during significant or prolonged rainfall. Action: Ensure adequate holding volume is available within TCR Draw down storage via preferential reuse from TCR over supply from Lake Lyell Utilise discharge infrastructure at Pipers Flat Creek or transfer system to Lake Wallace to draw down storage Refer to EnergyAustralia Dam Safety Emergency Plan	Trigger 1: Notify EnergyAustralia Environmental Coordinator or Operations Manager Trigger 2: Notify EnergyAustralia Environmental Coordinator or Operations Manager Refer as necessary to emergency contact list within Appendix A of the EnergyAustralia Dam Safety Emergency Plan Document incidents and outcomes of assessments undertaken in relevant environmental reports

Aspect	Normal	Level 1	Level 2	Response
Discharges to Pipers Flat Creek or Lake Wallace from WTP	Discharges to Pipers Flat Creek less than or equal to environmental flow requirements No discharges to Lake Wallace	Trigger: Discharges occur to Pipers Flat Creek in excess of environmental flow requirements and have resulted in operation of Pipers Flat Creek valve Discharges occur to Lake Wallace that are less than historical average flow (based on two years) Action: At Pipers Flat Creek, visually assess the environment surrounding and downstream (500 m) of the outlet infrastructure At Lake Wallace, undertake visual assessment of environment downstream (500 m) of Lake Wallace as part of standard inspection regime	Trigger: Discharges occur to Pipers Flat Creek and overflows occur via emergency spillway Discharges occur to Lake Wallace that are in excess of historical average flow (based on two years) Action: At Lake Wallace undertake a waterway stability review using a geomorphologist for 500 m to 1,000 m downstream Obtain records of flow rates that contributed to Cox River At Pipers Flat Creek undertake a waterway stability review using a geomorphologist for 500 m to 1,000 m downstream The assessment is to include Thompsons Creek and address requirements detailed within the EnergyAustralia Dam Safety Emergency Plan Undertake a round of aquatic ecology monitoring at either PFup (for discharges to Pipers Flat Creek) or CR6 (for discharges to Lake Wallace)	Trigger 1: Notify EnergyAustralia Environmental Coordinator or Operations Manager Trigger 2: Notify EnergyAustralia Environmental Coordinator or Operations Manager Refer as necessary to emergency contact list within Appendix A of the EnergyAustralia Dam Safety Emergency Plan Document incidents and outcomes of assessments undertaken in relevant environmental reports

Aspect	Normal	Level 1	Level 2	Response
Water quality from WTP	Water quality within the expected treated water range	Trigger: Water quality elevated above the treated water range for at least one parameter Action: Undertake investigation Review influent water quality	Trigger: Water quality elevated above the treated water range for at least two parameters Action: Undertaken a round of plant maintenance Review influent water quality and flow rate	Trigger 1: Notify Springvale Mine Environmental Coordinator or Mine Manager Trigger 2: Notify Springvale Mine Environmental Coordinator or Mine Manager Notify DPE Notify EPA (if environmental harm occurs or a condition of EPL not met) Document incidents and outcomes of assessments undertaken in relevant environmental reports
Water quality within TCR	Water quality within the bounds of historical baseline data	Trigger: Water quality elevated above the historical baseline data for at least one parameter Action: Undertaken investigation of TCR operation	Trigger: Water quality elevated above the historical baseline data for at least two parameters Action: Undertake investigation of TCR operation.	Trigger 1: Notify EnergyAustralia Environmental Coordinator or Operations Manager Trigger 2: Notify EnergyAustralia Environmental Coordinator or Operations Manager Document incidents and outcomes of assessments undertaken in relevant environmental reports.

Aspect	Normal	Level 1	Level 2	Response
Water quality at monitoring sites on Pipers Flat Creek and Coxs River downstream of Lake Wallace	Water quality within the bounds of historical baseline data	Trigger: Observed exceedance of an SSGV for one parameter during a single monitoring event Action: Desktop assessment of the provenance of the impact Check hardness modified guideline value if exceedance is for an applicable metal	Trigger: Observed exceedance of an SSGV for two or more parameters during a single monitoring event. Action: Desktop assessment of the provenance of the impact Check hardness modified guideline value if exceedance is for an applicable metal If these studies indicate that the exceedances are a result of TCR water quality undertake further assessment of treated water and TCR water quality	Trigger 1: Notify Springvale Mine Environmental Coordinator or Mine Manager Trigger 2: Notify Springvale Mine Environmental Coordinator or Mine Manager Document incidents and outcomes of assessments undertaken in relevant environmental reports

9. Conclusions

The assessment of water resources has been undertaken to determine the potential impact of the amended Project on the surface water environment. The assessment investigated the potential impacts of the amended Project on the local water cycle, surface water quality, the fish community within TCR, stream health and downstream water users.

The amended Project water resources assessment builds on the works previously prepared for the EIS and modified the necessary components and features to consider the potential impacts to surface water as a result of the transfers of excess treated water to TCR.

The consideration of the complete water supply network to MPPS was increased in detail as part of the assessment considering the transfer rules, volumes and operational conditions of not only TCR, Lake Wallace, and Lake Lyell. The water and salt balance undertaken for the Coxs River considered the same operational scenarios that were undertaken for the EIS including 0%, 25%, 50%, 75% and 100% power generation water demands from MPPS.

There are no likely impacts to the groundwater environment identified as a result of the amended Project, due to the minimal groundwater interactions expected with the construction of any additional pipeline alignments.

The release of excess treated water to TCR will dilute the water in the reservoir, as the former is predicted to be considerably less saline. Minimal change to the water quality of TCR is predicted due to the large volume of TCR and the unlikelihood of any sustained, high-volume releases of treated water to the reservoir.

Negligible change to the water quality in the downstream receiving environments of Thompsons Creek and Pipers Flat Creek is predicted. SSGVs were derived based on the historical water quality monitoring record for Pipers Flat Creek and the DGVs recommended by ANZECC (2000). No exceedances of the derived SSGVs are predicted as a result of the amended Project, though the values will provide thresholds which will trigger further investigations into the provenance of any exceedances, as per the TARP outlined in Section 8.1.3.

The environmental tolerances of rainbow trout, brown trout and flathead gudgeon were established based on a literature review (refer to Section 6.4). Based on the predicted treated water quality, it is unlikely that the amended Project will have an impact on the fish community. The temperature and the low hardness of the proposed release have the potential to be outside the ranges of trout tolerance, however these factors are not likely to effect the fish community given the size and depth of the impoundment.

The distribution of trout species within TCR is predicted to change in response to changes in water level, due to changes in the availability of preferred habitat, however this is not predicted to result in any mortality or reduction in survival of the species. The treated water releases are not predicted to be toxic to any of the fish species in TCR.

The amended Project continues to provide an overall benefit to the catchment down to Lake Burragorang. Compared with the original EIS, the assessment of NorBE indicated that the amended Project from Wangcol Creek from LDP006 down to the Coxs River's confluence with Sawyers Swamp Creek will not provide any benefit to the catchment as a result of impacts to EC from the introduction of residual load on the SCSS water management system.

The amended Project will not significantly alter downstream water users with respect to quality however some users may experience an increased variation in surface water flow due to either the removal of constant flow rates or a greater dominance of natural catchment contributions.

The results of the water and salt balance modelling indicated that, for the 50% power generation scenario, the amended Project is predicted to increase the flow into Wangcol Creek at the confluence with the Coxs River by up to 2% on average compared to existing conditions and by up to 4% compared to the do nothing scenario. The electrical conductivity (EC) in Wangcol Creek was predicted to increase as a result of the discharges from the SCSS, by up to 16% compared to the do nothing scenario. However, future changes in the water management system at SCSS were found to mitigate this increase, with only a 1% increase in EC compared to existing conditions.

For the results for proposed conditions modelled in the 50% power generation scenario, inflows to Lake Wallace, Lake Lyell and Lake Burragorang from the Coxs River were predicted to decrease, compared to existing conditions and the do nothing scenario. The EC of inflows to the major reservoirs within the Coxs River was also predicted to decrease compared to both existing and do nothing scenarios. This occurs as a result of the treatment of mine water make using RO processes to decrease EC as part of the Project, compared to the modelled discharge of untreated mine water to Sawyers Swamp Creek in the do nothing scenario.

The water and salt balance modelling results indicated that, for 0% and 25% power generation scenarios, the use of TCR to store excess treated water is not sustainable over the life of the Project. A power generation requirement of 32% at MPPS was predicted to be the upper limit for the sustainable use of TCR to store excess treated water. In the event that water supply from the SDWTS exceeds power generation demands, TCR can be utilised for a two year timeframe (for the 0% power generation scenario) before additional extraction from the reservoir is required. If the water level of TCR is required to be reduced, the preferred operation is to transfer water to Lake Wallace via the Wallerawang Pipeline, rather than release water to Pipers Flat Creek. The likelihood of an extended downturn in power generation below 32% for a constant period greater than two years is highly unlikely and hence the need to transfer significant volumes elsewhere is also unlikely, specifically for the volumes considered as part of the 0% and 25% power generation scenarios.

The assessment of 50% power generation scenario indicated that the operating level with TCR would need to be reduced to hold excess water during the peak water supply from SDWTS. The reduction in water level would be approximately 1.2 m below the current operating level. This predicted change is within the historical fluctuation level of TCR.

The assessment of the 75% and 100% power generation scenarios indicated that the current operating level of TCR could be maintained (± 0.1 m). This is largely due to the fact that 100% of the water supplied by the Project will be consumed by MPPS over the life of the Project. A power generation requirement of 61% at MPPS was predicted to be the lower limit to maintain the current operating level of TCR (± 0.1 m).

The assessment of operational scenarios for emergency storage of excess treated water considered the maximum potential supply of 42 ML/day. The assessment indicated that for a five and ten day emergency storage of excess treated water would require approximately 0.4 m and 0.6 m reduction in water level in TCR respectively.

Water monitoring requirements for the amended Project have been proposed with a reduction of monitoring requirements within Wangcol Creek and an increased monitoring requirement at TCR and downstream of Pipers Flat Creek and Lake Wallace (in the event that transfers from TCR to Lake Wallace are required).

A TARP has been prepared an example of the likely daily management requirements required in the operational phase of the amended Project. A similar plan structure is likely to be implemented as part of the new water management plans for the proposed WTP.

The commissioning phase report remains a key requirement for the implementation of the proposed WTP following approval of the Project. As part of the amended Project, this will be modified to address the requirements of mitigating risk to TCR and for the new connection requirements of excess treated water to the main supply line from TCR to MPPS.

10. References

Allen, G. R., Midgley, S. H. and Allen, M. (2002) *Field Guide to the Freshwater Fishes of Australia*, Western Australian Museum, Perth.

ANZECC (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, National Water Quality Management Strategy, Australian and New Zealand Environment and Conservation Council Agriculture and Resource Management Council of Australia and New Zealand.

Aurecon (2016a) *Thompsons Creek Dam: 2016 Intermediate Safety Surveillance Report*, prepared for EnergyAustralia.

Aurecon (2016b) *Lyell Dam: Intermediate Dam Safety Surveillance Report*, prepared for EnergyAustralia.

Chessman, B.C. (2003) *New sensitivity grades for Australian river macroinvertebrates*, Marine and Freshwater Research 54, pp 95-103.

CSIRO (2015) *Springvale and Angus Place Hydrogeological Predictions*, prepared for Centennial Coal.

CSIRO (2016) *Springvale and Angus Place Hydrogeological Predictions*, prepared for Centennial Coal.

Department of the Environment (2013) *Significant Impact Guidelines 1.3: Coal Seam Gas and Large Coal Mining Developments – Impacts on Water Resources*, Australian Government Department of the Environment.

DPI Water (2016) *NSW Water Register*, Department of Primary Industries Water, Office of Water (site access: <http://www.water.nsw.gov.au/water-licensing/register>).

EnergyAustralia (2016) *Water for Mt Piper Power Station*, Weekly update of water (DAM) storage levels for Mt Piper & Wallerawang Power Station, weekly reports 2013 to 2016 (site accessed: <https://www.energyaustralia.com.au/about-us/what-we-do/generation-assets/wallerawang-mtpiper-power-station/water-for-mtpiper-wallerawang-power-station>).

Environment Canada (2013) *Federal Environmental Quality Guidelines: Cobalt*.

GHD (2016a) *Springvale Water Treatment Project: Water Resources Impact Assessment*, prepared for EnergyAustralia and Centennial Coal.

GHD (2016b) *Springvale Water Treatment Project: Aquatic Ecology Impact Assessment*, prepared for EnergyAustralia and Centennial Coal.

GHD (2016c) *Western Coal Services: Site Water and Salt Balance Assessment*, prepared for Springvale Coal.

GHD (2016d) *Lidsdale Siding: Water Management Plan*, prepared for Ivanhoe Coal Pty Limited.

GHD (2016e) *Water quality and quantity provisions, and the management of residuals and waste streams, Part 1: Water Specification*, prepared for EnergyAustralia and Springvale Coal.

Molony, B. (2001) *Environmental requirements and tolerances of Rainbow trout (Oncorhynchus mykiss) and Brown trout (Salmo trutta) with special reference to Western Australia: A review*, Fish. Res. Rep. West. Aust. 130, pp 1-28.

MPR (2015) *Western Coal Services Aquatic Ecology Monitoring Wangcol and Pipers Flat Creeks Autumn 2015*, prepared for Centennial Coal Pty Ltd by Marine Pollution Research Pty Ltd.

MPR (2016) *Western Coal Services Aquatic Ecology Monitoring Wangcol and Pipers Flat Creeks Spring 2015*, prepared for Centennial Coal Pty Ltd by Marine Pollution Research Pty Ltd.

NHMRC (2016) *National Water Quality Management Strategy, Australian Drinking Water Guidelines 6, 2011, Version 3.3 Updated November 2016*, National Health and Medical Research Council, Natural Resource Management Ministerial Council, Australian Government.

Pusey, B., Kennard, M., Arthington, A.H, (2004) *Freshwater fishes of north-eastern Australia*, CSIRO Publishing & Griffith University, Centre for Riverine Landscapes.

WaterNSW (2015) *Neutral or Beneficial Effect on Water Quality Assessment Guideline*, Sydney Catchment Authority.

Appendices

Appendix A – Assessment requirements

Table A-1 WaterNSW requirements

Requirements	Where addressed
For various MPSS operational capacity modelling scenarios, assess the adequacy of the capacity of the Thompsons Creek Reservoir and Lake Lyell for storing treated mine water, specifically when treated mine water is not being used by MPSS (worst case scenario).	Section 6.2
For various MPSS operational capacity modelling scenarios, predictions for changes to water quality in the Thompsons Creek Reservoir and Lake Lyell; overflows to Coxs River and impacts on water quality and ecological integrity of Coxs River including comparison with current releases (quantity and quality) from the storages to Coxs River and any requirements for additional management measures for the storages.	Predicted changes to TCR water quality: Section 6.3.2 Predicted change to downstream water quality and ecological integrity: Section 6.5 Additional management measures: Section 8
Whether mixing of the low ionic content treated water with 'dirty' water will be required prior to releasing into the Thompsons Creek Reservoir, as proposed originally for releases to Wangcol Creek, specifically given the use of the reservoir for recreational fishing.	No mixing with 'dirty' water will be required (Section 6.1).
Updates to the Upper Coxs River Action and Monitoring Plan (UCRAMP)	To be undertaken following Project approval

Table A-2 Significant impact test

Element	Triggers an impact	Reasoning
Changes to hydrology		
Flow regimes (volume, timing, duration, frequency)	No	No change to discharges from TCR
Recharge rates	No	No active groundwater interactions
Aquifer pressure or pressure relationships between aquifers	No	No active groundwater interactions
Groundwater table levels	No	No active groundwater interactions

Element	Triggers an impact	Reasoning
Groundwater/surface water interactions	No	Connectivity exists between surface and groundwater environments however these are existing with no change proposed in relation to these interactions
River/floodplain connections	No	No change to discharges from TCR
Inter-aquifer connectivity	No	No active groundwater interactions
Changes to water quality		
Create risks to human or animal health or to the condition of the natural environment	No	No risk predicted associated with release of treated water to TCR
Substantially reduce the amount of water available for human consumptive uses or for other uses, including environmental, which are dependent on water of a particular quality	No	No reduction in the amount of water available is predicted
Cause persistent organic chemicals, heavy metals, salts or other potentially harmful substances to accumulate in the environment	No	No accumulation of potentially harmful substances predicted
ANZECC water quality assessment undertaken	Yes	Applied to TCR and modelled treated water quality
Changes to ecosystem function and integrity		
Areas of the water resource being destroyed or substantially modified in a way that has an adverse effect on a water-dependent ecosystem	No	Water volumes produced are reused by industry
An adverse change to the benefits or services provided by a water resource	No	No change to beneficial use categories
A change in the biological diversity or species composition of a water resource or its ecological connectivity to other water resources	No	No change to water quality properties or connectivity within Coxs River

Element	Triggers an impact	Reasoning
The habitat or lifecycle of native species which are ecologically associated with the water resource or which are important determinants of the water resource's character being seriously affected	No	No change to native species associated with a water resource
An invasive or pest species that is harmful to the ecosystem functioning or integrity of the water resource becoming established (or an existing invasive or pest species being spread) in the water resource.	No	No risk to pest species forming specifically as a result of the amended Project
Cumulative impacts		
An assessment of the cumulative impacts of all other known projects in the surface or groundwater source area	Yes	Standard cumulative assessment approach down to the boundary of Lake Burragorang
Timing, scale and value		
An assessment of the impacts in both the short and long term. The long term will at a minimum be 100 years, unless otherwise defined by a peer reviewed hydrogeological model	Yes	Assessment period determined from length of groundwater supply (2035) No hydrogeology component.
Timing of the activities that are likely to impact water resources	Yes	Up to 2035
A robust water balance that identifies when in the project timing water impacts are likely to be greater than the existing situation	Yes	Regional water and salt balance that considers both local (operational level) and regional scales
A complete or revised existing local and regional water balance and hydrogeological model	Yes	Development of new modelling considering multiple scales (operations and regional) of modelling
A statement as to the value of the water resource must be included in the significant impact test. This statement must be in the context of the services provided by the resource as well as the connectivity of the resource to other water resources. Services include provisioning to other industries or potable water supplies, cultural services and supporting ecosystem services.	Yes	The value of Cocks River is high as it contributes to the drinking water supplies of Sydney

Table A-3 Consolidated IESC checklist

Element	Assessed within WRIA
Background data and modelling	
Identification of the water related assets Identification of the geological formation/aquifer to which GDEs are connected Location of springs and other groundwater dependent ecosystems A site specific water balance complemented by a regional water balance A description of the water resources of the site A description of the geology and hydrogeology at a local and regional level, including definition of the geological sequence The depth to aquifers and standing water levels, hydro-chemical characteristics A description of the likely recharge sources for each aquifer, details of discharges from each aquifer, direction of groundwater flow and contours of groundwater elevations for all aquifers Surface water assessment and model, including hydrology and water quality parameters Relevant information to describe the existing state of water related ecosystems	Yes
Water and salt balance	
A site specific water balance and a site specific salt balance, complemented by a regional balance of both water and salt covering the larger area of potential impact An assessment of the changes to any water storage or flow of water in the system as a result of the project, including changes to salt loads	Yes
Assessment of the likely significant impacts on water resources and water related assets	
Consideration of the State based policies and guidelines Predicted change to both local and regional water balances Impacts associated with surface water diversions Estimates of the quantity and quality of operational discharges of water, including emergency discharges Indication of the vulnerability to contamination and the likely impacts on the identified water assets Consideration of the impacts of water management infrastructure on the biodiversity assets	Yes

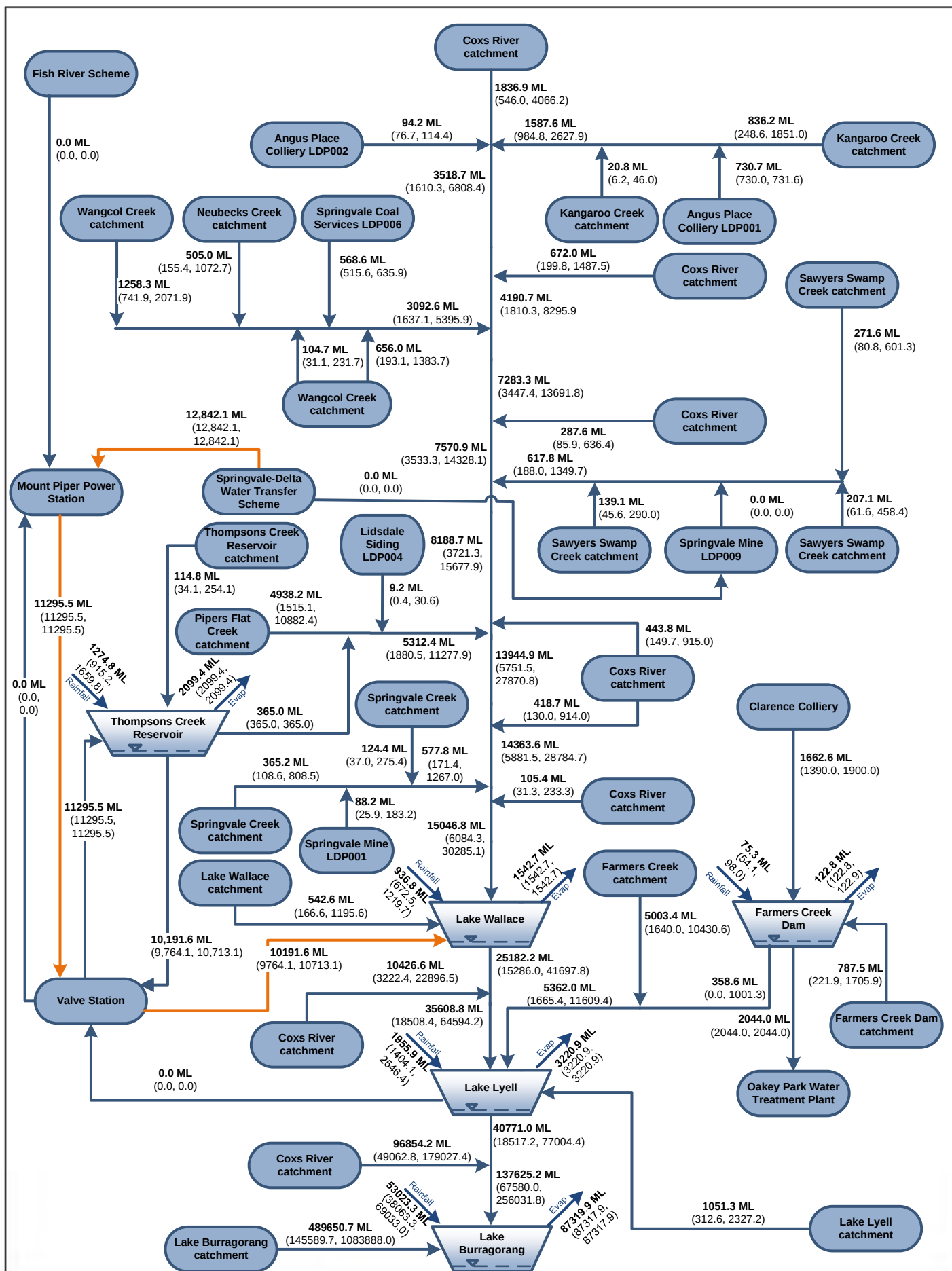
Element	Assessed within WRIA
Assessment of the cumulative impact of the project with past, present and known future projects	
Proposed mitigation measures for each identified impact	
Assessment of cumulative impacts	
The cumulative impact assessment needs to consider all past, present and known future projects, undertaking with regard to the regional water balance. Catchment and regional scale information Total existing and planning licensed and extracted water for consumptive, industrial and agricultural purposes in the surface catchment and groundwater system Existing water quality guidelines, targets, environmental flow objectives and requirements for the ecosystems of the surface and groundwater systems The proportional increase in water resource use and impacts as a consequence of the proposal The overall level of risk to water related assets that combine probability of occurrence with severity of impact of all past, present and known future projects	Yes
Ongoing management and monitoring	
Plan of management is to be included that focuses on the avoid, mitigate, manage and offset principles Clearly defined monitoring objectives Maps/figures demonstrating location of bores, their purpose and distribution such that impacts to groundwater gradients, flow directions, recharge processes, quality and water levels in each aquifer Variables such as water levels, EC, pH and other quality parameters to be measured and the interval for measurement An ANZECC water quality assessment and the development of guideline trigger values	Yes

Appendix B – Additional water and salt balance results

B.1 Water balance results

B.1.1 Annual results

The predicted values for each of the water transfers within the Coxs River catchment for proposed conditions in 2031 are provided in Figure B-1, Figure B-2, Figure B-3 and Figure B-4 for scenarios 1, 2, 4 and 5 respectively.



© 2016. Whilst every care has been taken to prepare this figure, GHD make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the figure being inaccurate, incomplete or unsuitable in any way and for any reason.

LOCATION	Cocks River
SEAM	NA
DRAWN	SM
CHECKED	TD
APPROVED	LH
SCALE	NTS



Amended Springvale Water Treatment Project
Water Resources Impact Assessment

Annual water transfers
Proposed conditions (2031)
Scenario 1



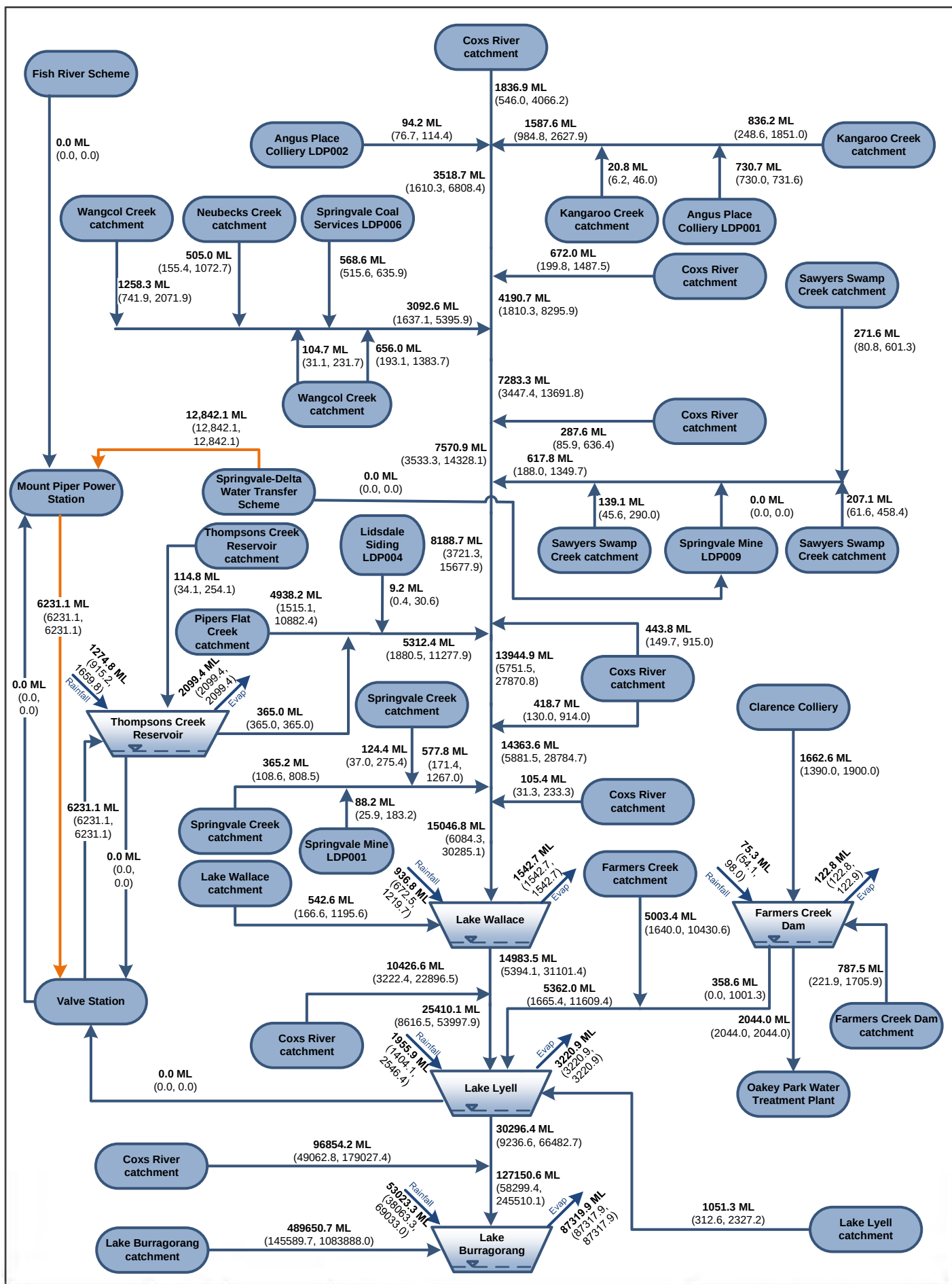
Centennial Coal



EnergyAustralia

DATE Dec 2016

Figure B-1



© 2016. Whilst every care has been taken to prepare this figure, GHD make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the figure being inaccurate, incomplete or unsuitable in any way and for any reason.

LOCATION	Cocks River
SEAM	NA
DRAWN	SM
CHECKED	TD
APPROVED	LH
SCALE	NTS



Amended Springvale Water Treatment Project
Water Resources Impact Assessment

Annual water transfers
Proposed conditions (2031)
Scenario 2



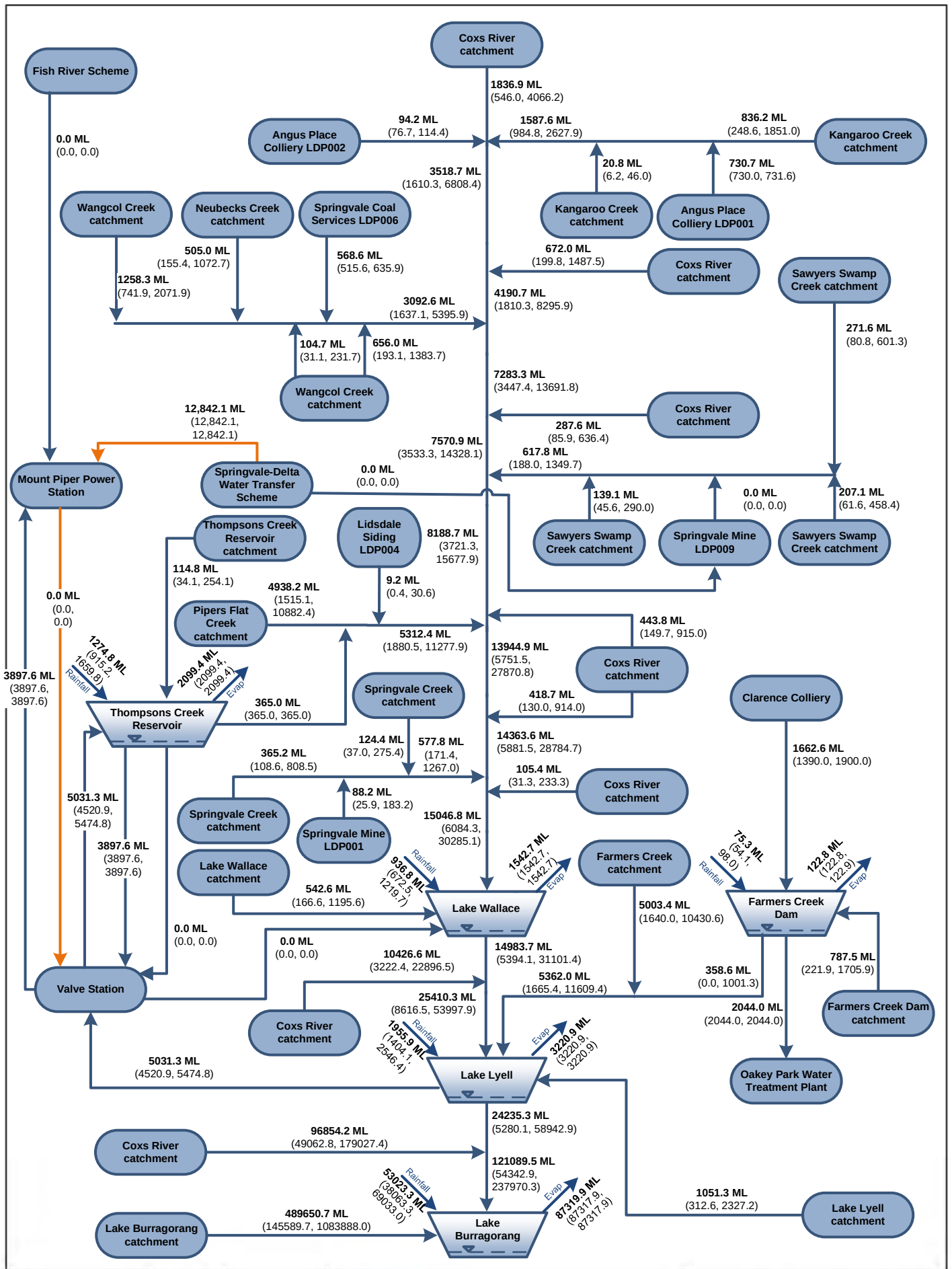
Centennial Coal



EnergyAustralia

DATE Dec 2016

Figure B-2



© 2016. Whilst every care has been taken to prepare this figure, GHD make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the figure being inaccurate, incomplete or unsuitable in any way and for any reason.

LOCATION	Cocks River
SEAM	NA
DRAWN	SM
CHECKED	TD
APPROVED	LH
SCALE	NTS



Amended Springvale Water Treatment Project
Water Resources Impact Assessment

Annual water transfers
Proposed conditions (2031)
Scenario 4



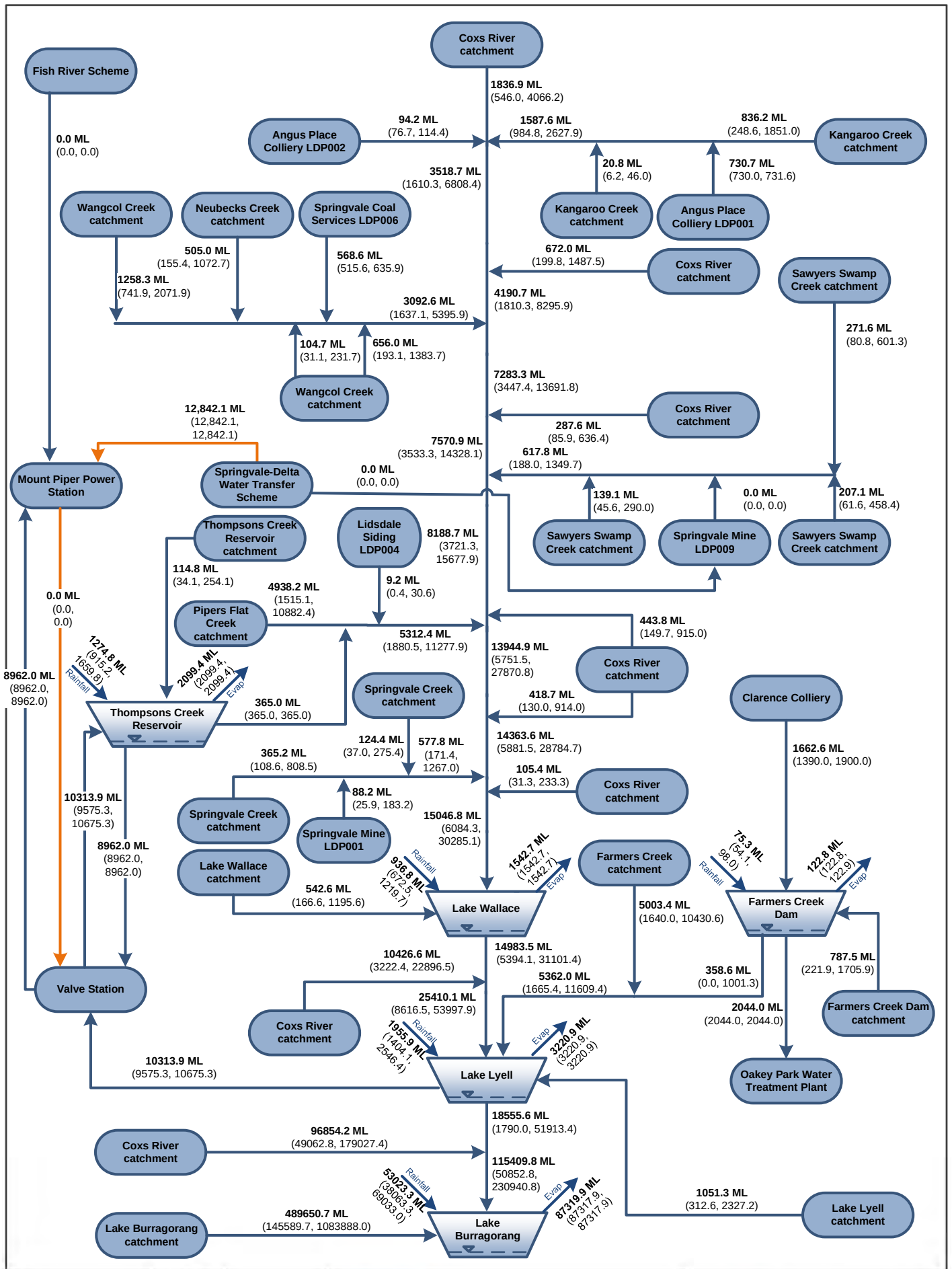
Centennial Coal



EnergyAustralia

DATE Dec 2016

Figure B-3



© 2016. Whilst every care has been taken to prepare this figure, GHD make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the figure being inaccurate, incomplete or unsuitable in any way and for any reason.

LOCATION	Cocks River
SEAM	NA
DRAWN	SM
CHECKED	TD
APPROVED	LH
SCALE	NTS



Amended Springvale Water Treatment Project
Water Resources Impact Assessment

Annual water transfers
Proposed conditions (2031)
Scenario 5



Centennial Coal



EnergyAustralia

DATE Dec 2016

Figure B-4

B.1.2 Time series results

Monthly average time series results are presented for scenarios 1, 2, 4 and 5 are presented in Figure B-5 to B-26.

Scenario 1

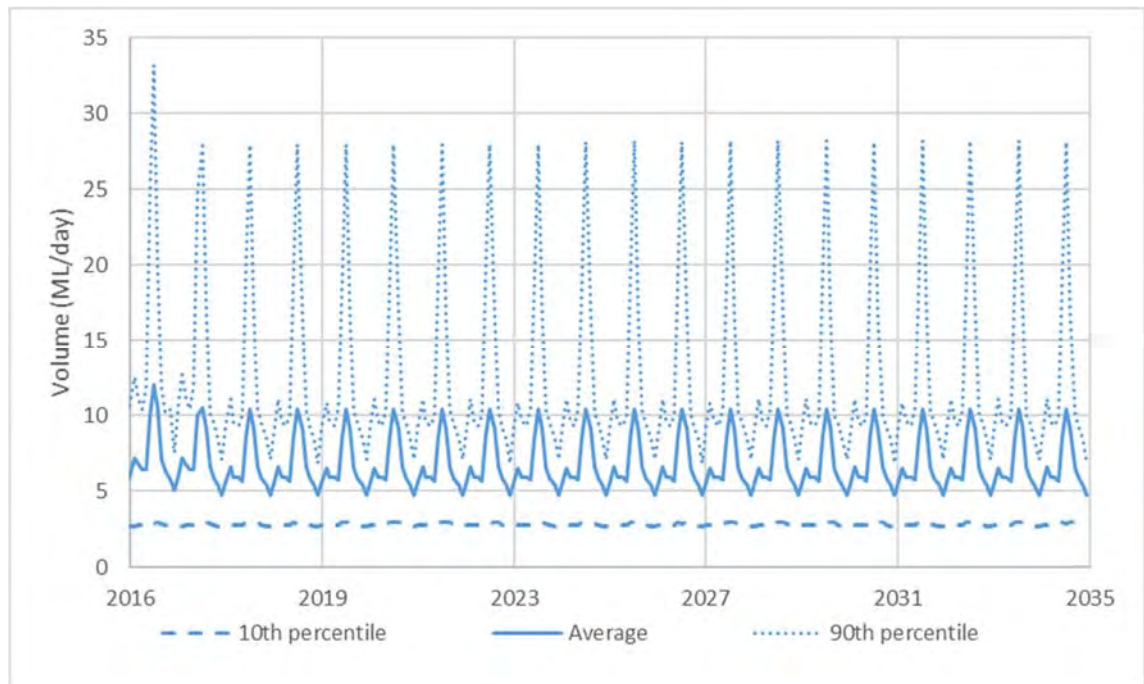


Figure B-5 Scenario 1 – Predicted flow of Wangcol Creek at LDP006

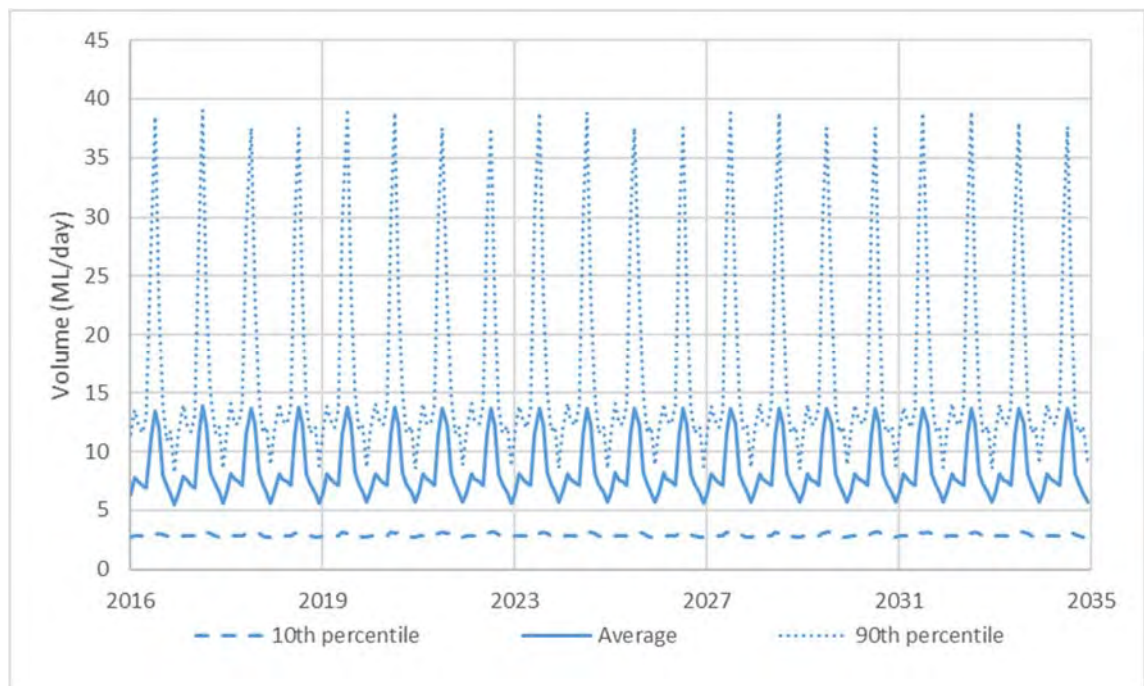


Figure B-6 Scenario 1 – Predicted flow of Wangcol Creek at the confluence with the Cocks River

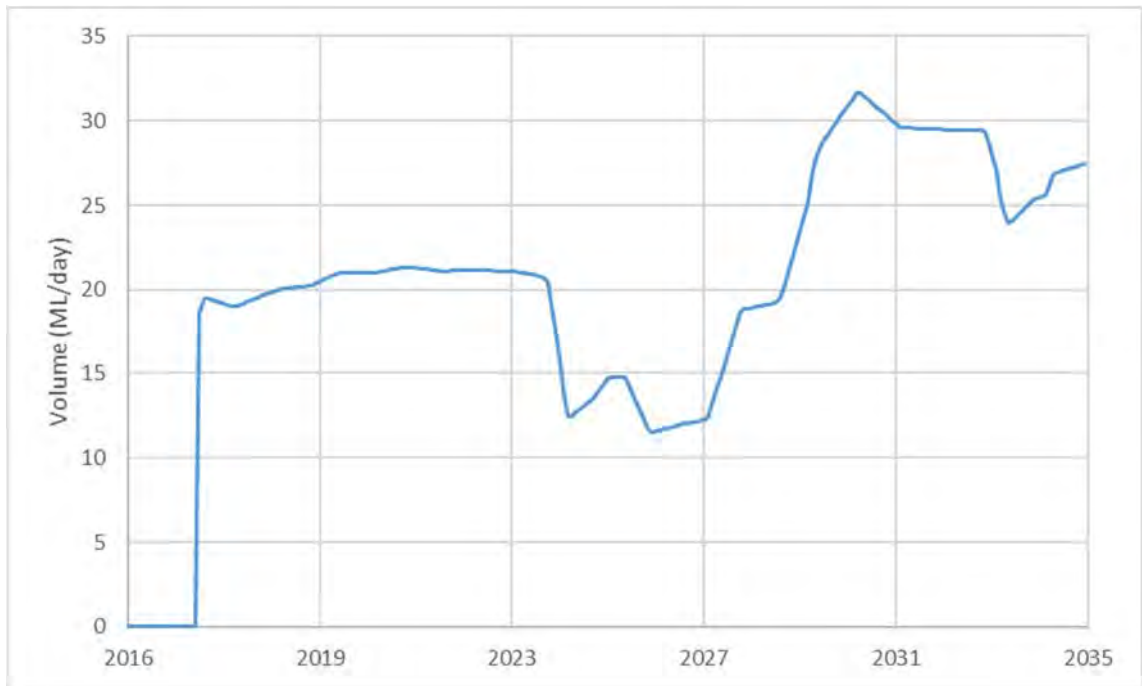


Figure B-7 Scenario 1 – Predicted transfer from Mount Piper Power Station to Thompsons Creek Reservoir

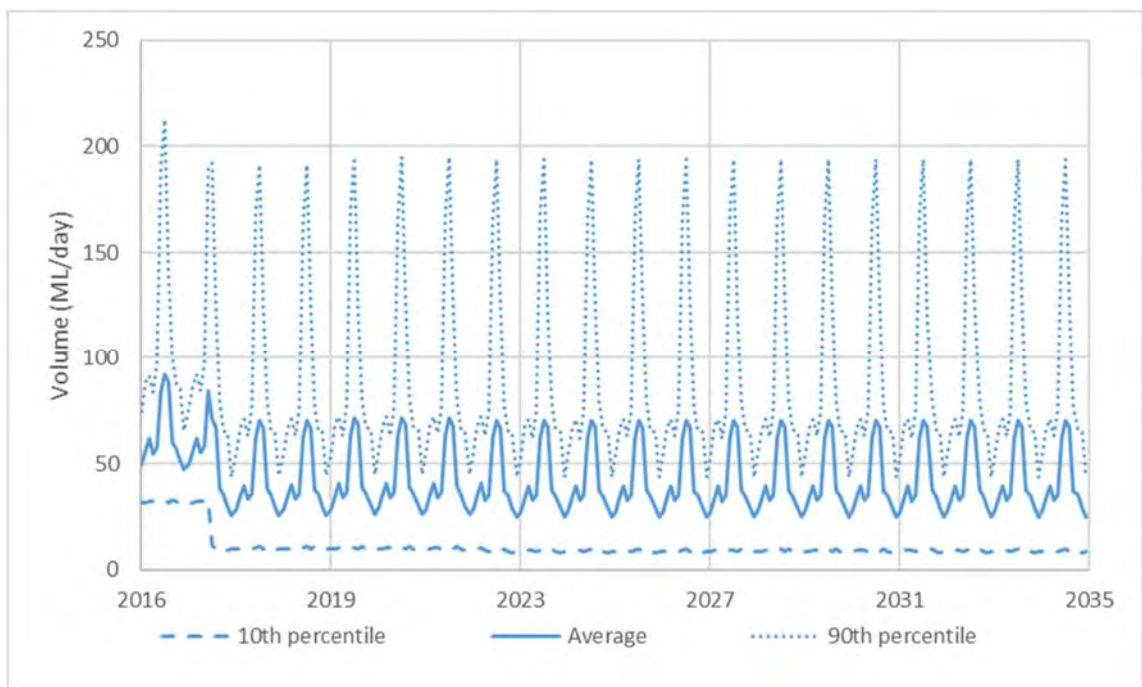


Figure B-8 Scenario 1 – Predicted flow from Cocks River to Lake Wallace

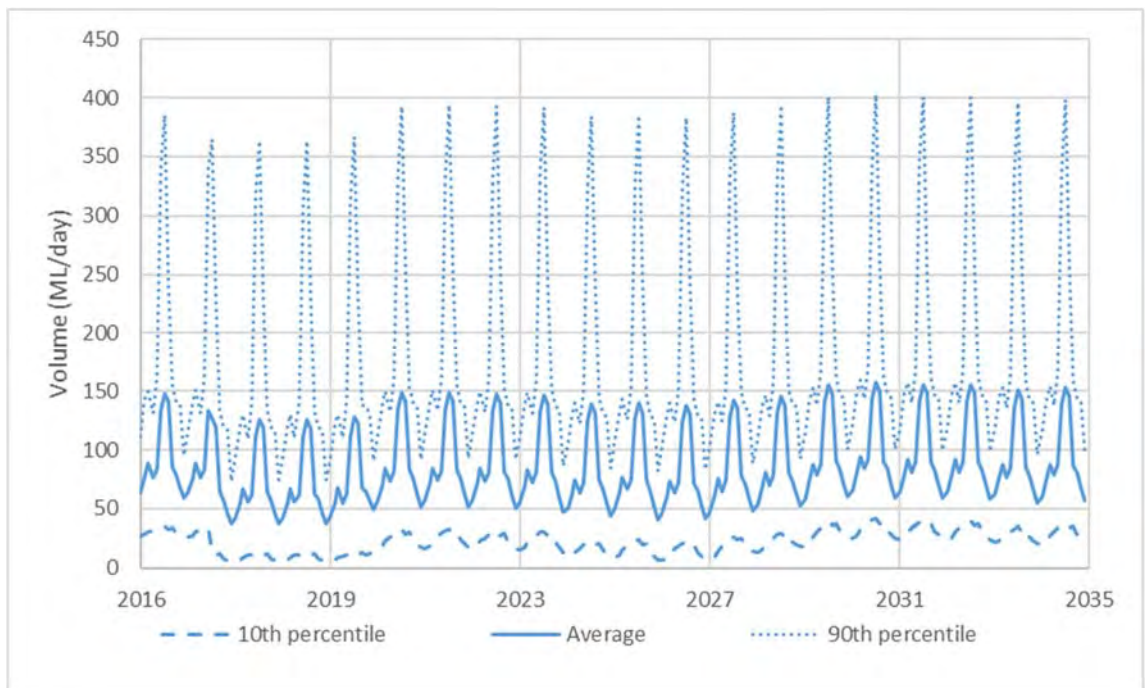


Figure B-9 Scenario 1 – Predicted flow from Coxs River to Lake Lyell

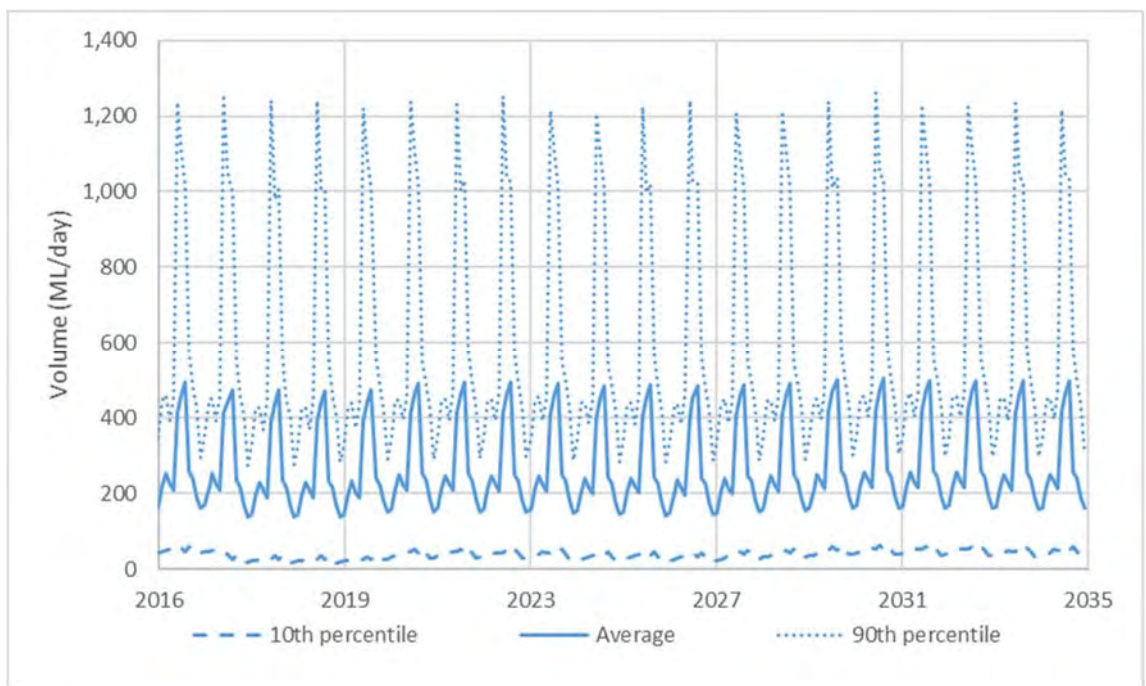


Figure B-10 Scenario 1 – Predicted flow from Coxs River to Lake Burragorang

Scenario 2

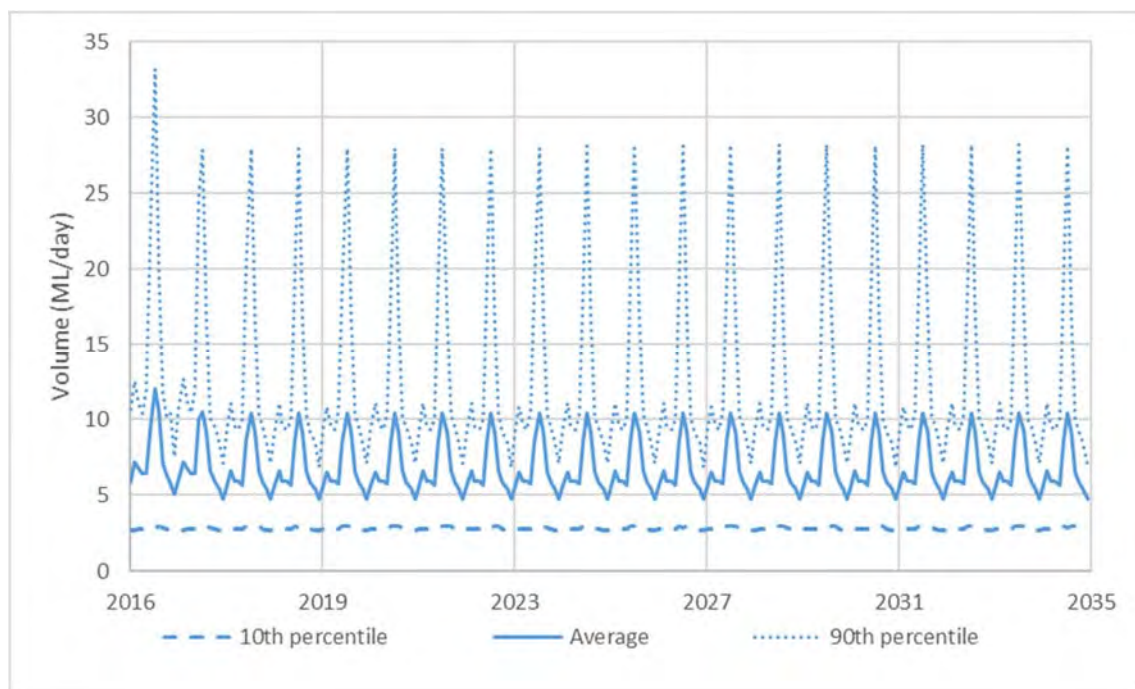


Figure B-11 Scenario 2 – Predicted flow of Wangcol Creek at LDP006

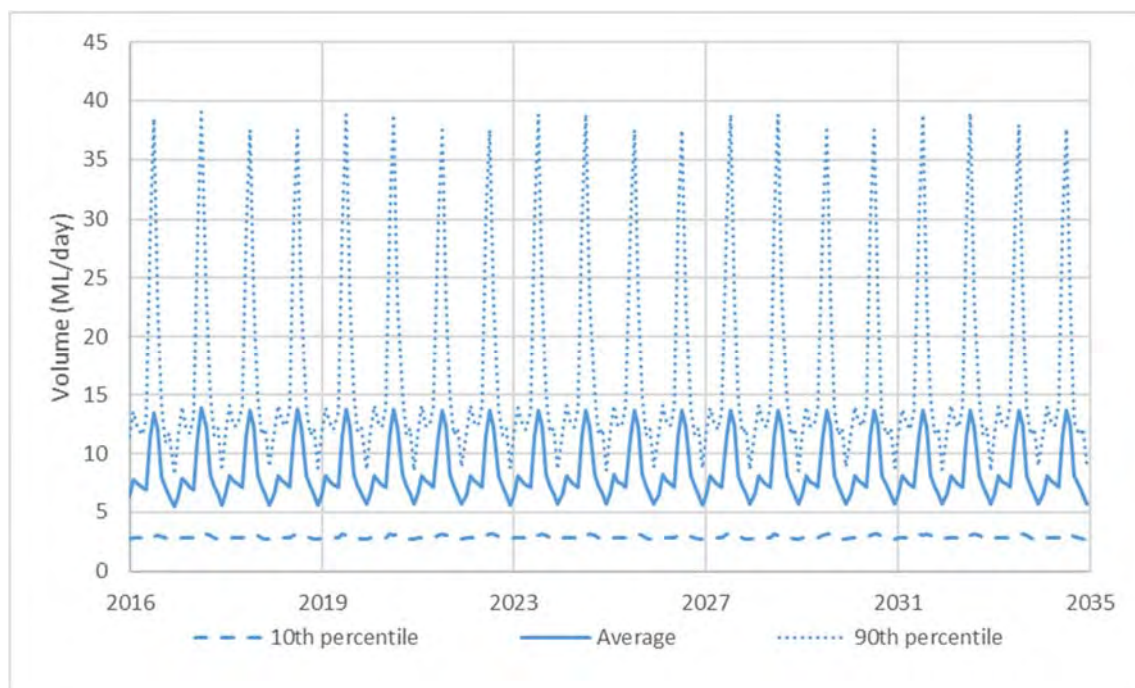


Figure B-12 Scenario 2 – Predicted flow of Wangcol Creek at the confluence with the Coss River

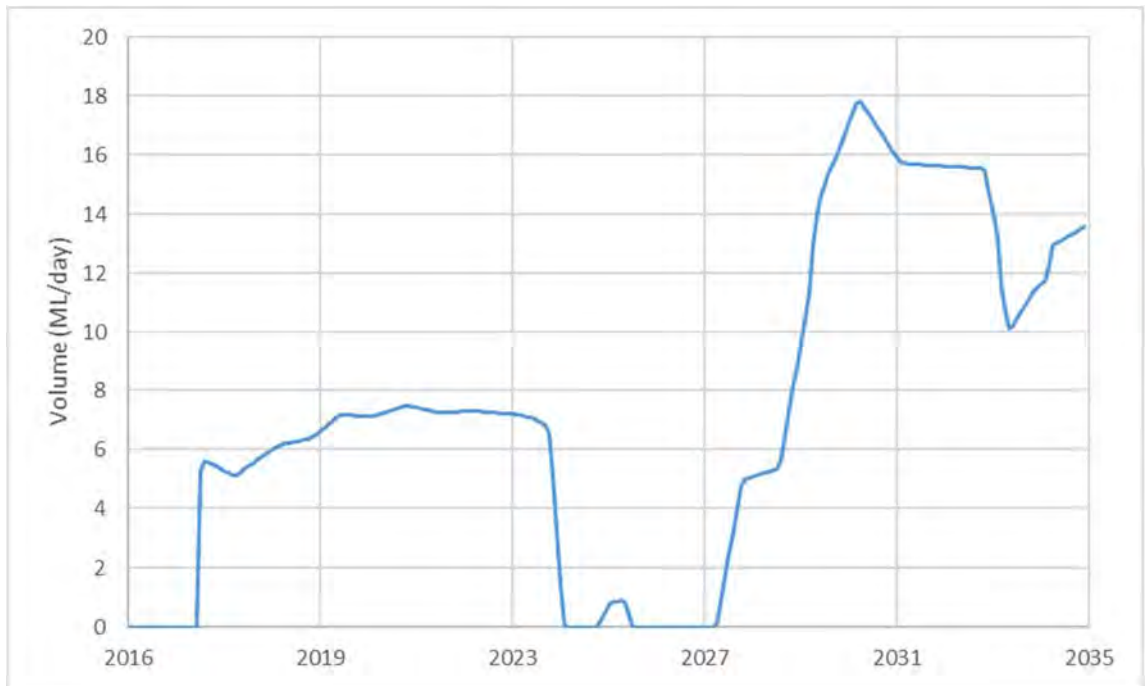


Figure B-13 Scenario 2 – Predicted transfer from Mount Piper Power Station to Thompsons Creek Reservoir

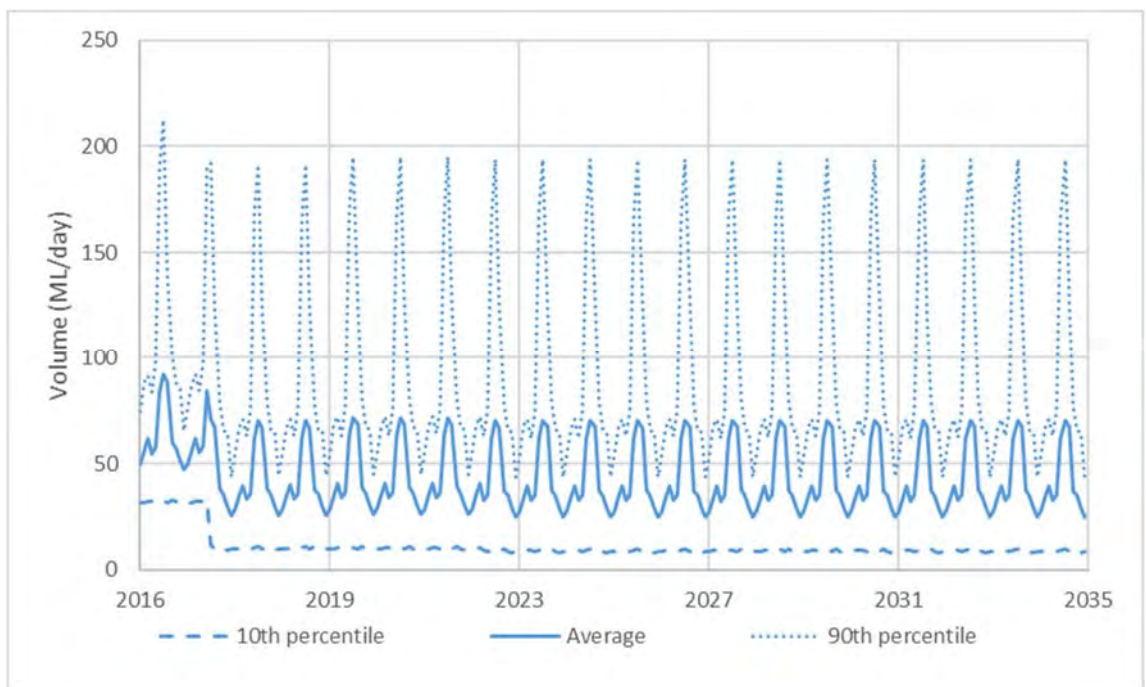


Figure B-14 Scenario 2 – Predicted flow from Coxs River to Lake Wallace

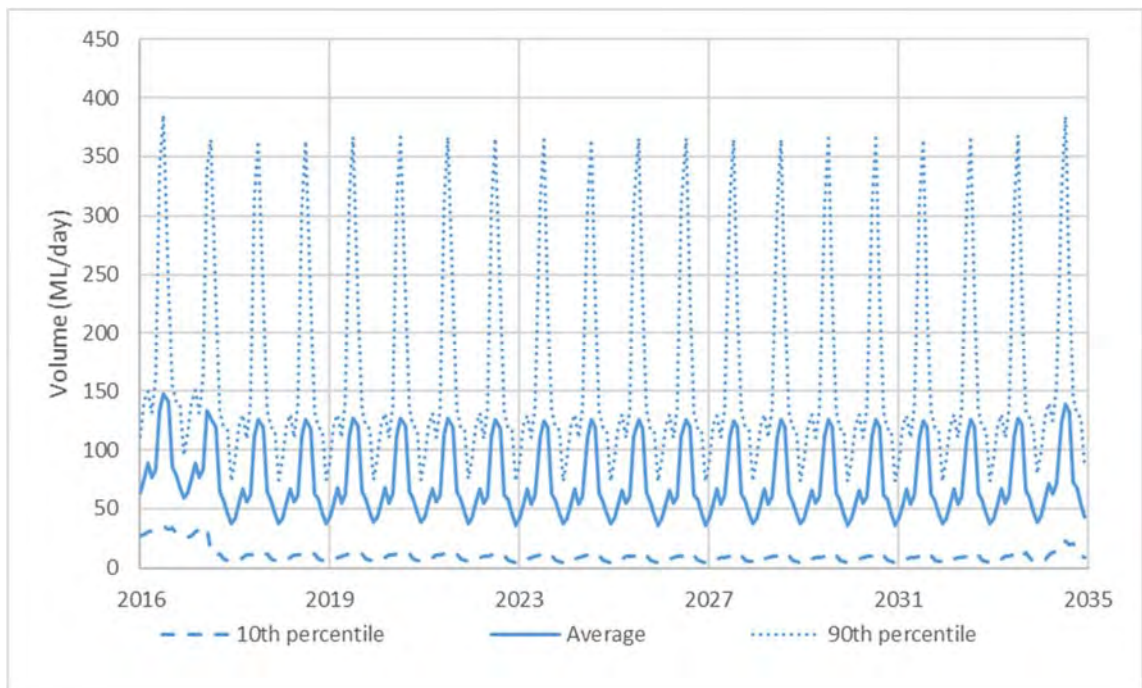


Figure B-15 Scenario 2 – Predicted flow from Coxs River to Lake Lyell

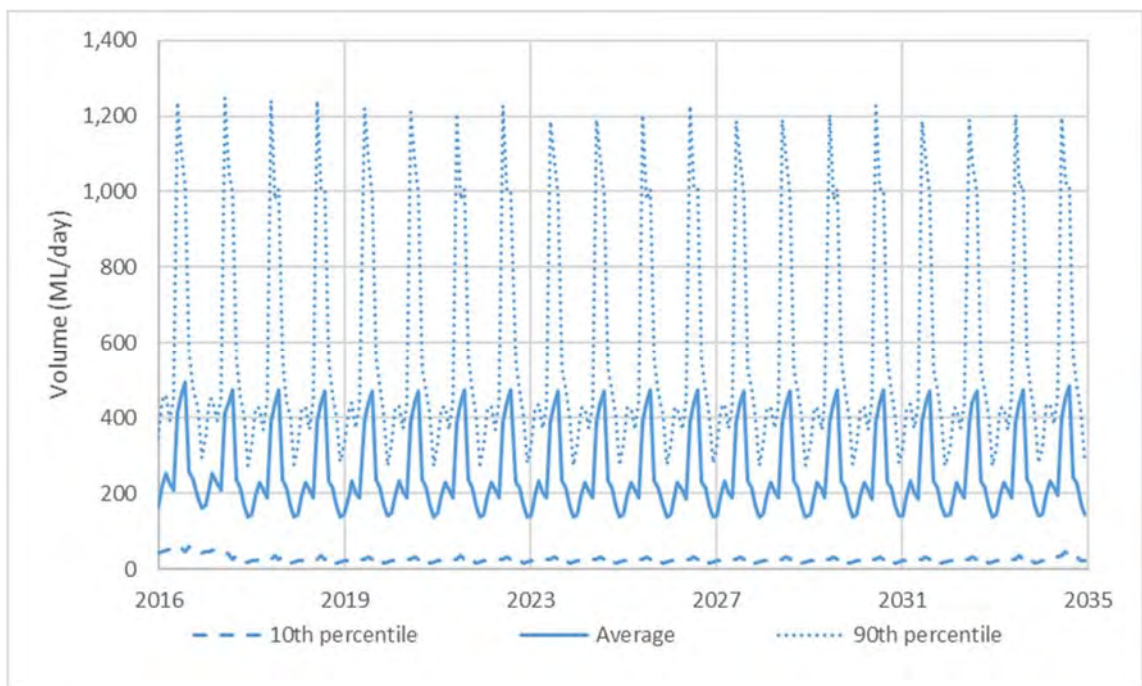


Figure B-16 Scenario 2 – Predicted flow from Coxs River to Lake Burragorang

Scenario 4

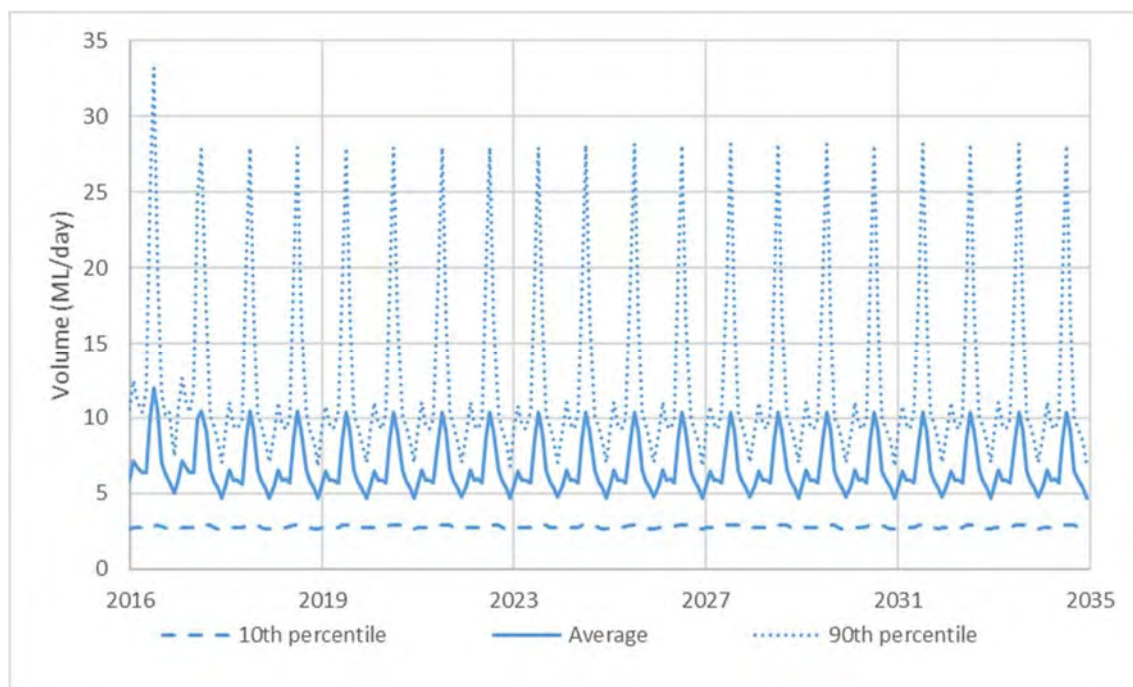


Figure B-17 Scenario 4 – Predicted flow of Wangcol Creek at LDP006

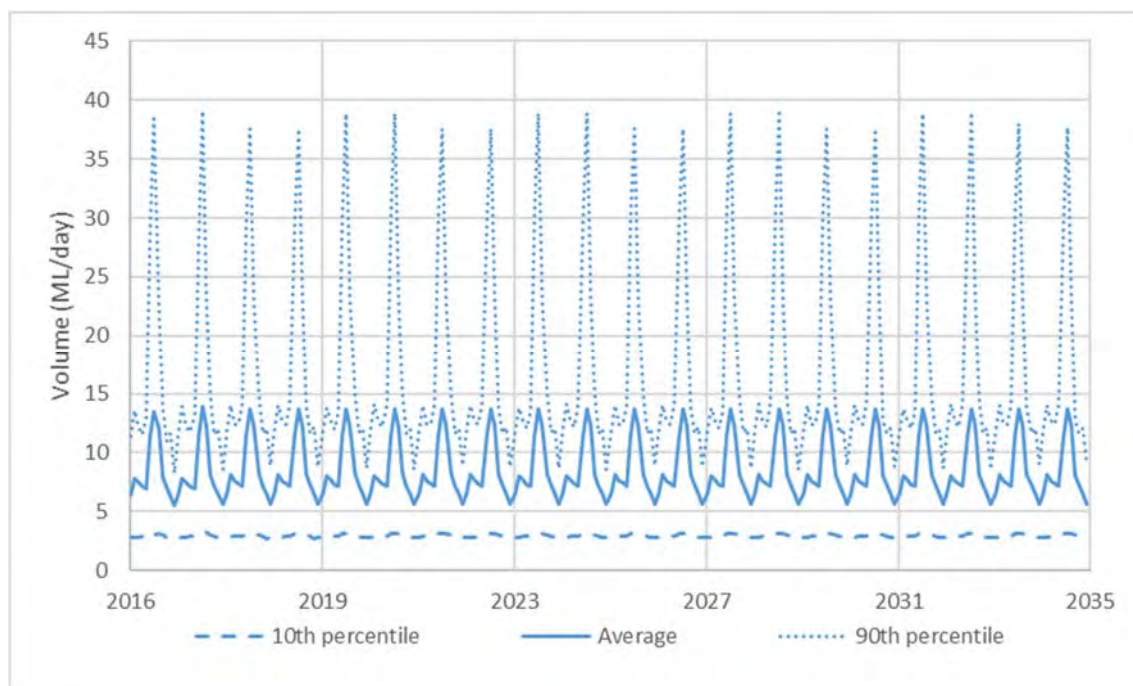


Figure B-18 Scenario 4 – Predicted flow of Wangcol Creek at the confluence with the Coss River

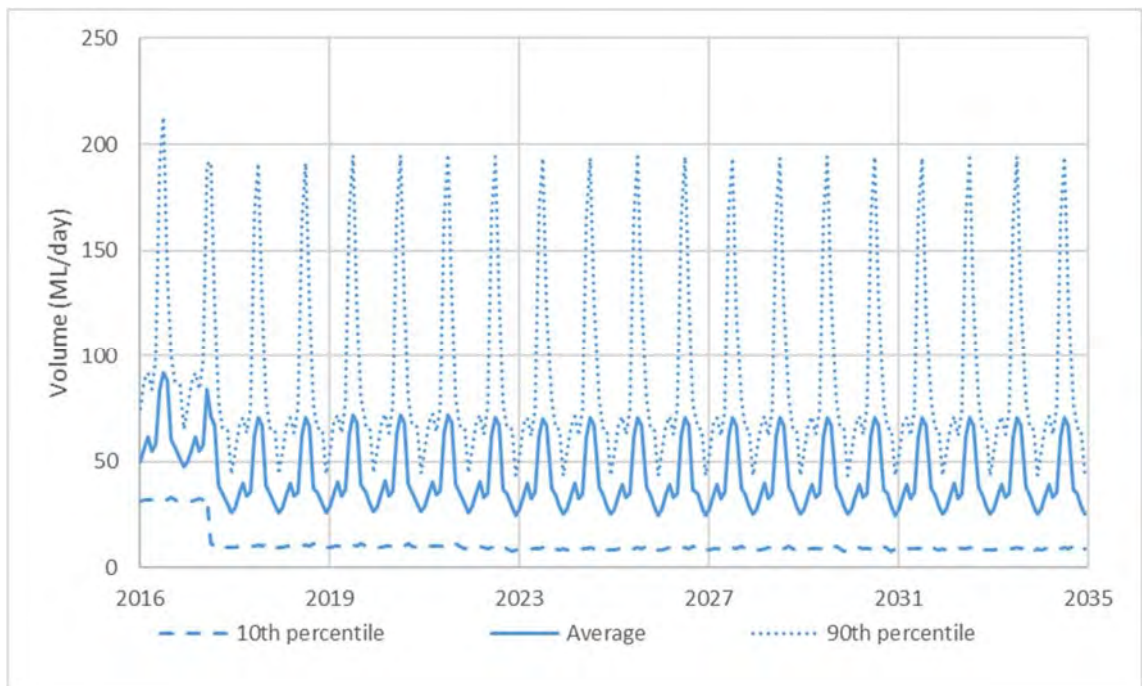


Figure B-19 Scenario 4 – Predicted flow from Cocks River to Lake Wallace

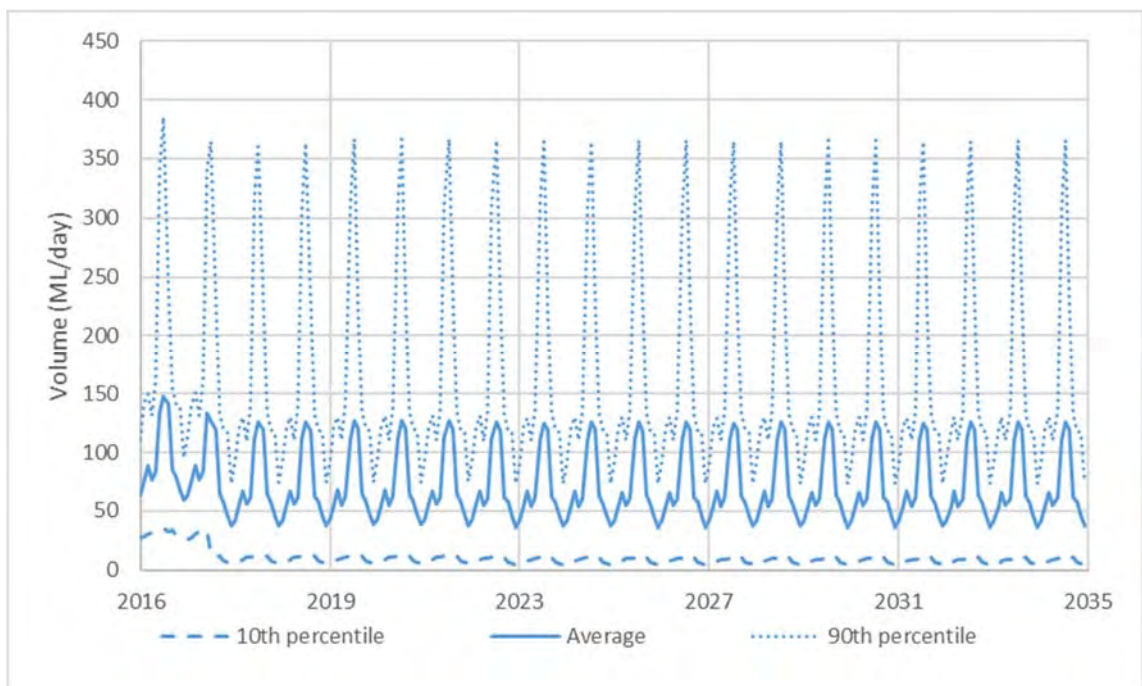


Figure B-20 Scenario 4 – Predicted flow from Cocks River to Lake Lyell

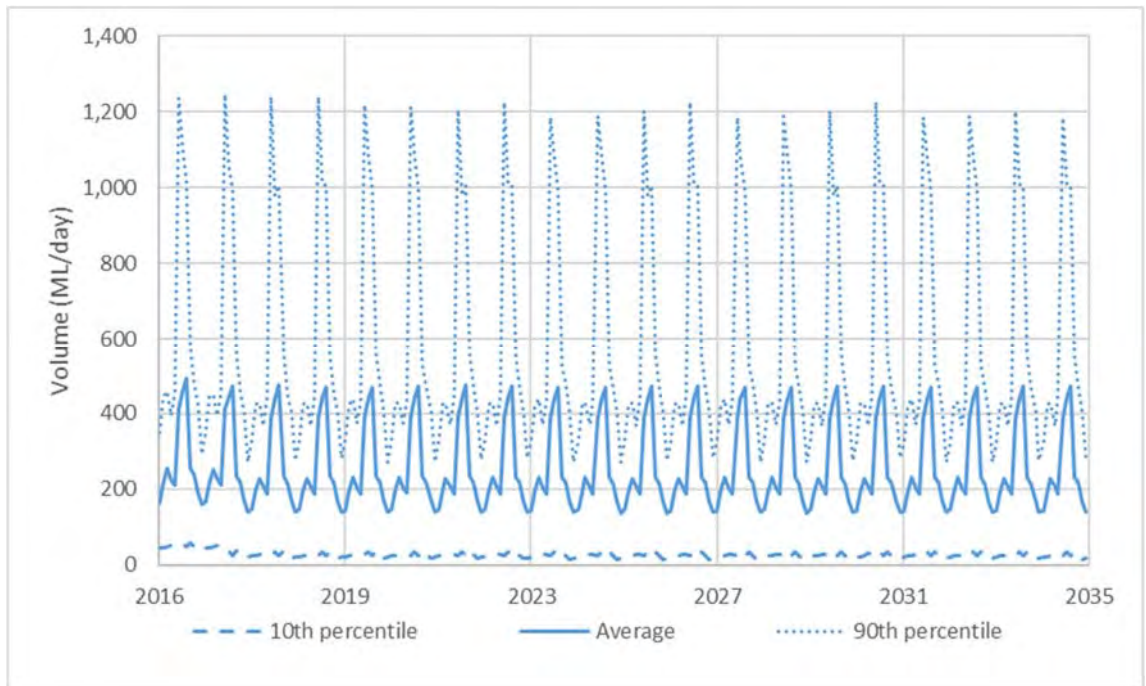


Figure B-21 Scenario 4 – Predicted flow from Cocks River to Lake Burragorang

Scenario 5

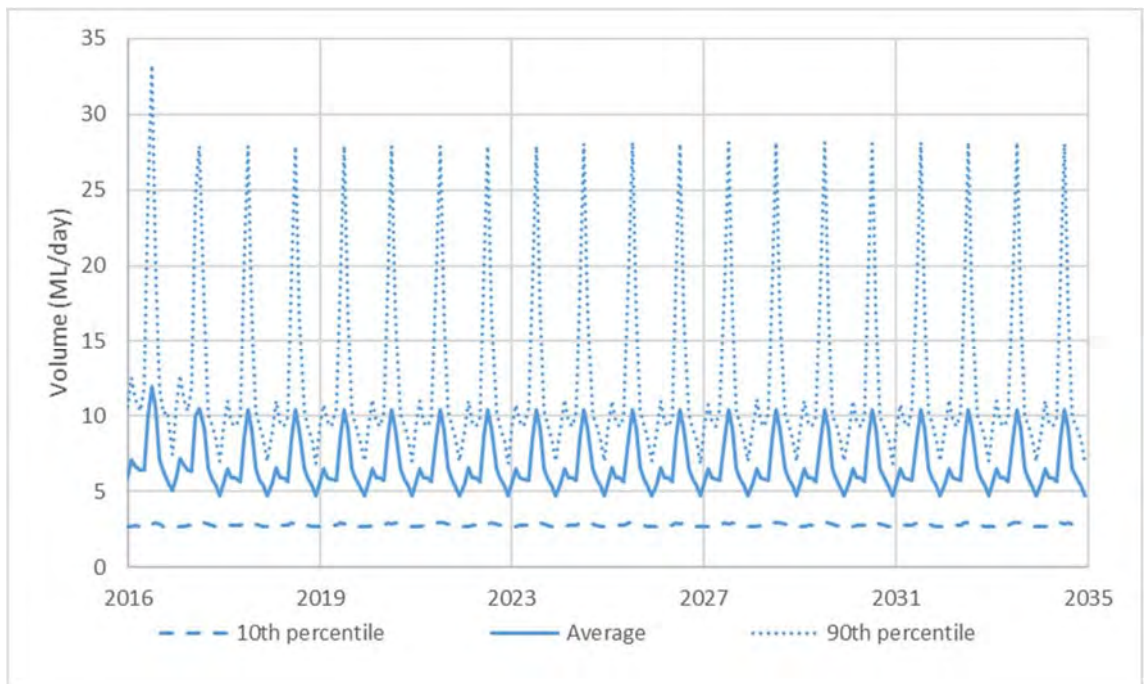


Figure B-22 Scenario 5 – Predicted flow of Wangcol Creek at LDP006

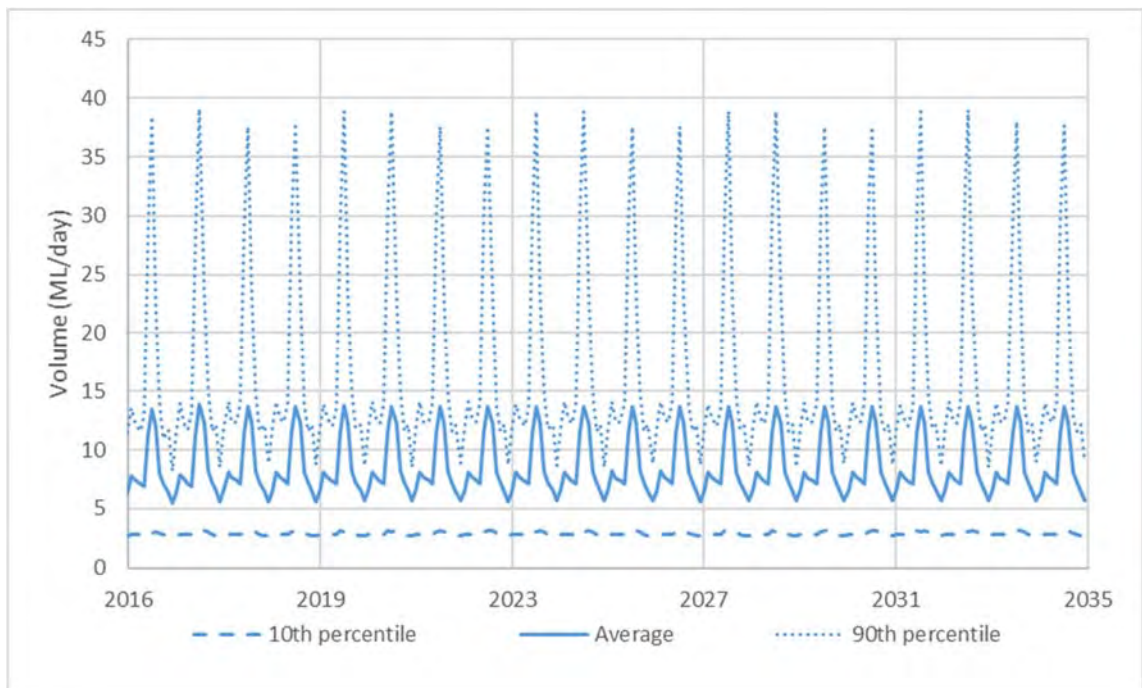


Figure B-23 Scenario 5 – Predicted flow of Wangcol Creek at the confluence with the Cocks River

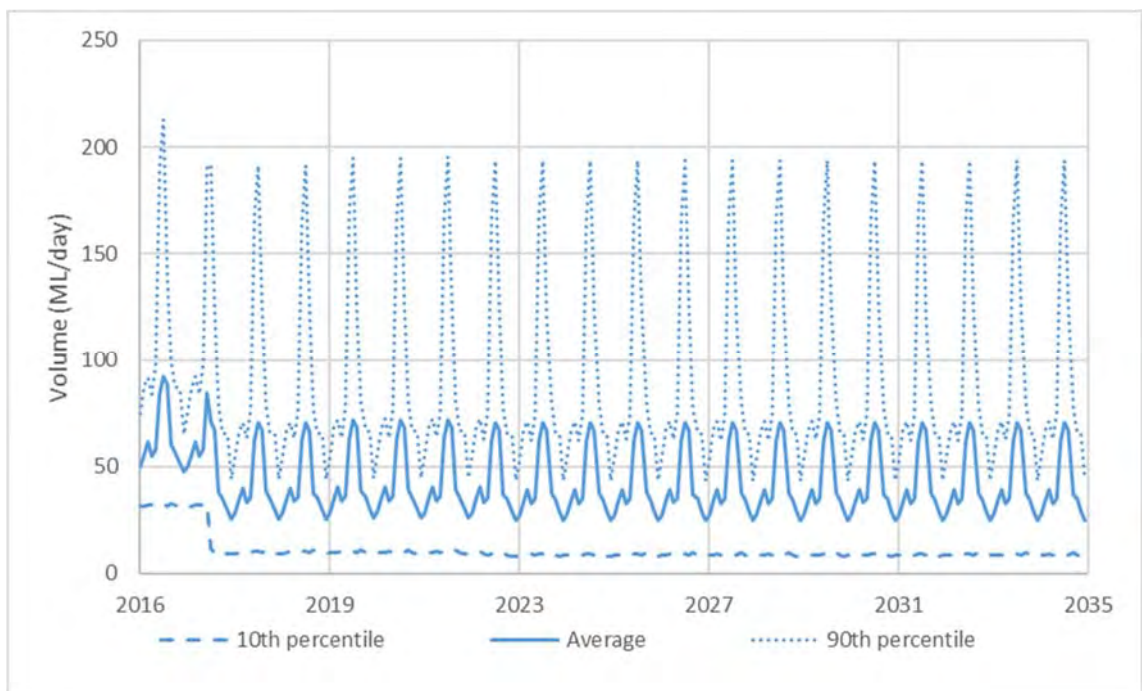


Figure B-24 Scenario 5 – Predicted flow from Cocks River to Lake Wallace

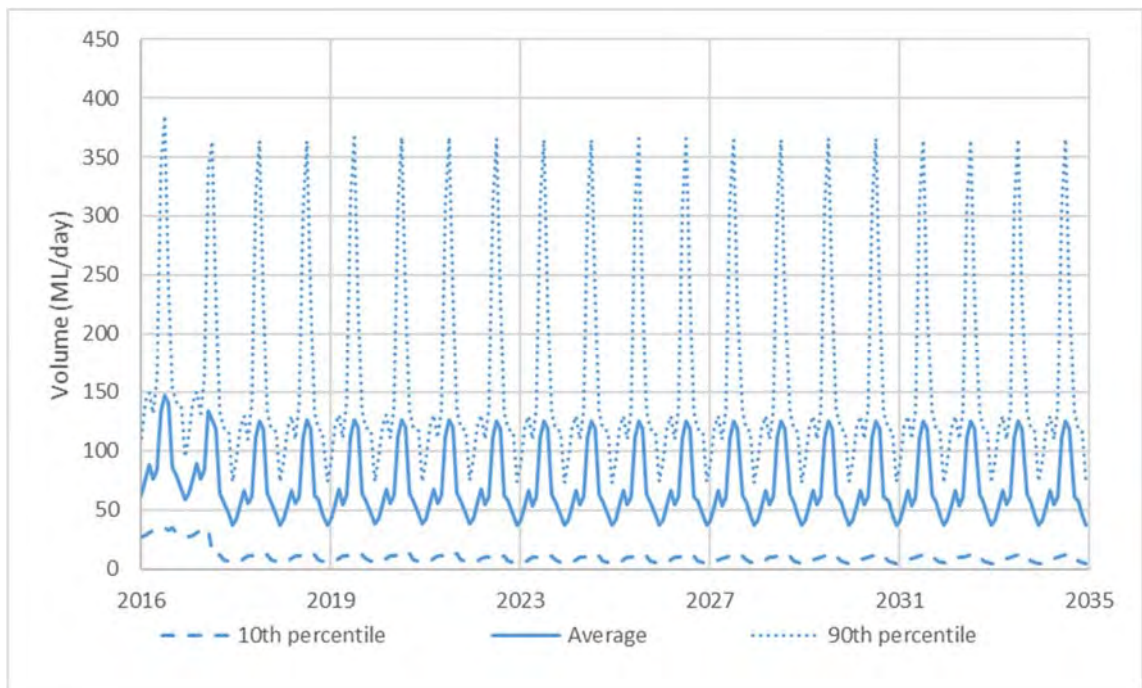


Figure B-25 Scenario 5 – Predicted flow from Cocks River to Lake Lyell

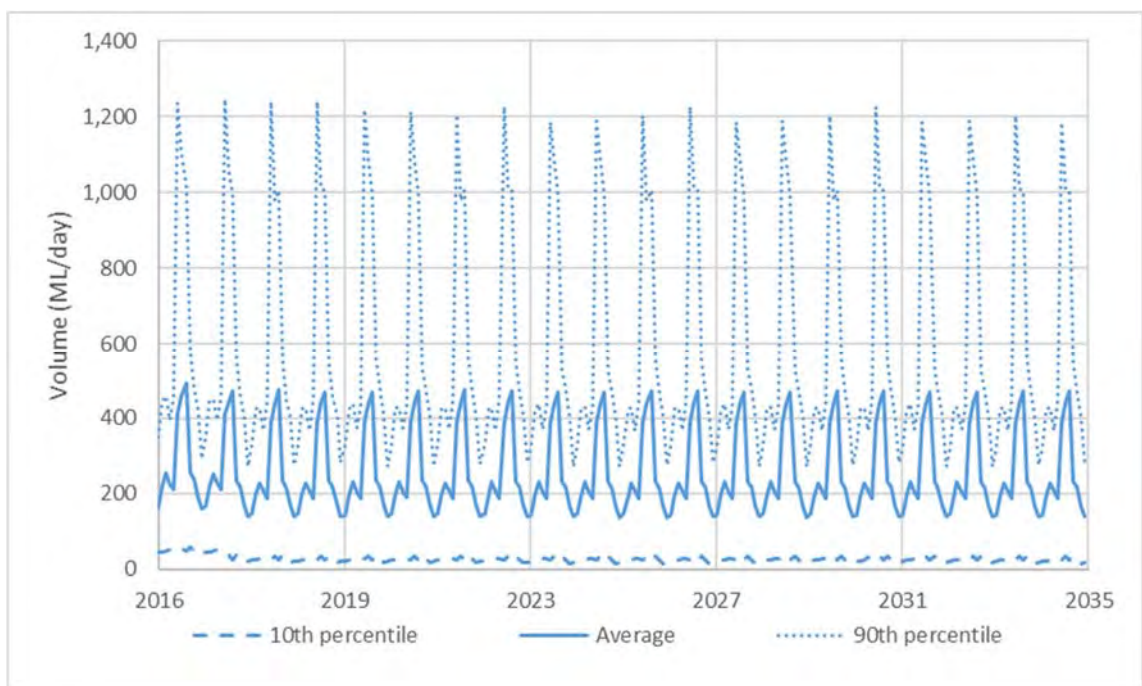
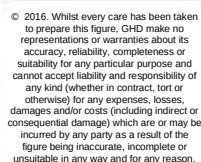


Figure B-26 Scenario 5 – Predicted flow from Cocks River to Lake Burragorang

B.2 Salt balance results

B.2.1 Annual results

The predicted values for each of the salt transfers within the Cocks River catchment for proposed conditions in 2031 are provided in Figure B-27, Figure B-28, Figure B-29 and Figure B-30 for scenarios 1, 2, 4 and 5 respectively.

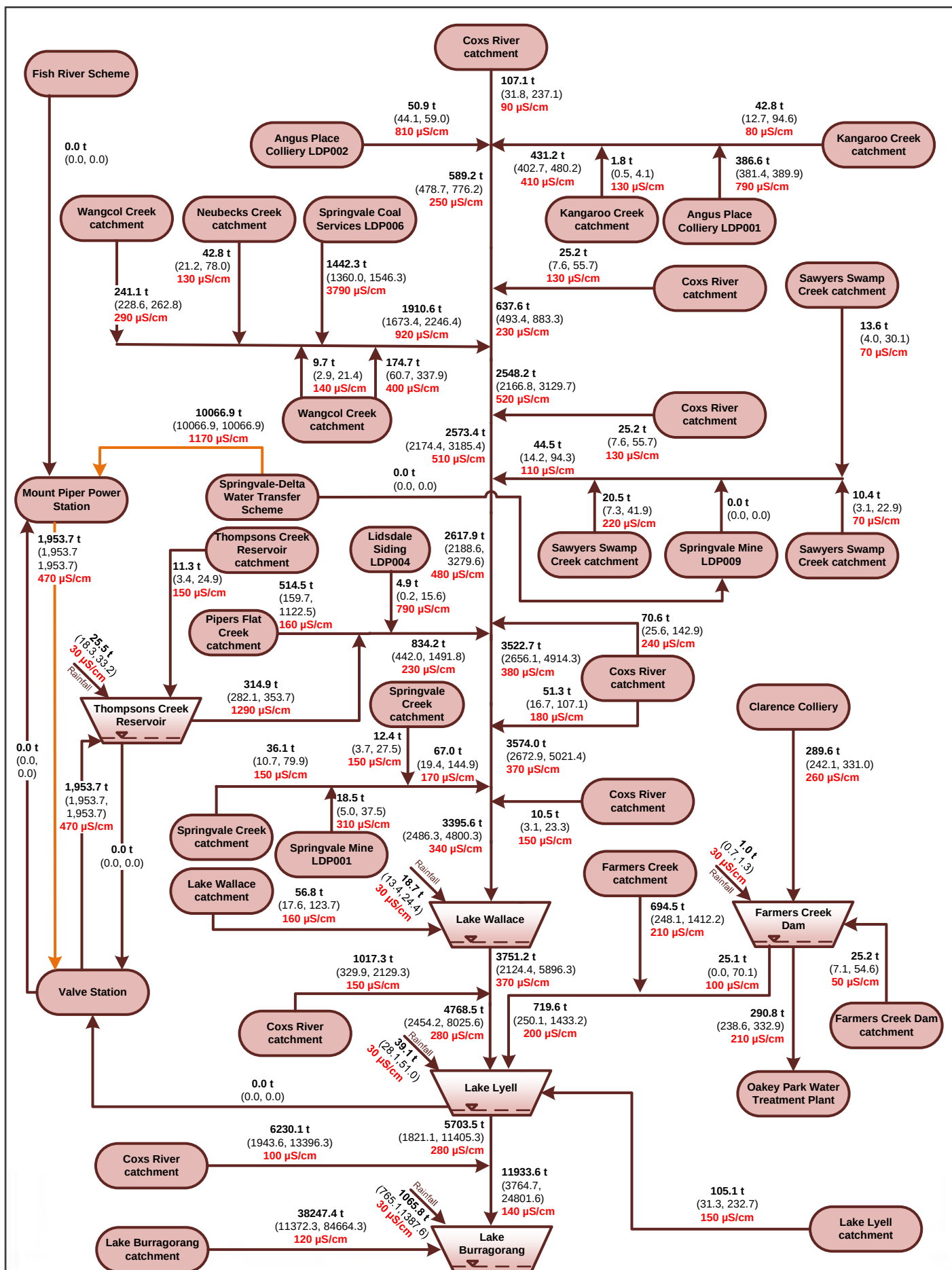


Annual salt transfers
Proposed conditions (2030)
Scenario 1



EnergyAustralia

Figure B-27



© 2016. Whilst every care has been taken to prepare this figure, GHD make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the figure being inaccurate, incomplete or unsuitable in any way and for any reason.

LOCATION	Coxs River
SEAM	NA
DRAWN	SM
CHECKED	TD
APPROVED	LH
SCALE	NTS



Amended Springvale Water Treatment Project
Water Resources Impact Assessment

Annual salt transfers
Proposed conditions (2031)
Scenario 2



Centennial Coal



EnergyAustralia

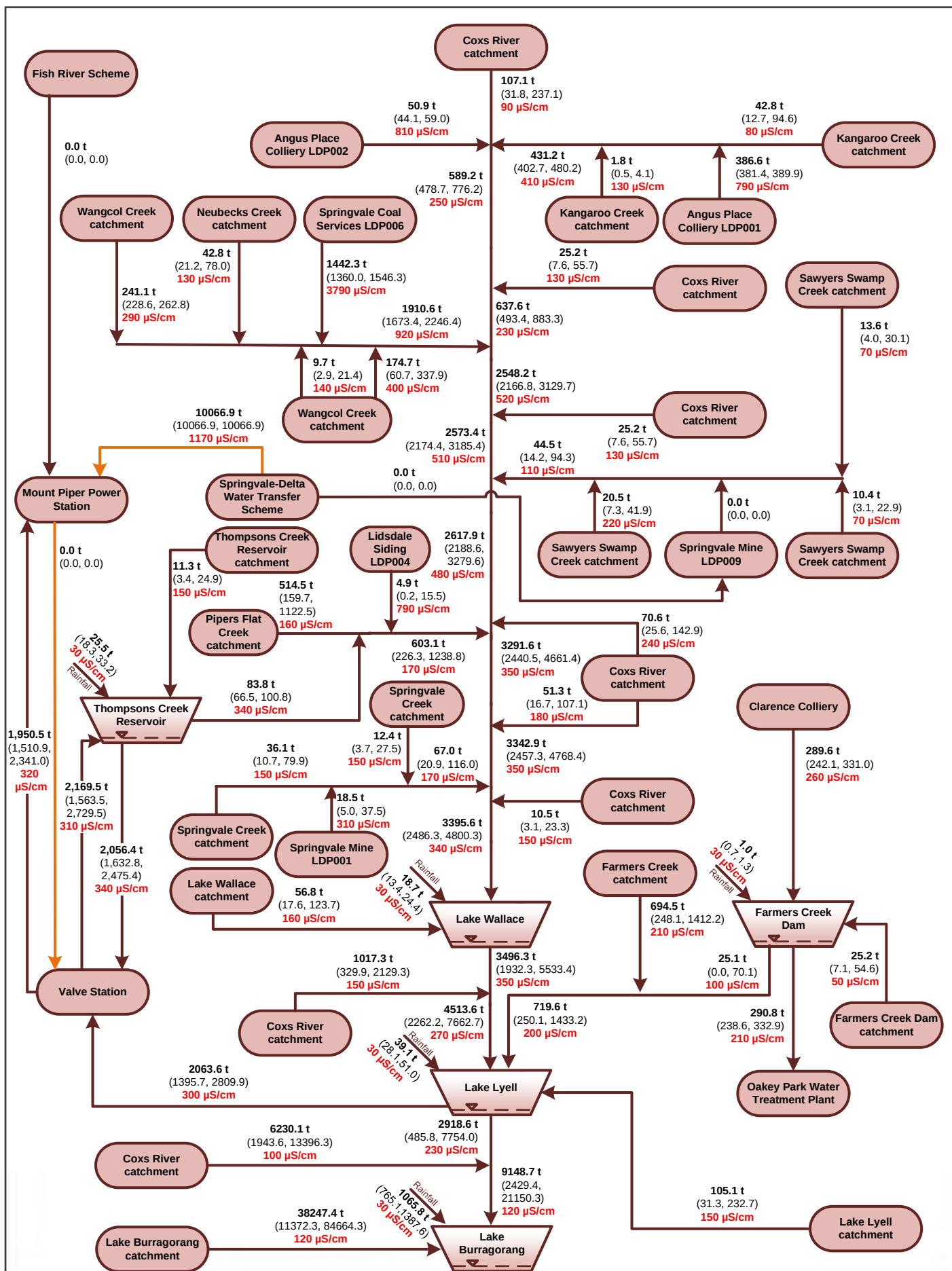
DATE Dec 2016

Figure B-28

The diagram illustrates the Coffs Harbour Water Supply System, showing the flow of water from various catchments and reservoirs through a network of pipes and treatment plants to the final distribution points. The system is divided into several main sections:

- Raw Water Intake:** Water is sourced from the Coffs River catchment, Kangaroo Creek catchment, Wangcol Creek catchment, Neubecks Creek catchment, Springvale Coal Services LDP006, Springvale Delta Water Transfer Scheme, Thompsons Creek Reservoir, Lidsdale Siding LDP004, Springvale Creek catchment, Lake Wallace catchment, Coxs River catchment, Farmers Creek catchment, Lake Burragarang catchment, and Lake Lyell catchment.
- Treatment and Distribution:** Water is treated at the Oakey Park Water Treatment Plant and distributed to various catchments and reservoirs, including Thompsons Creek Reservoir, Lake Wallace, Lake Lyell, Lake Burragarang, and Lake Lyell.
- Recycled Water:** Recycled water is shown in red, flowing from the Oakey Park Water Treatment Plant to various catchments and reservoirs, including Thompsons Creek Reservoir, Lake Wallace, Lake Lyell, Lake Burragarang, and Lake Lyell.

The diagram uses color-coded flows to represent different types of water: blue for raw water intake, green for treated water, and red for recycled water. Each flow is labeled with its volume in tonnes (t) and its salinity in microsiemens per centimetre (µS/cm). The diagram also shows the flow of water from the Coffs River catchment to the Coffs River catchment, and from the Coffs River catchment to the Coffs River catchment.



© 2016. Whilst every care has been taken to prepare this figure, GHD make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the figure being inaccurate, incomplete or unsuitable in any way and for any reason.

LOCATION	Coxs River
SEAM	NA
DRAWN	SM
CHECKED	TD
APPROVED	LH
SCALE	NTS



Amended Springvale Water Treatment Project
Water Resources Impact Assessment

Annual salt transfers
Proposed conditions (2031)
Scenario 5



Centennial Coal



EnergyAustralia

DATE Dec 2016

Figure B-30

B.2.2 Time series results

Monthly average time series results are presented for scenarios 1, 2, 4 and 5 are presented in Figure B-31 to B-52.

Scenario 1

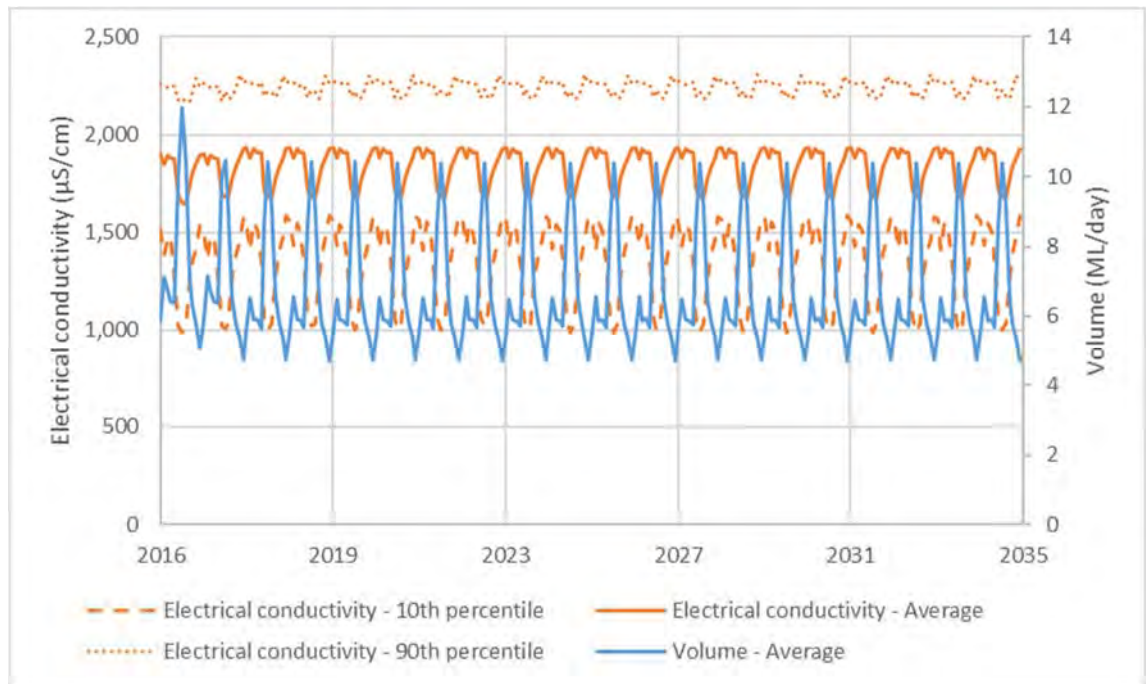


Figure B-31 Scenario 1 – Predicted EC of Wangcol Creek at LDP006

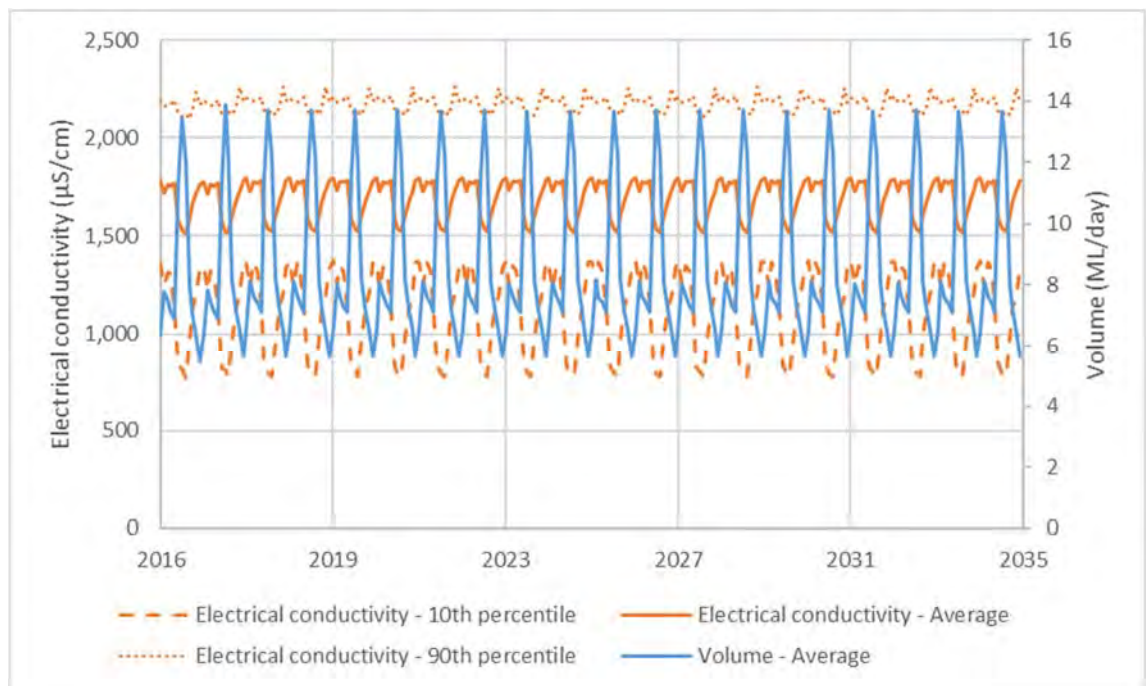


Figure B-32 Scenario 1 – Predicted EC of Wangcol Creek at the confluence with the Coss River

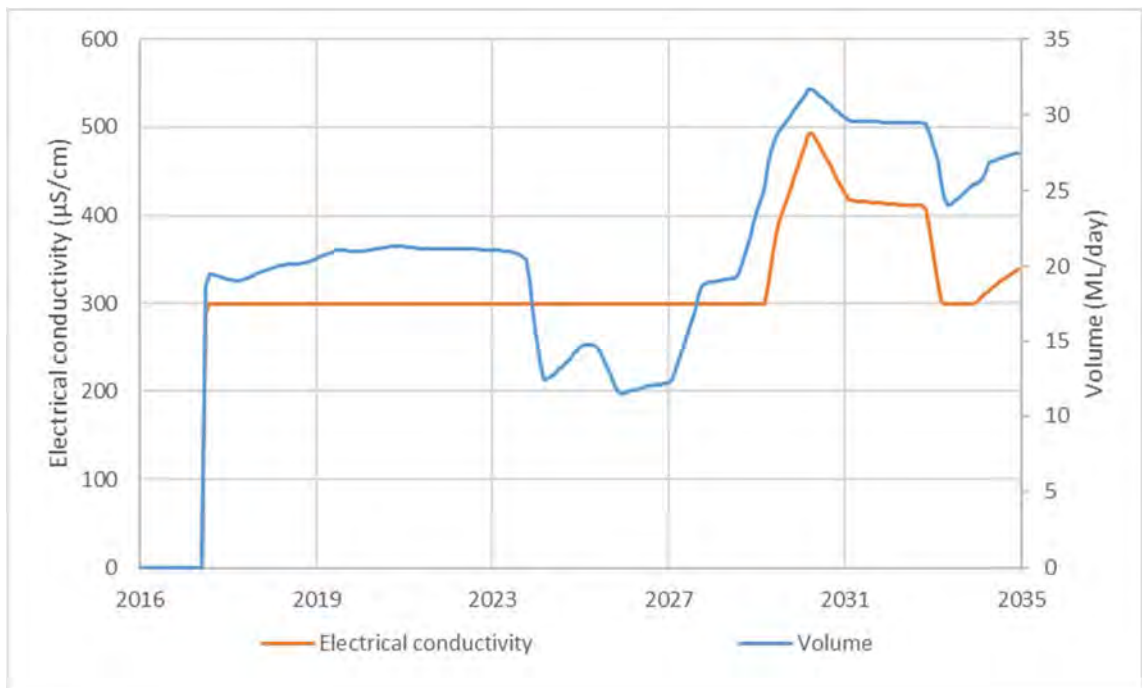


Figure B-33 Scenario 1 – Predicted EC of transfer from Mount Piper Power Station to Thompsons Creek Reservoir

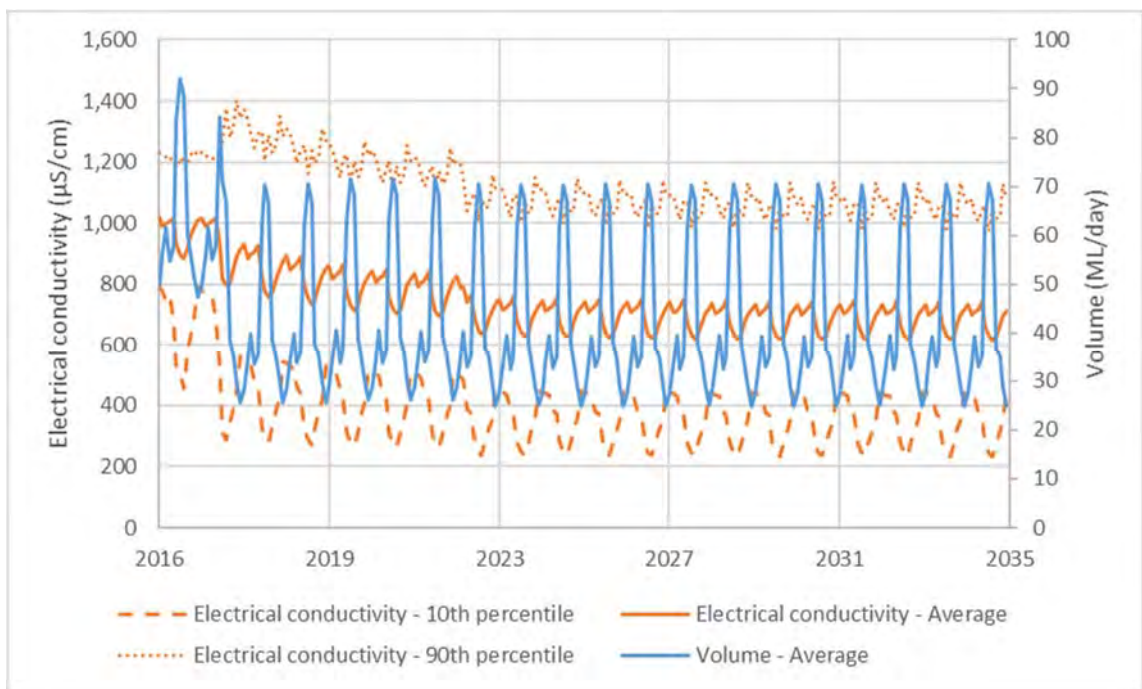


Figure B-34 Scenario 1 – Predicted EC of flow from the Coxs River to Lake Wallace

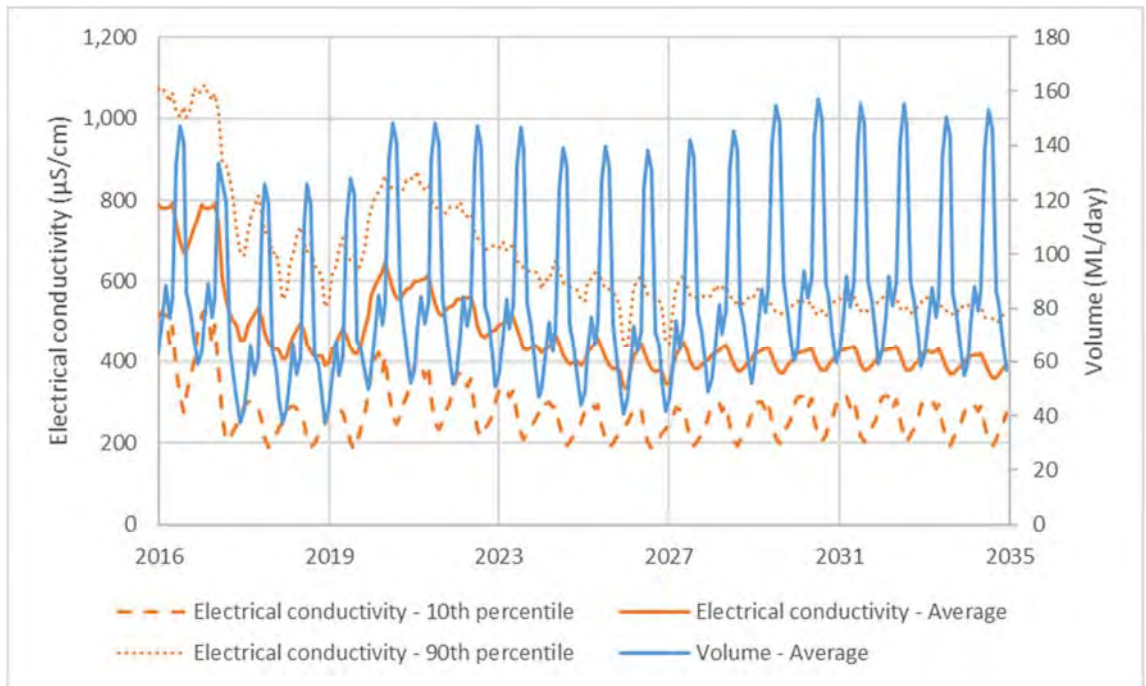


Figure B-35 Scenario 1 – Predicted EC of flow from the Cocks River to Lake Lyell

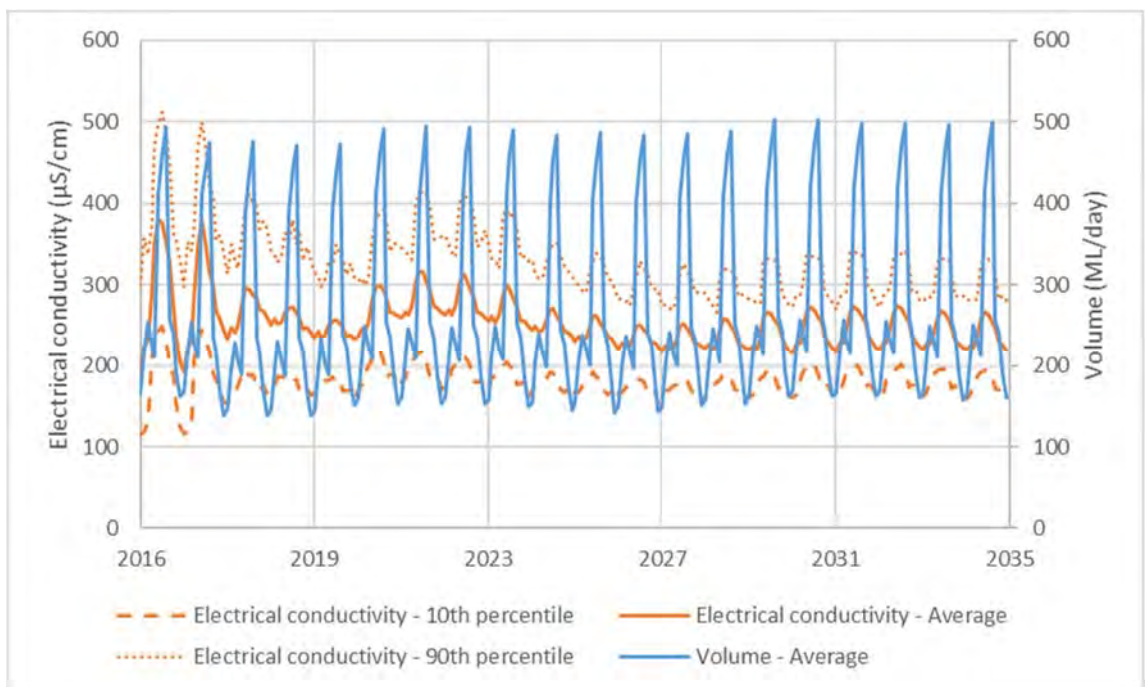


Figure B-36 Scenario 1 – Predicted EC of flow from the Cocks River to Lake Burragorang

Scenario 2

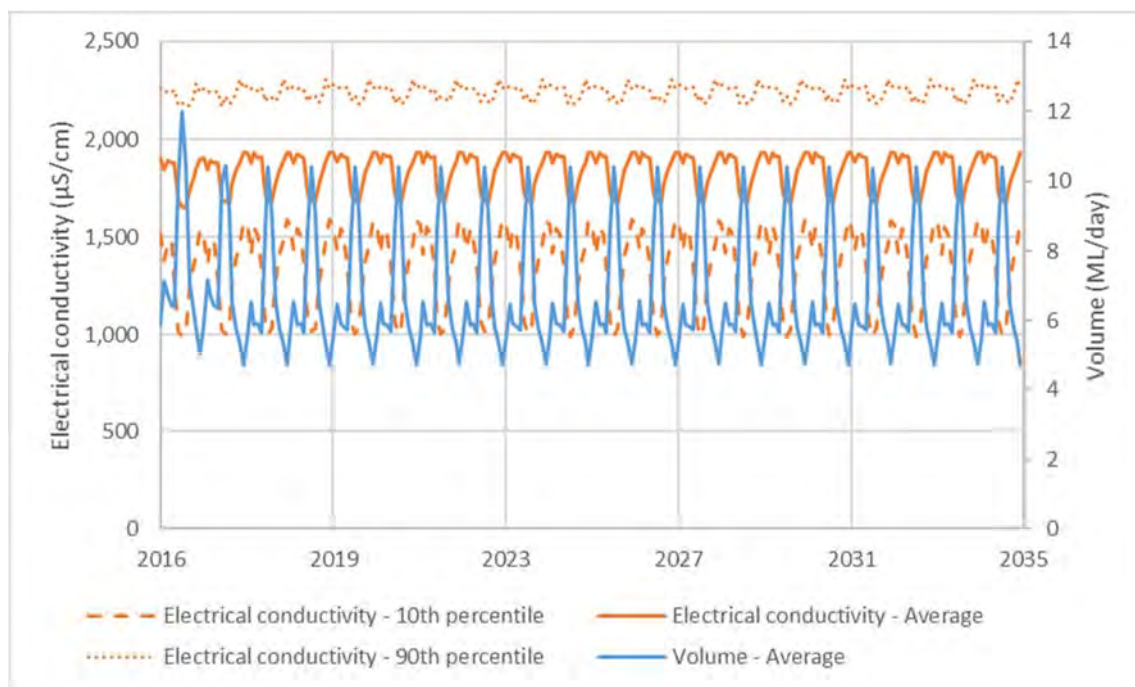


Figure B-37 Scenario 2 – Predicted EC of Wangcol Creek at LDP006

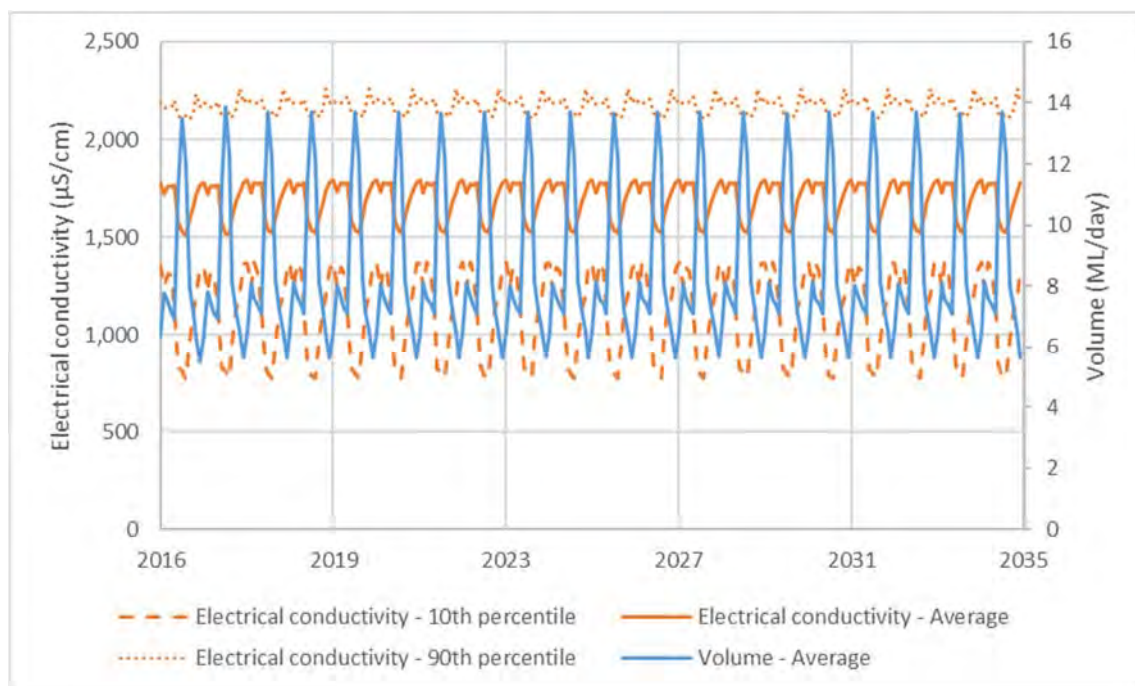


Figure B-38 Scenario 2 – Predicted EC of Wangcol Creek at the confluence with the Coffs River

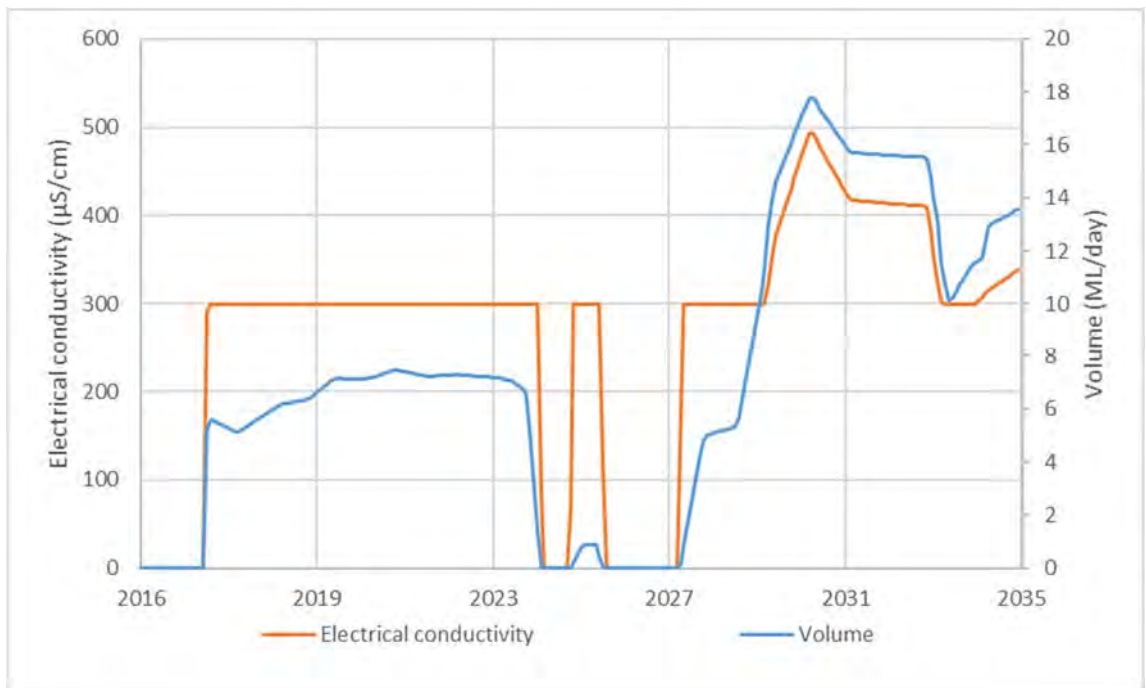


Figure B-39 Scenario 2 – Predicted EC of transfer from Mount Piper Power Station to Thompsons Creek Reservoir

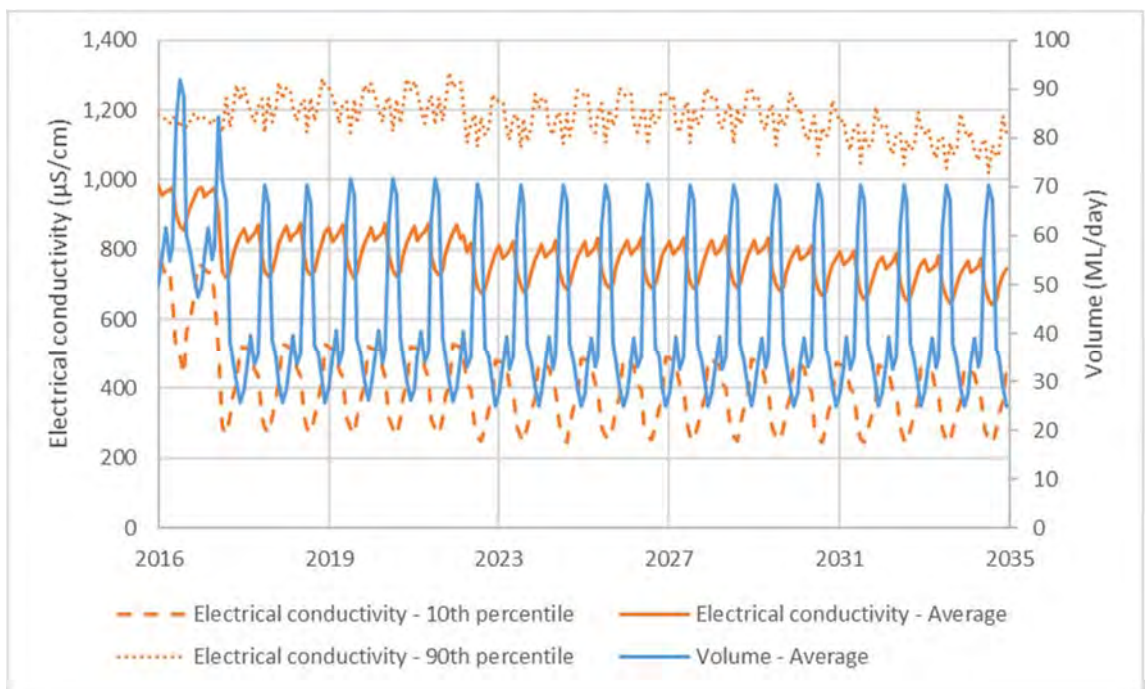


Figure B-40 Scenario 2 – Predicted EC of flow from the Coxs River to Lake Wallace

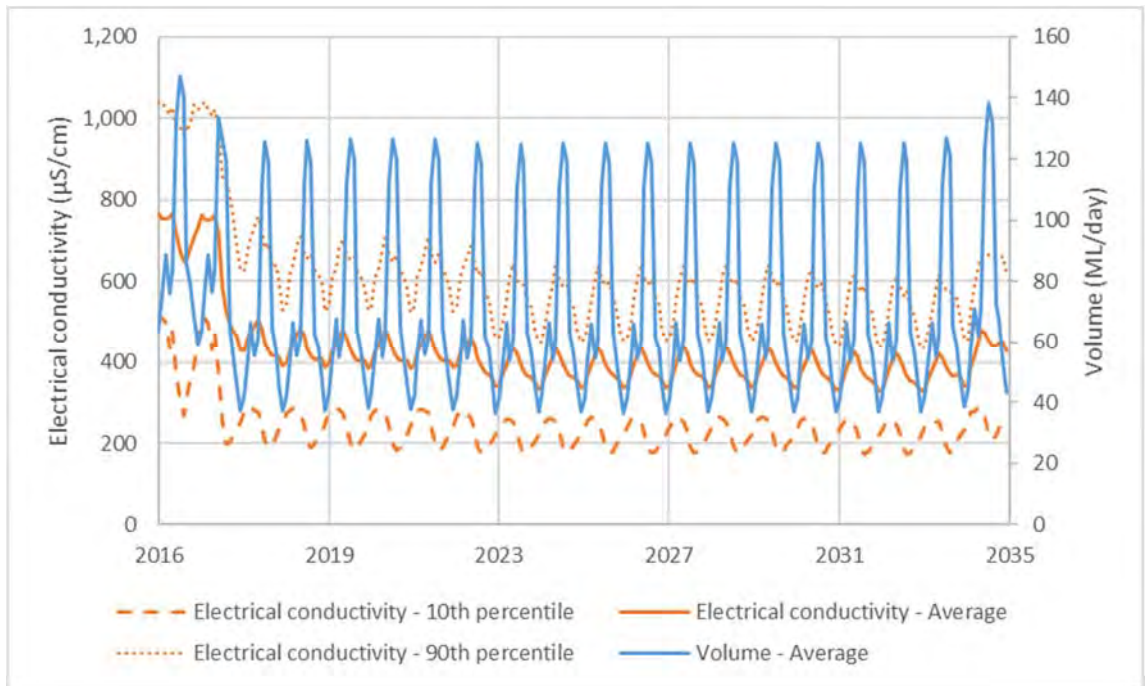


Figure B-41 Scenario 2 – Predicted EC of flow from the Cocks River to Lake Lyell

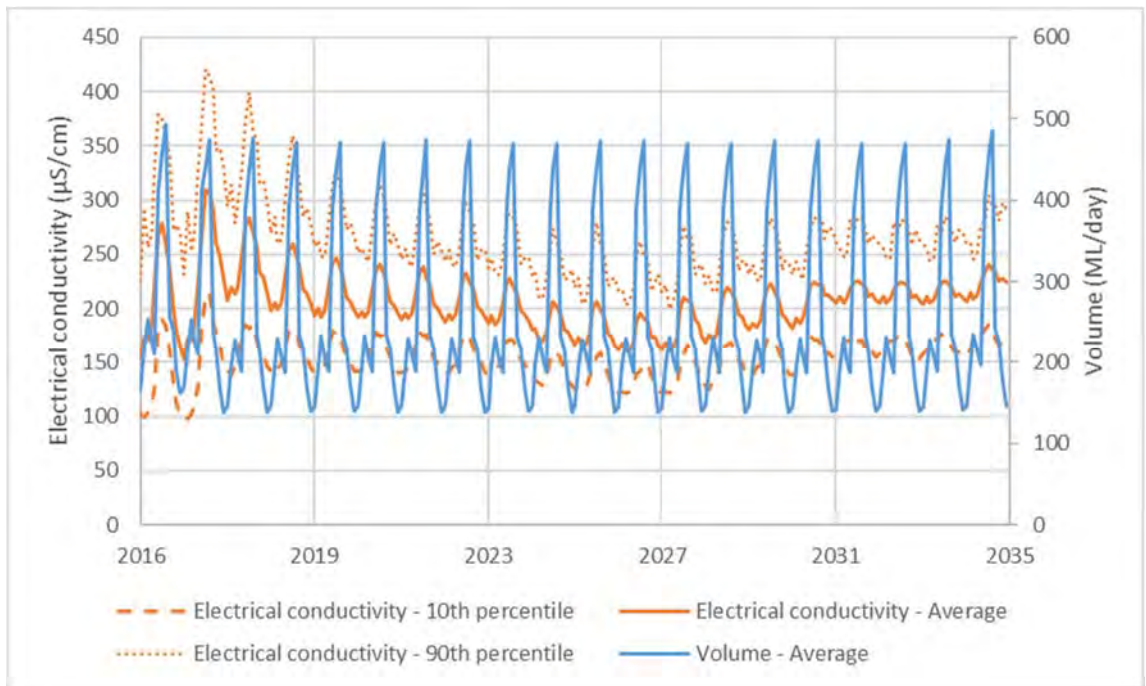


Figure B-42 Scenario 2 – Predicted EC of flow from the Cocks River to Lake Burragorang

Scenario 4

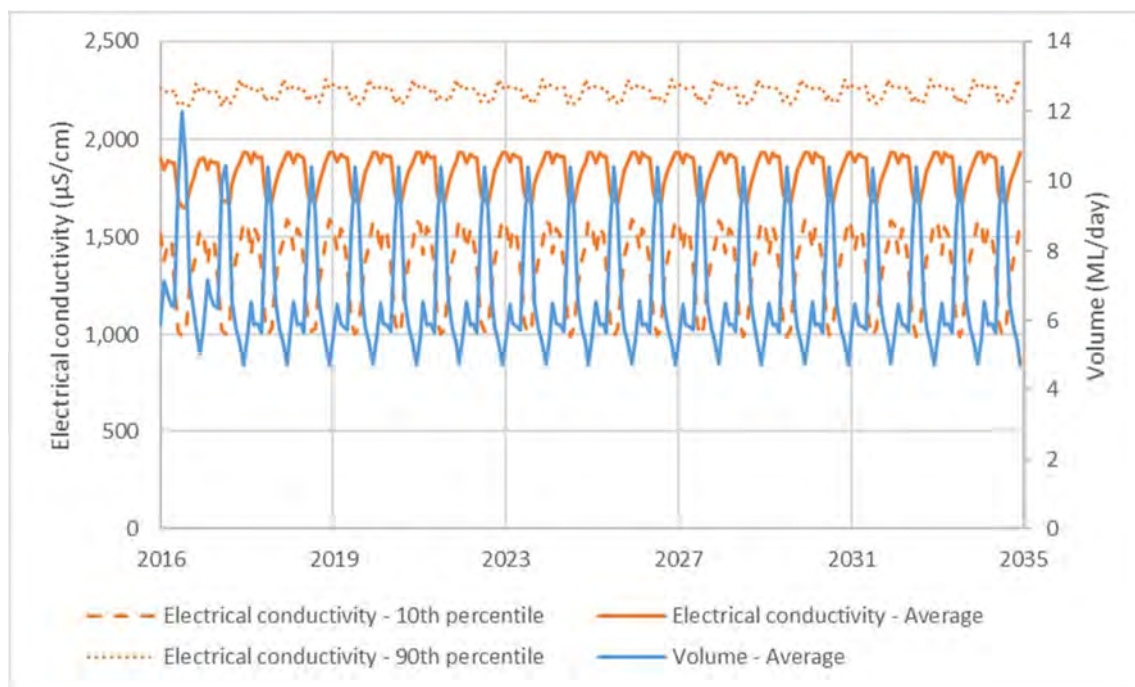


Figure B-43 Scenario 4 – Predicted EC of Wangcol Creek at LDP006

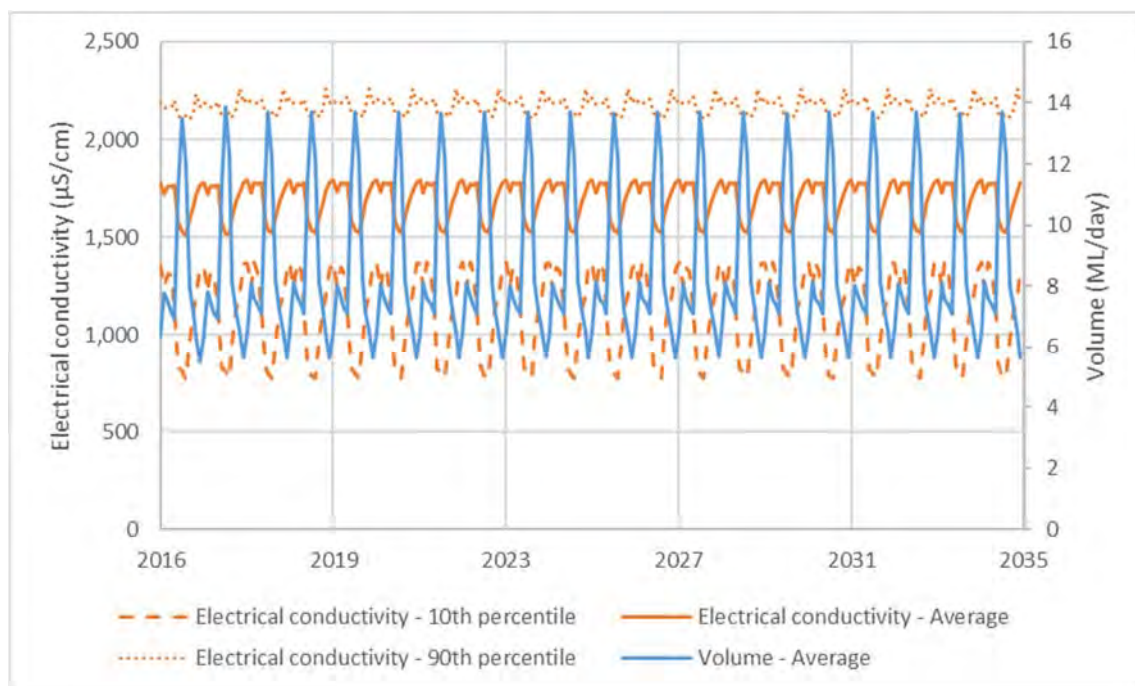


Figure B-44 Scenario 4 – Predicted EC of Wangcol Creek at the confluence with the Coffs River

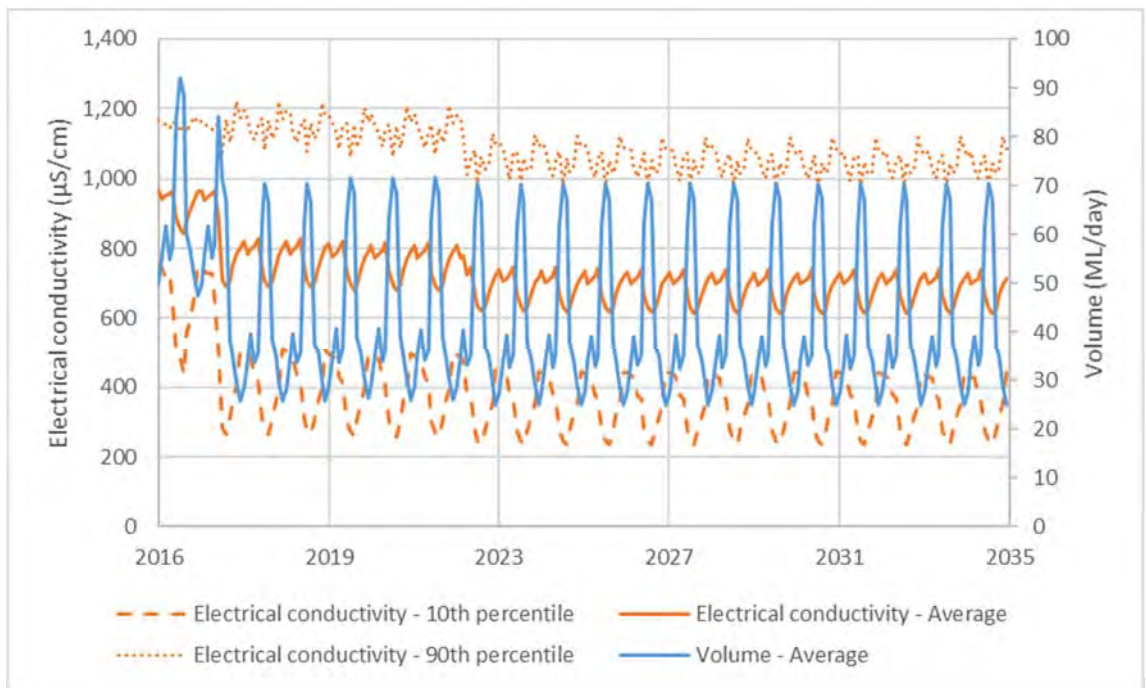


Figure B-45 Scenario 4 – Predicted EC of flow from the Coxs River to Lake Wallace

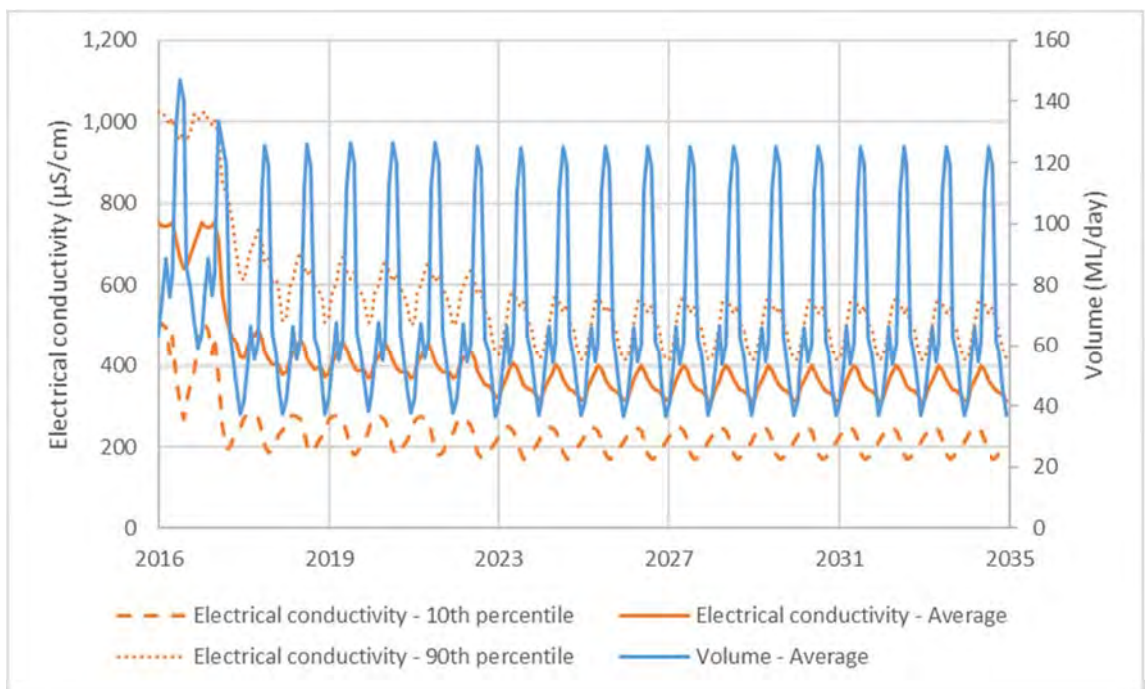


Figure B-46 Scenario 4 – Predicted EC of flow from the Coxs River to Lake Lyell

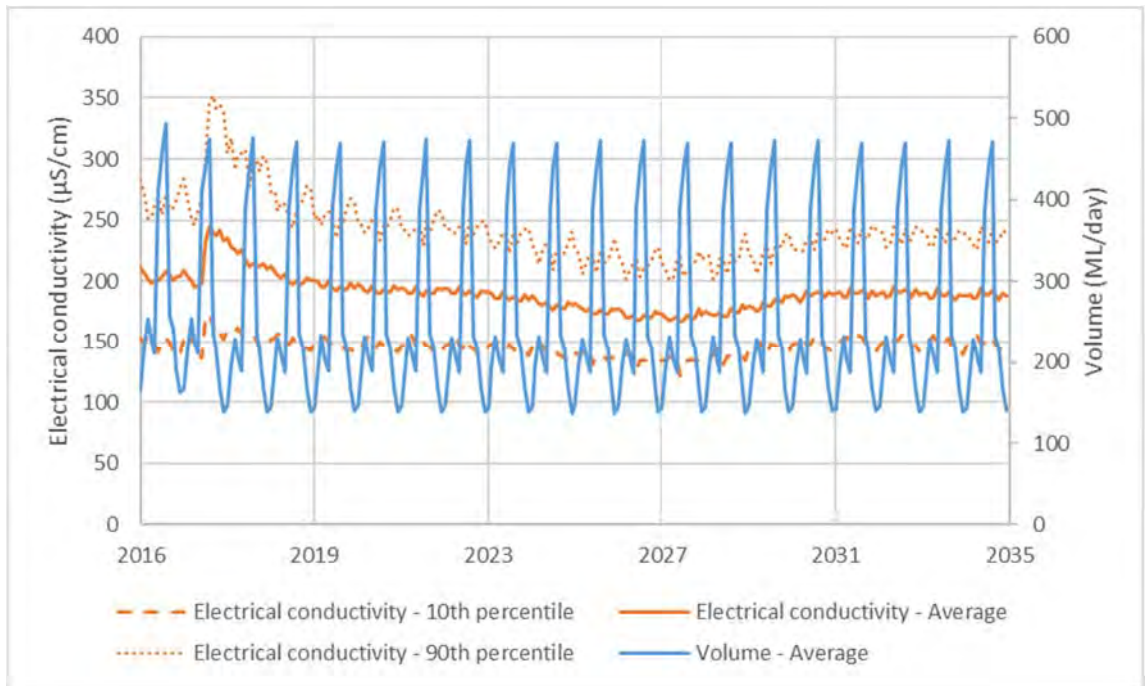


Figure B-47 Scenario 4 – Predicted EC of flow from the Coxs River to Lake Burragorang

Scenario 5

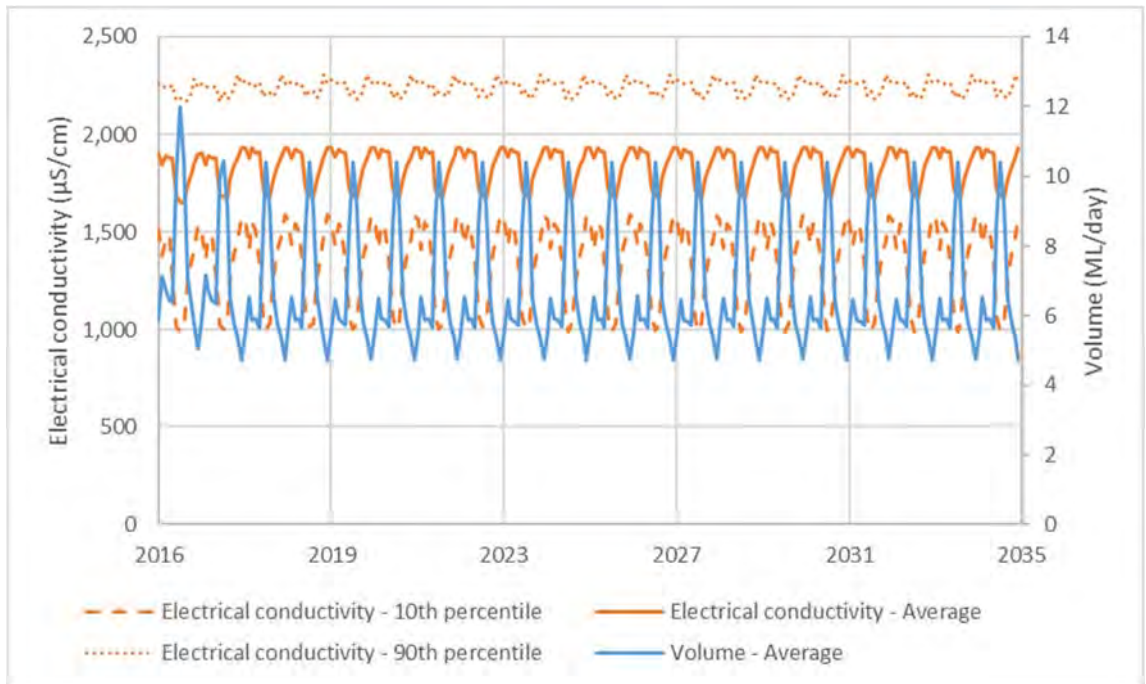


Figure B-48 Scenario 5 – Predicted EC of Wangcol Creek at LDP006

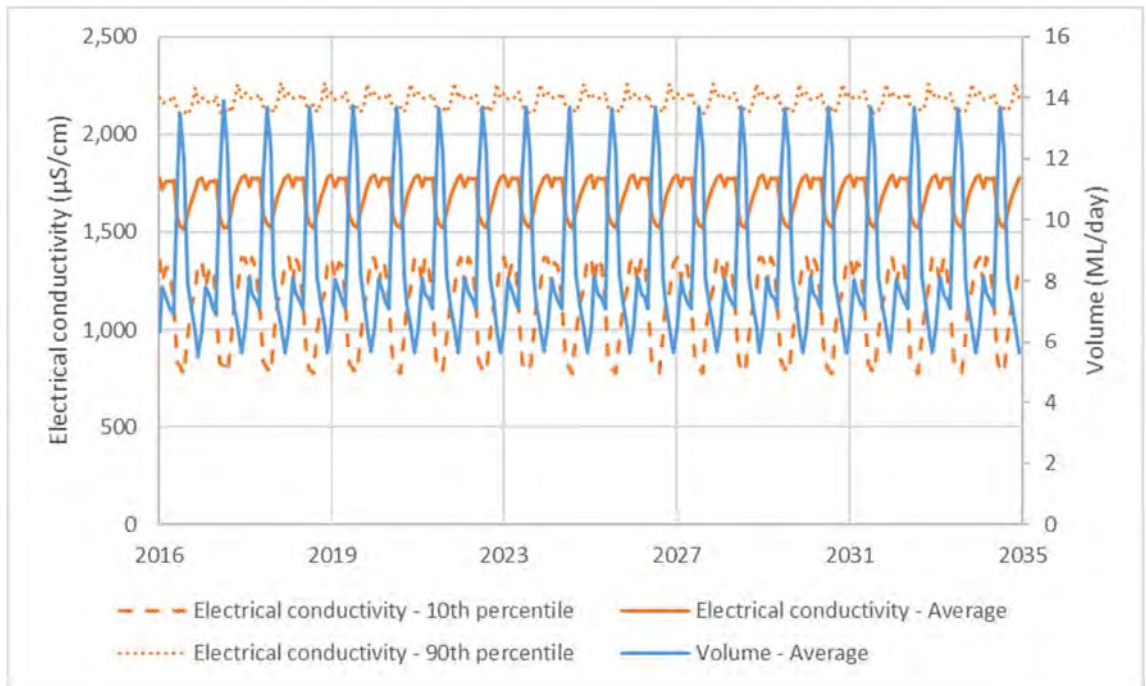


Figure B-49 Scenario 5 – Predicted EC of Wangcol Creek at the confluence with the Cocks River

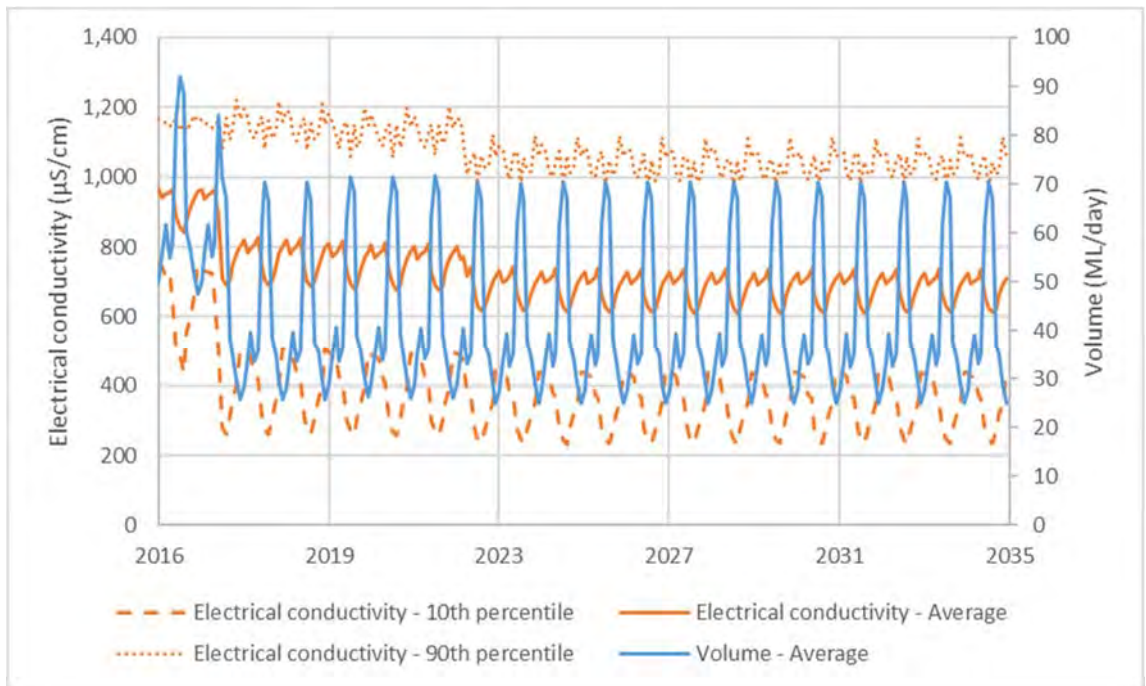


Figure B-50 Scenario 5 – Predicted EC of flow from the Cocks River to Lake Wallace

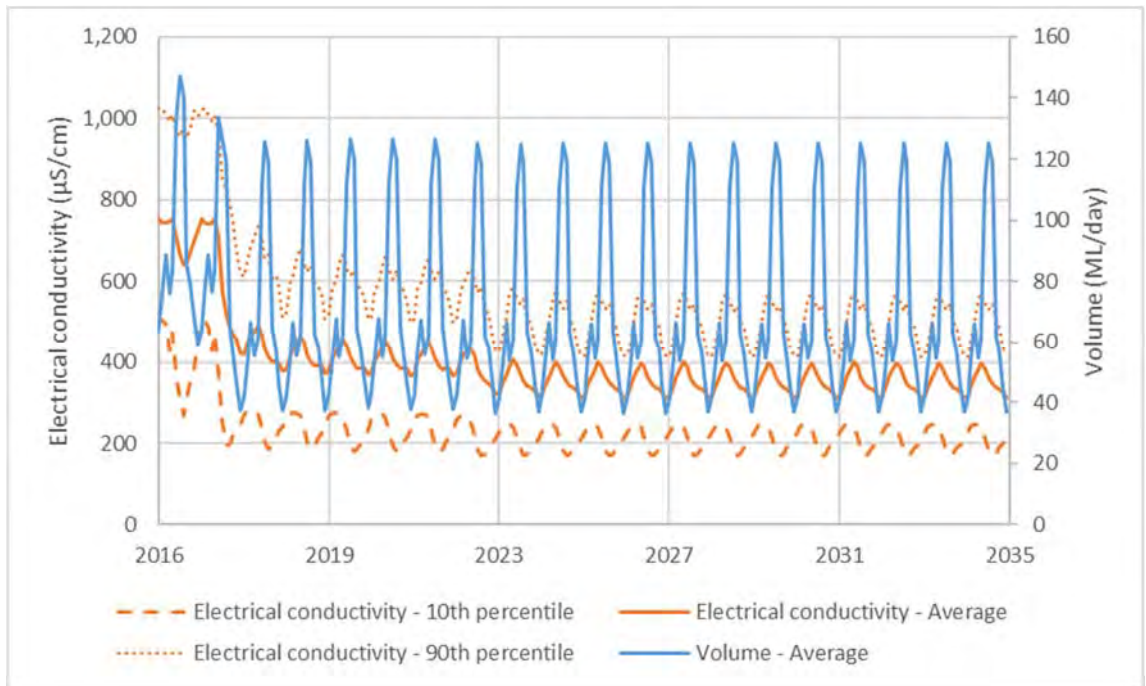


Figure B-51 Scenario 5 – Predicted EC of flow from the Cocks River to Lake Lyell

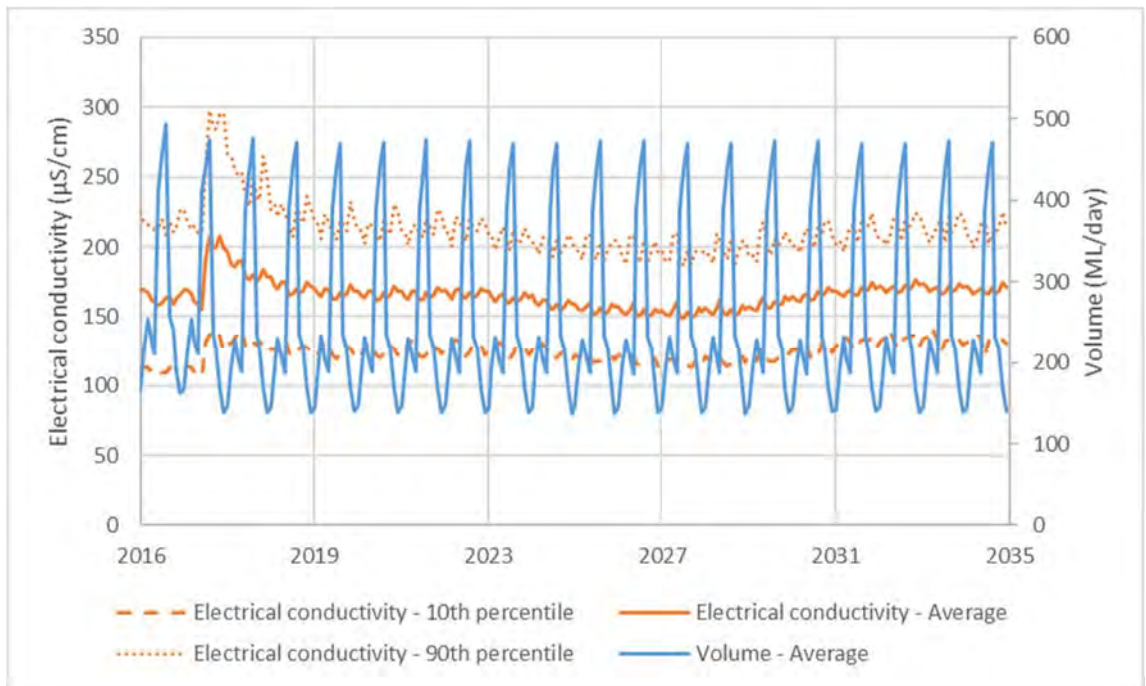
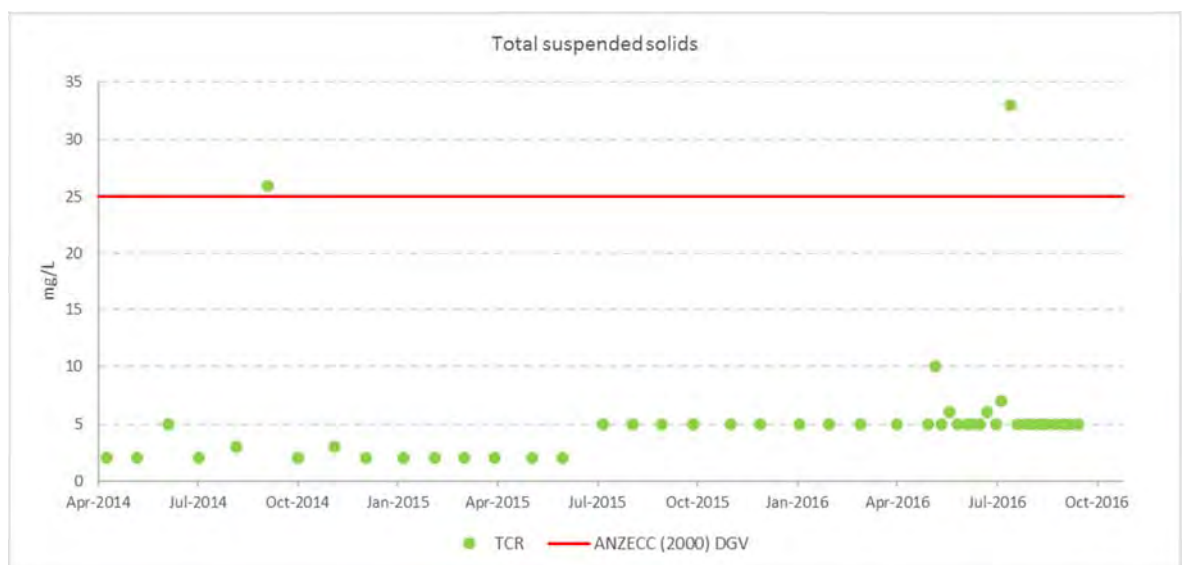
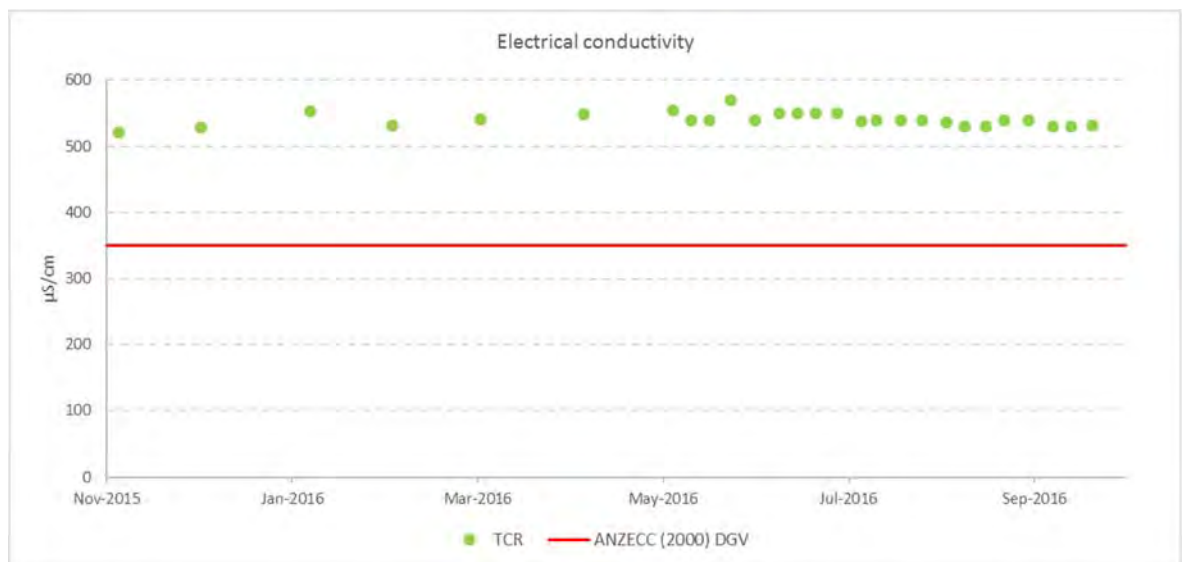


Figure B-52 Scenario 5 – Predicted EC of flow from the Cocks River to Lake Burragorang

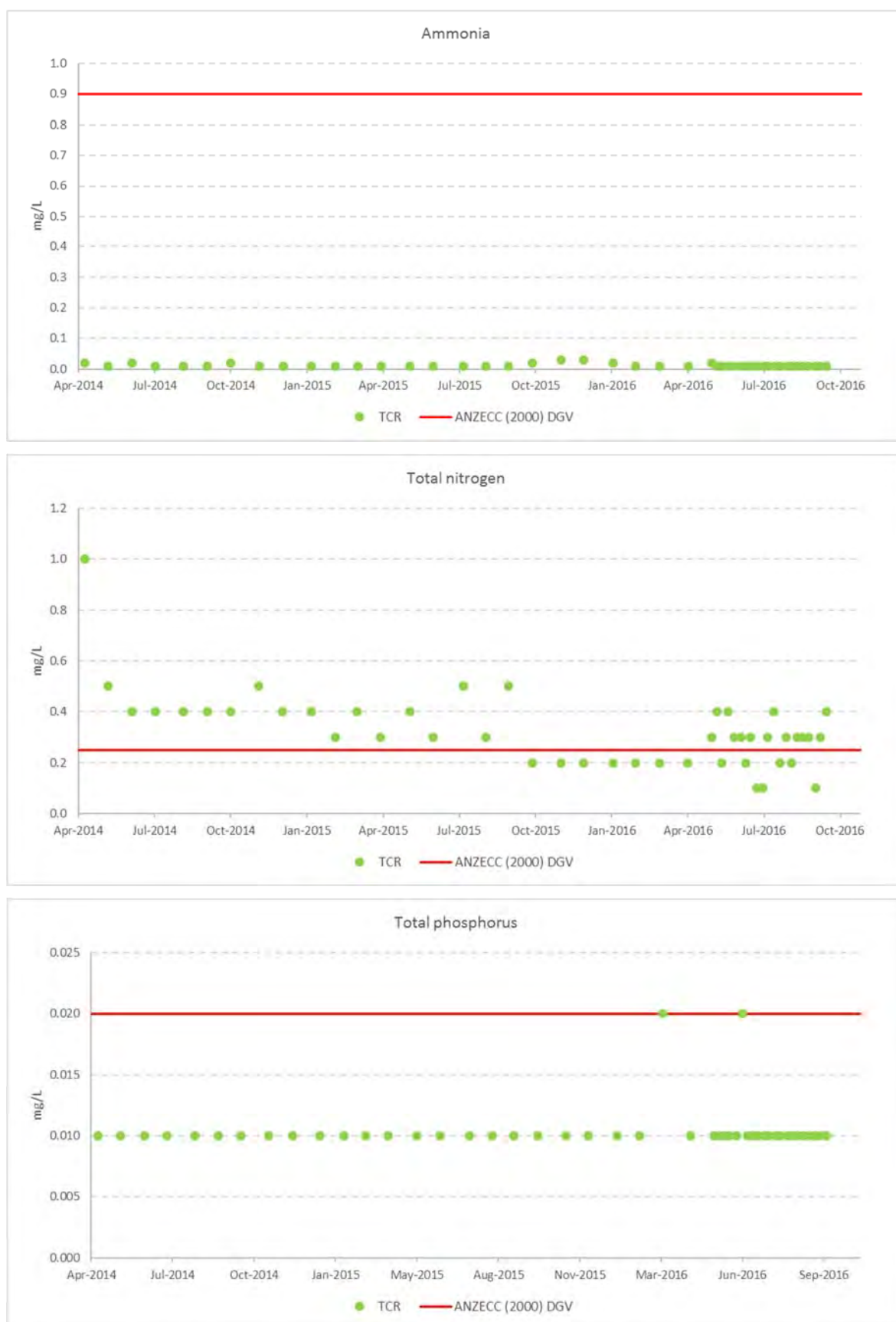
Appendix C – Surface water quality assessment

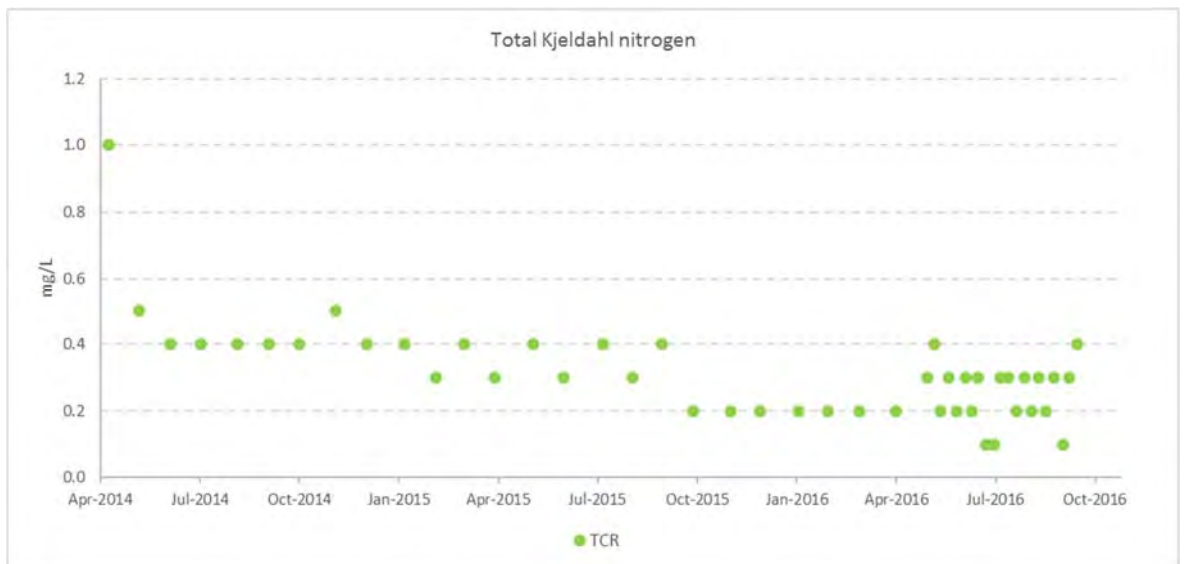
C.1 Thompsons Creek Reservoir

C.1.1 Physicochemical parameters

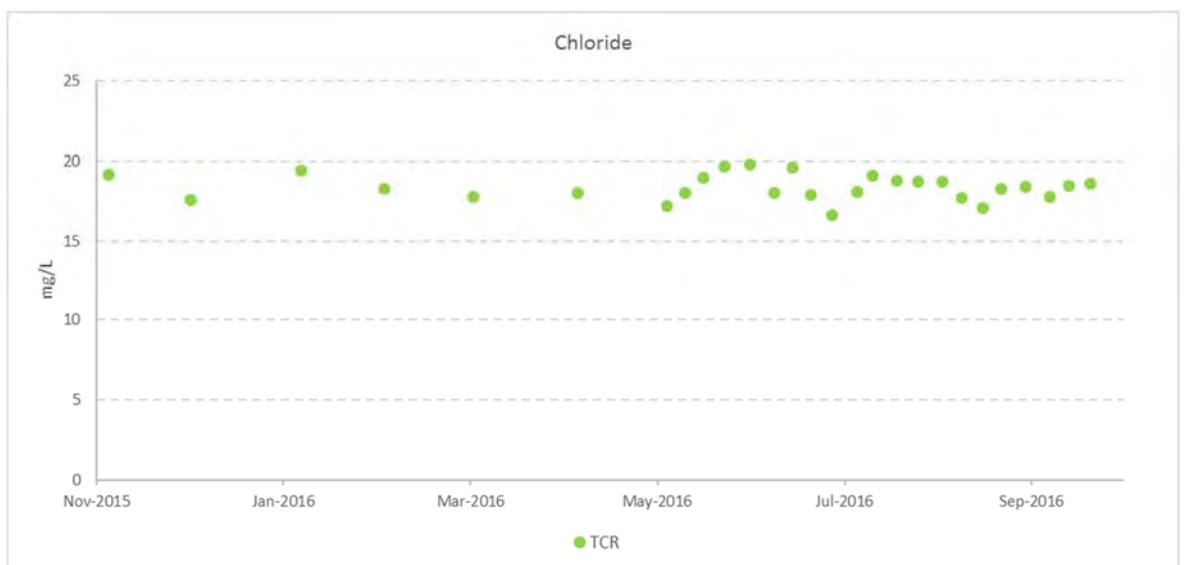
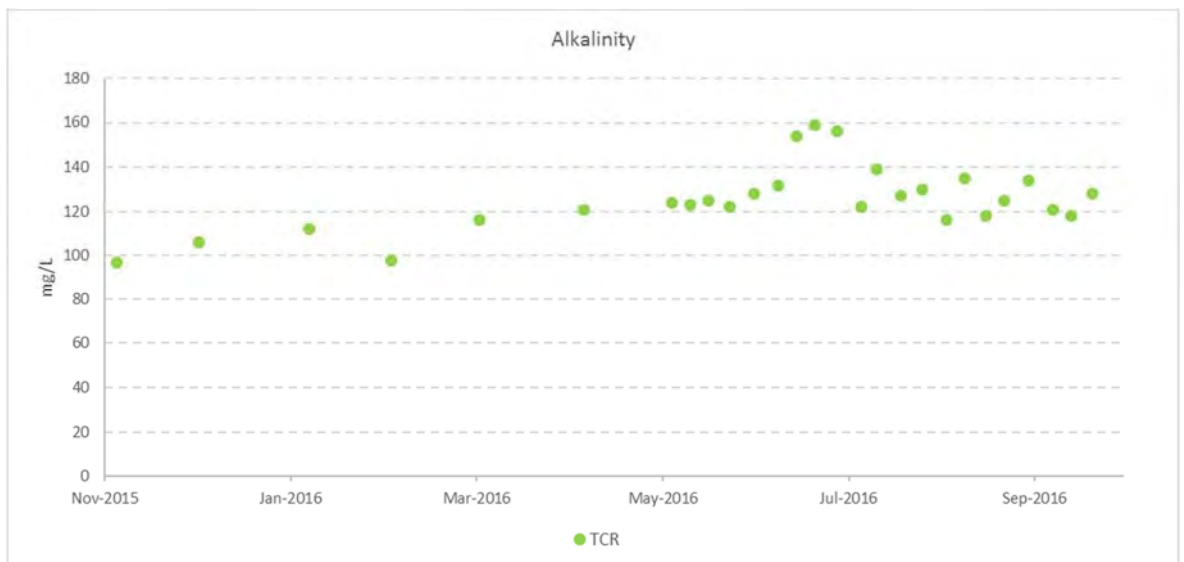


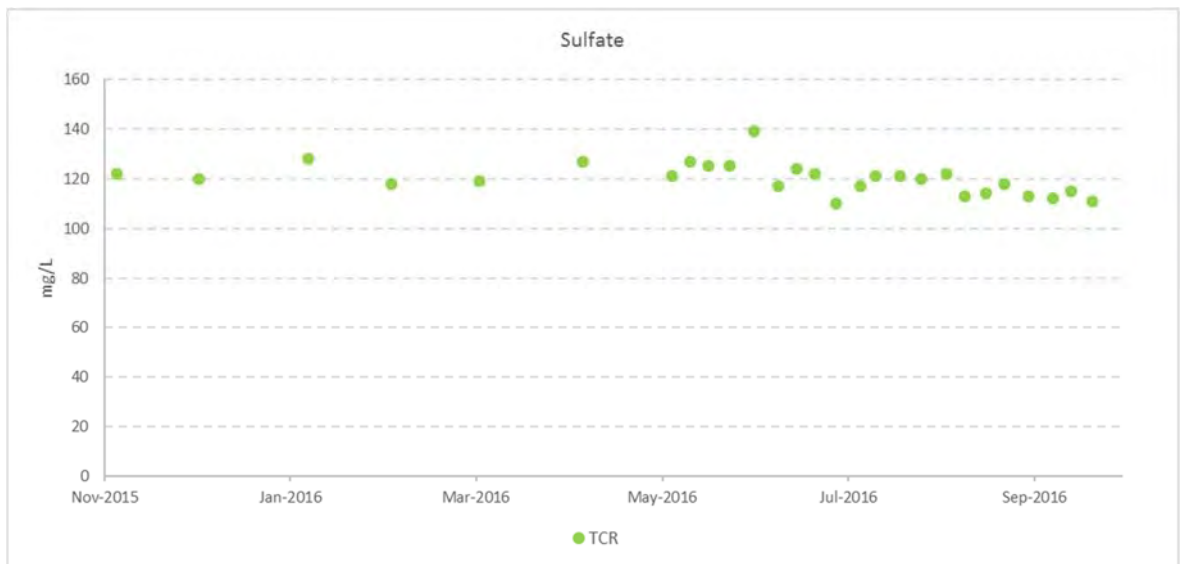
C.1.2 Nutrients



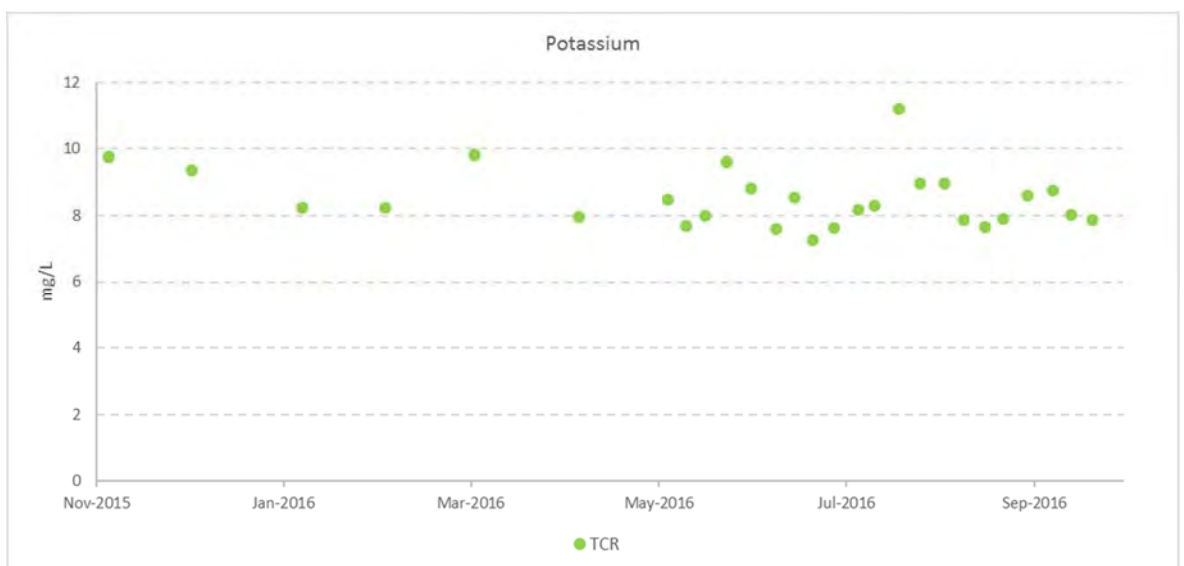
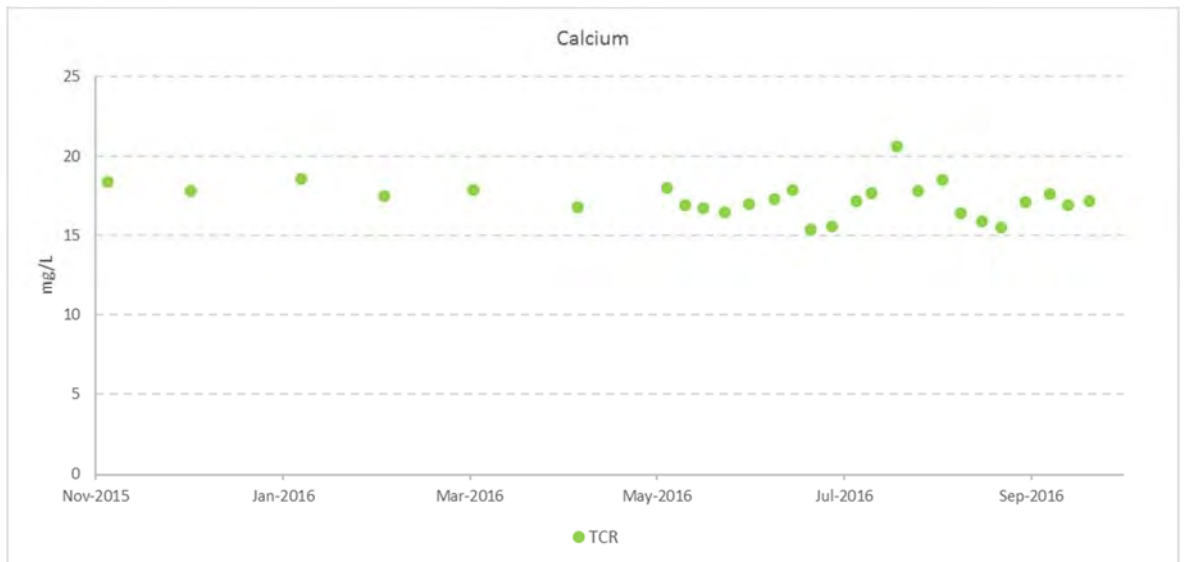


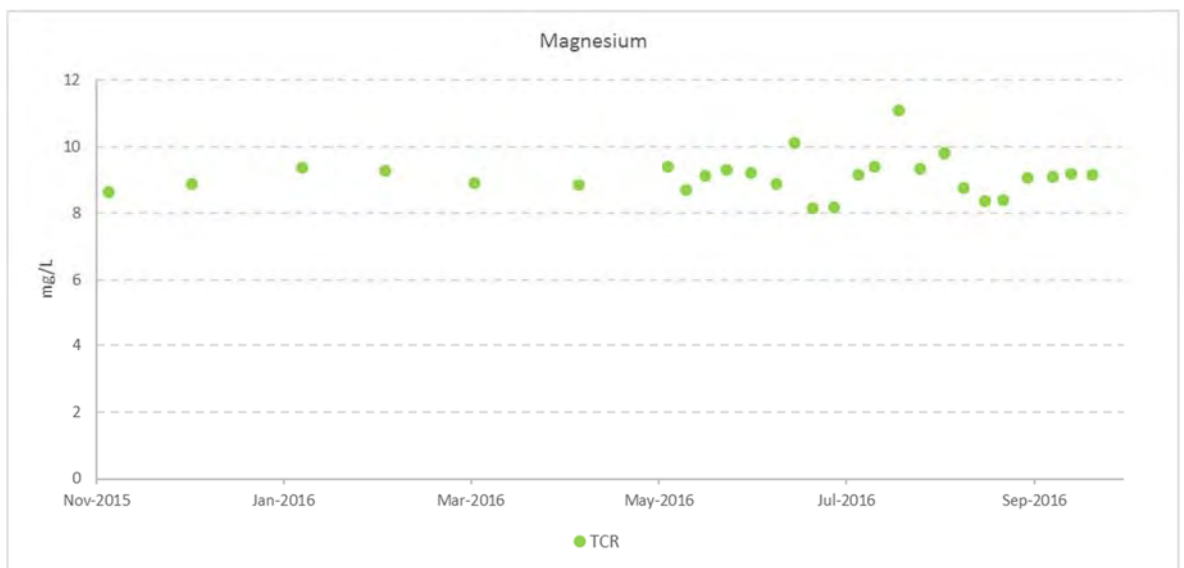
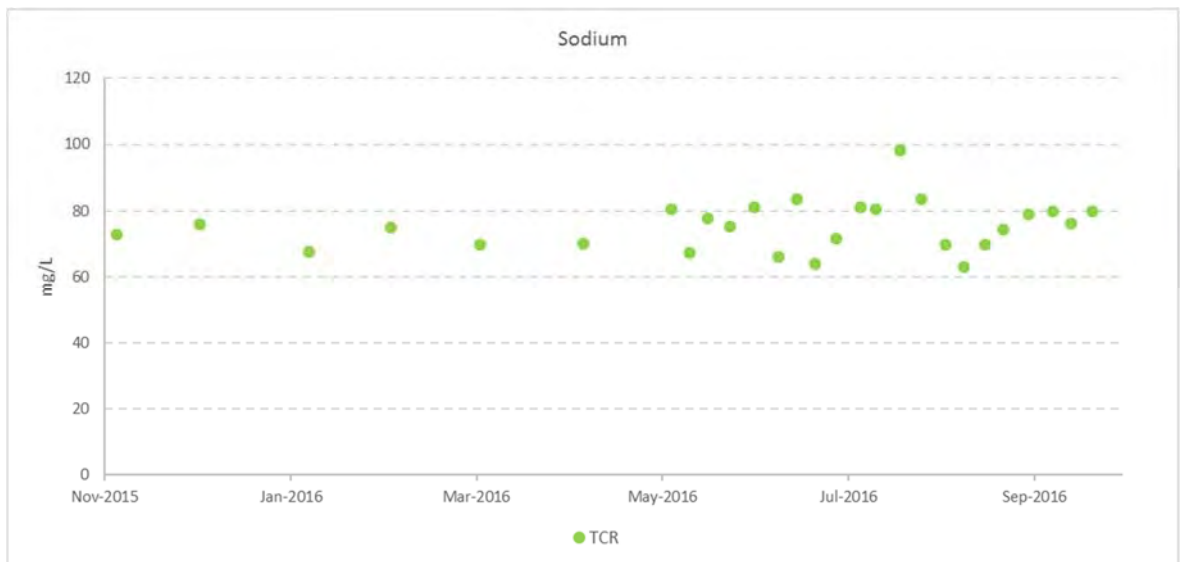
C.1.3 Anions



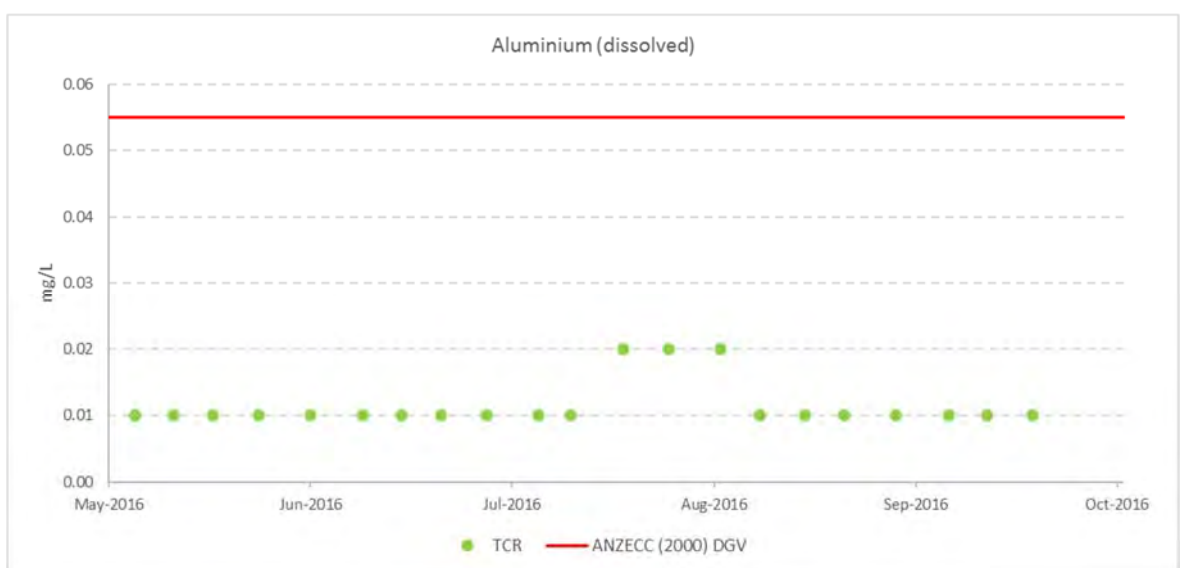


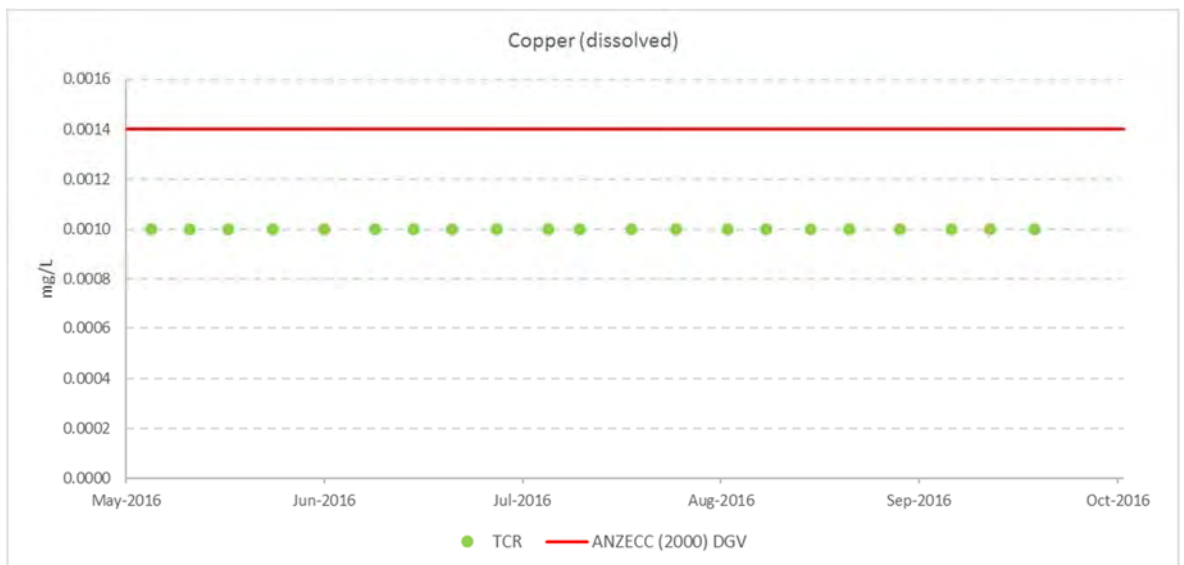
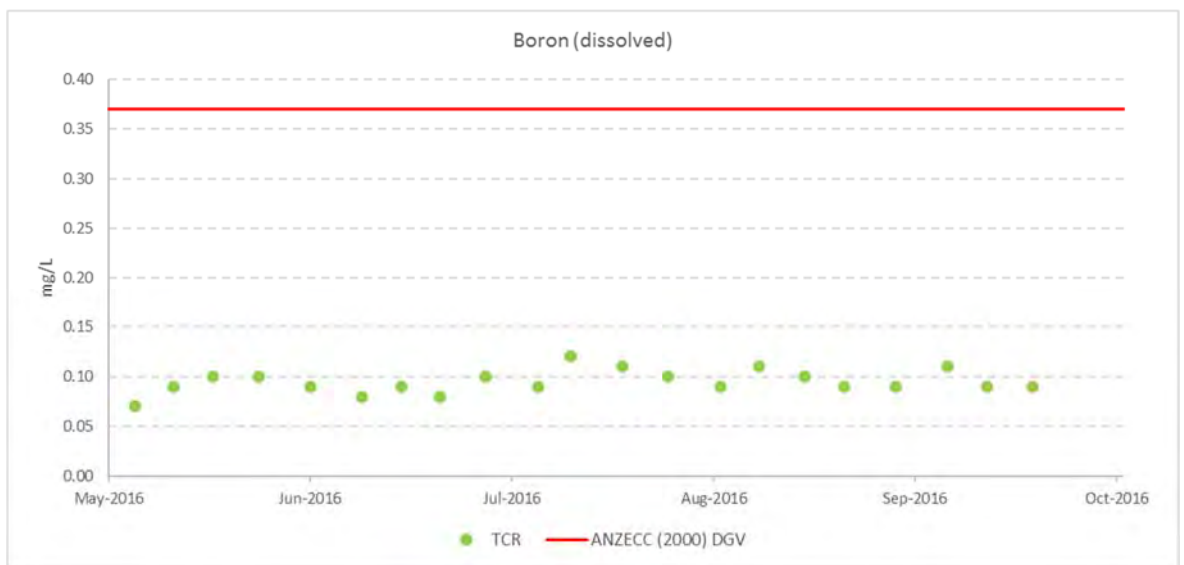
C.1.4 Cations

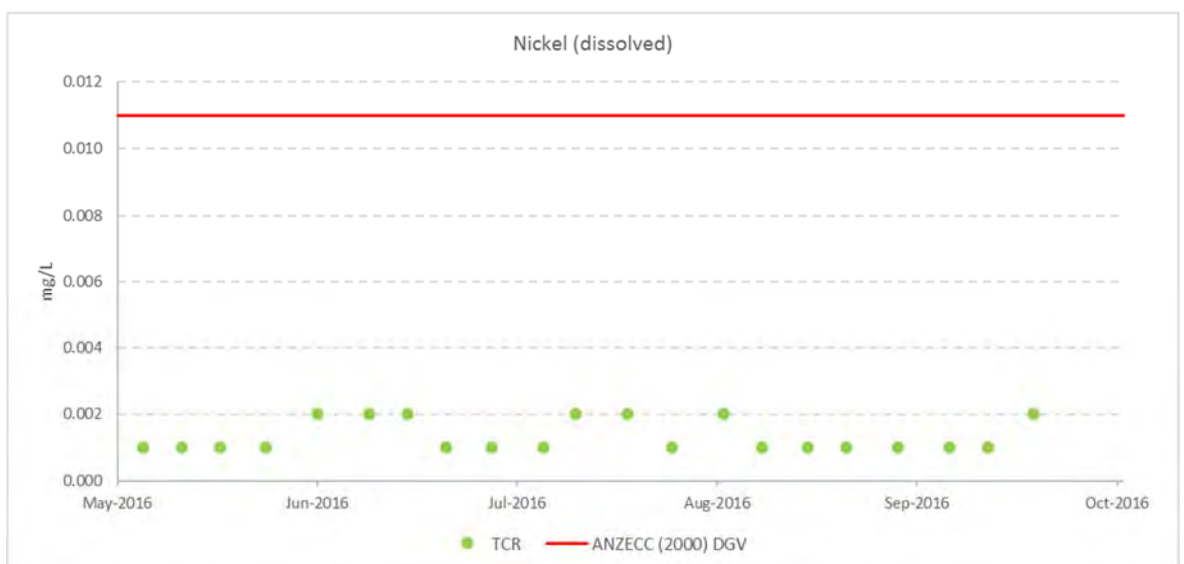
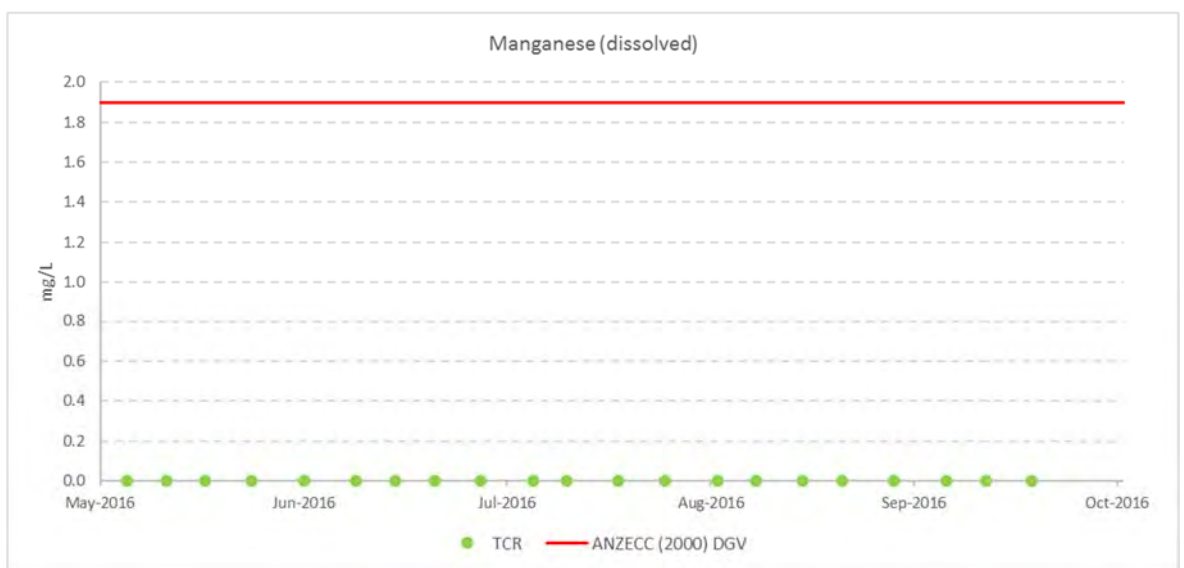
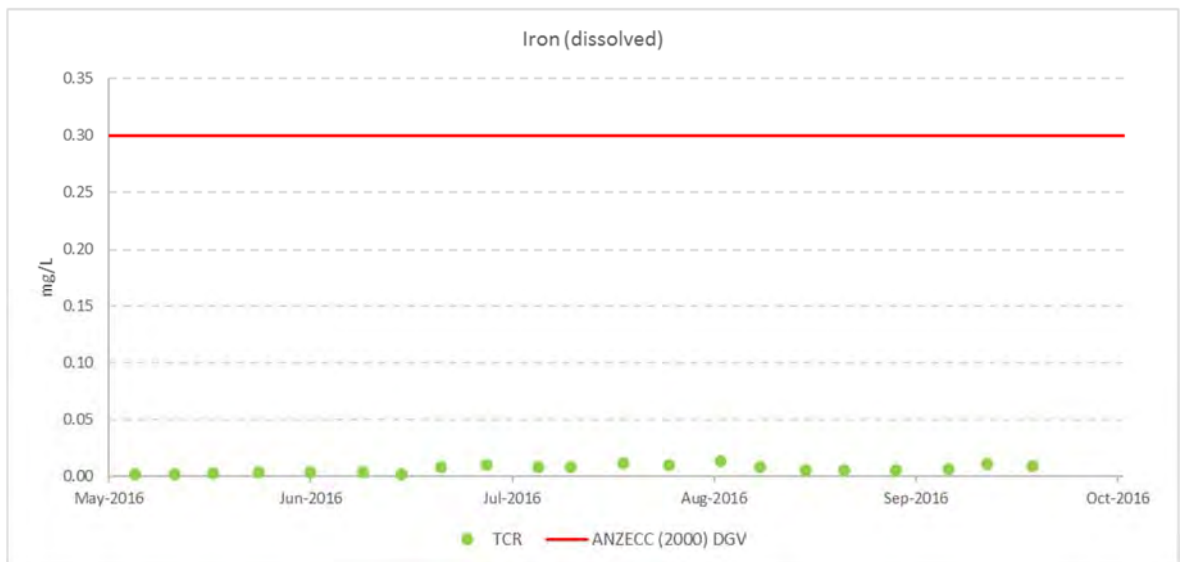


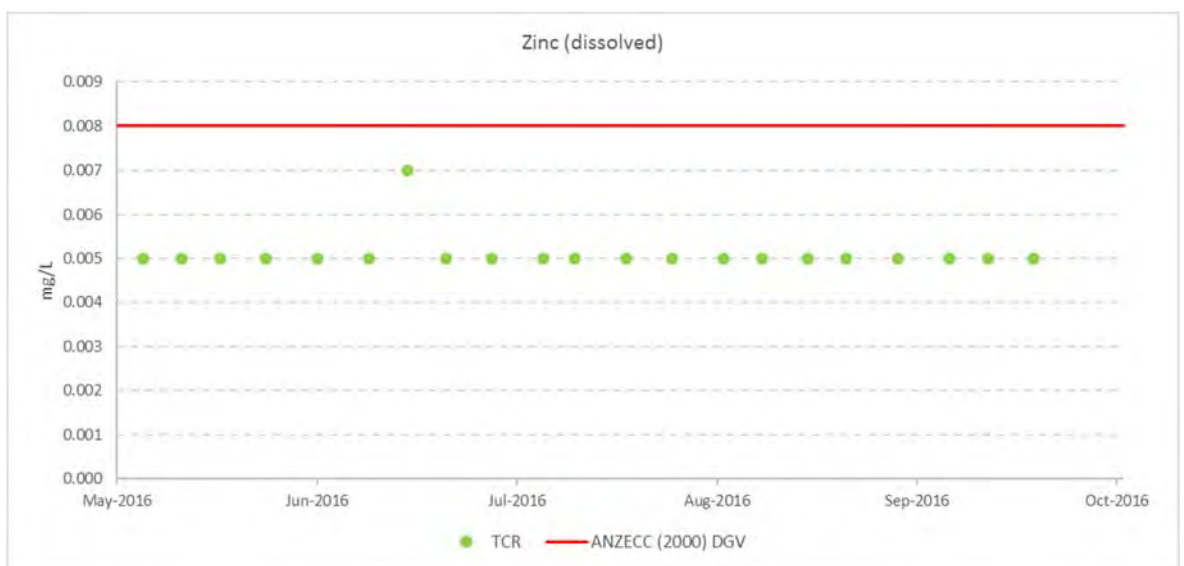
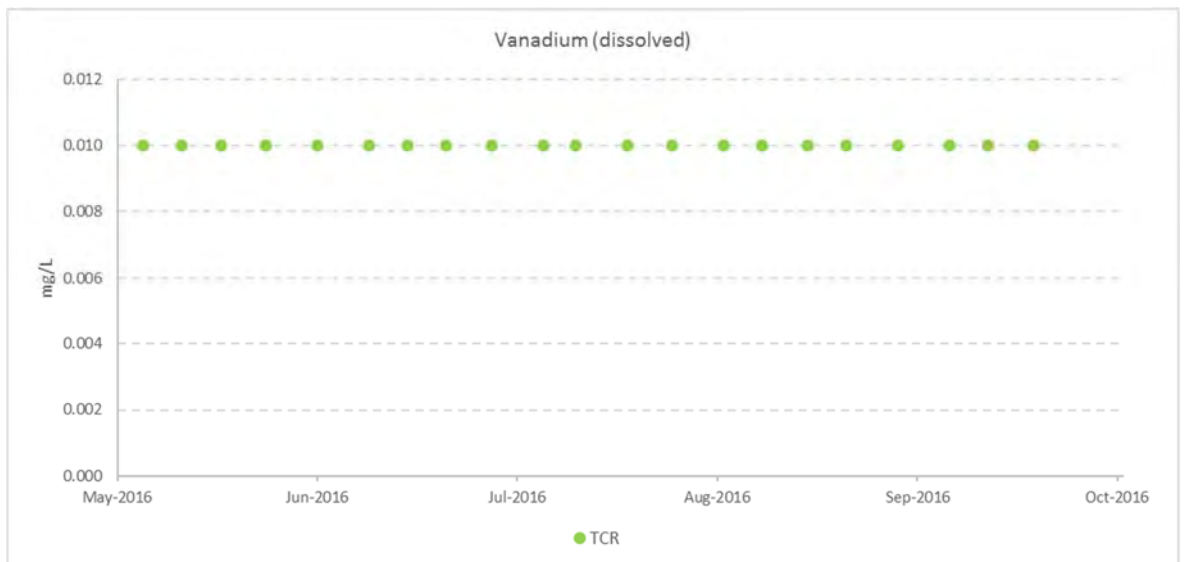


C.1.5 Metals



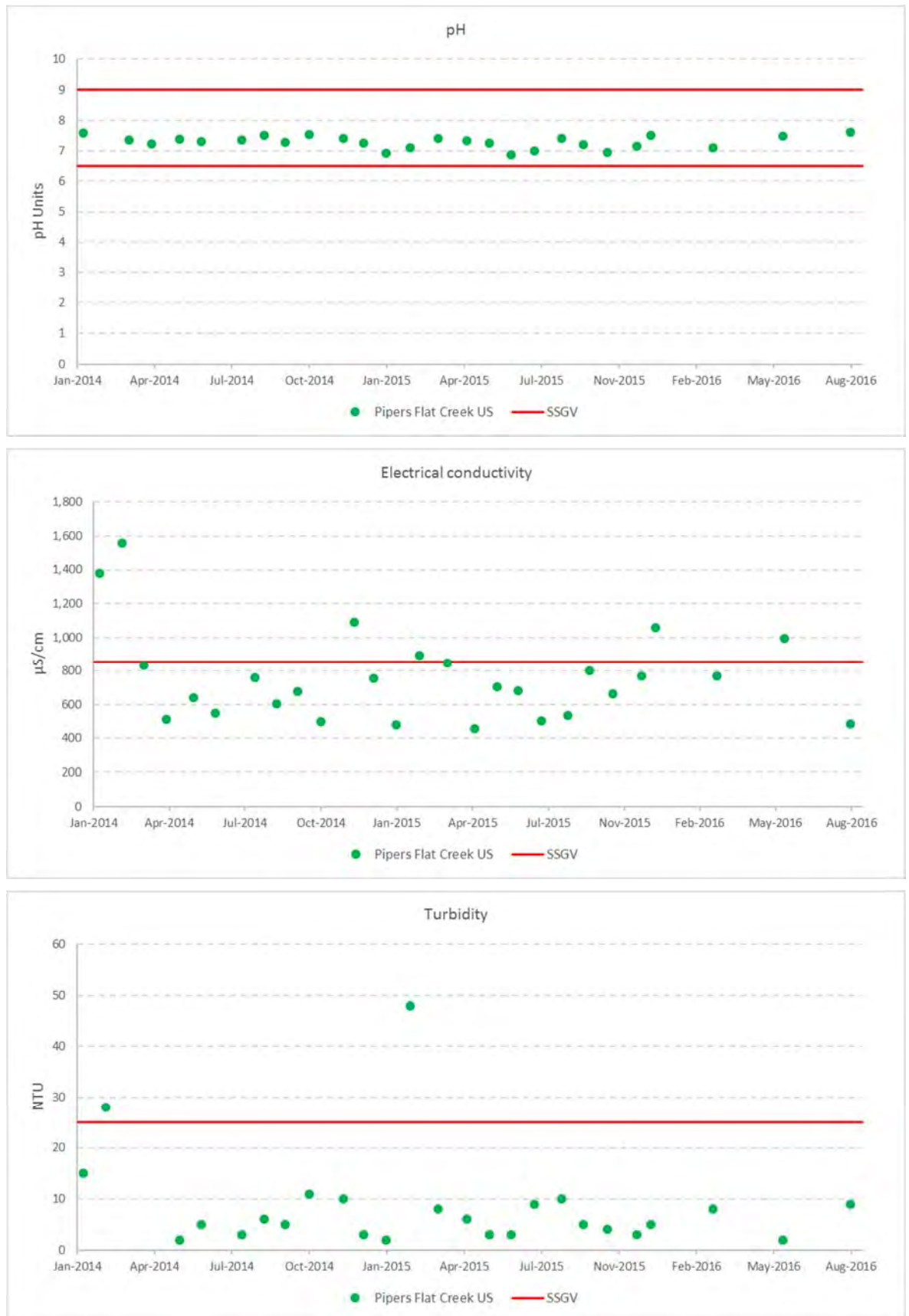


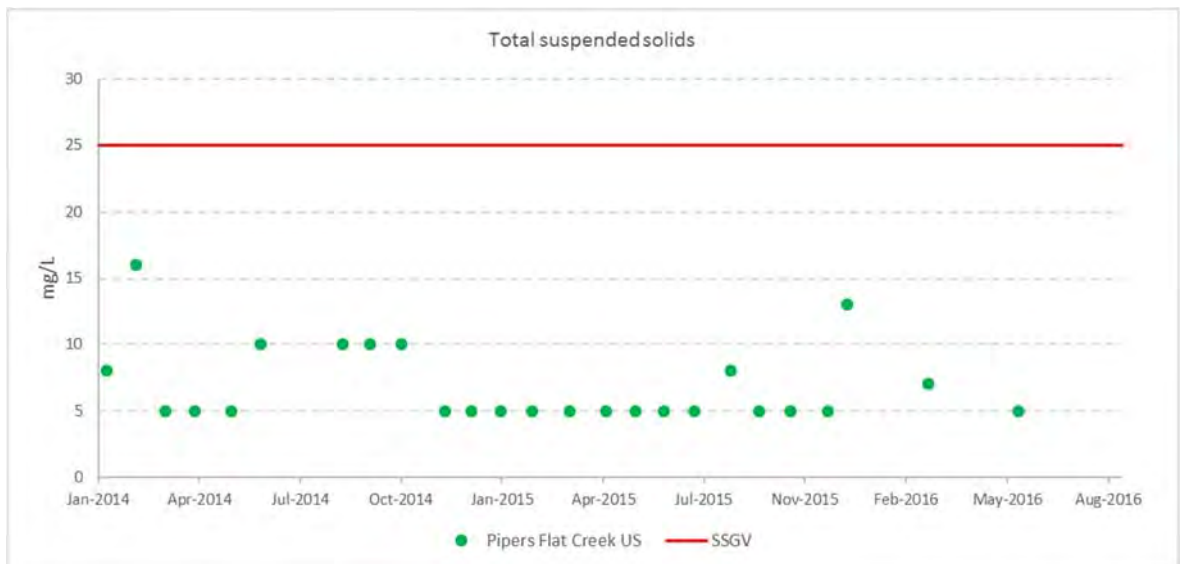




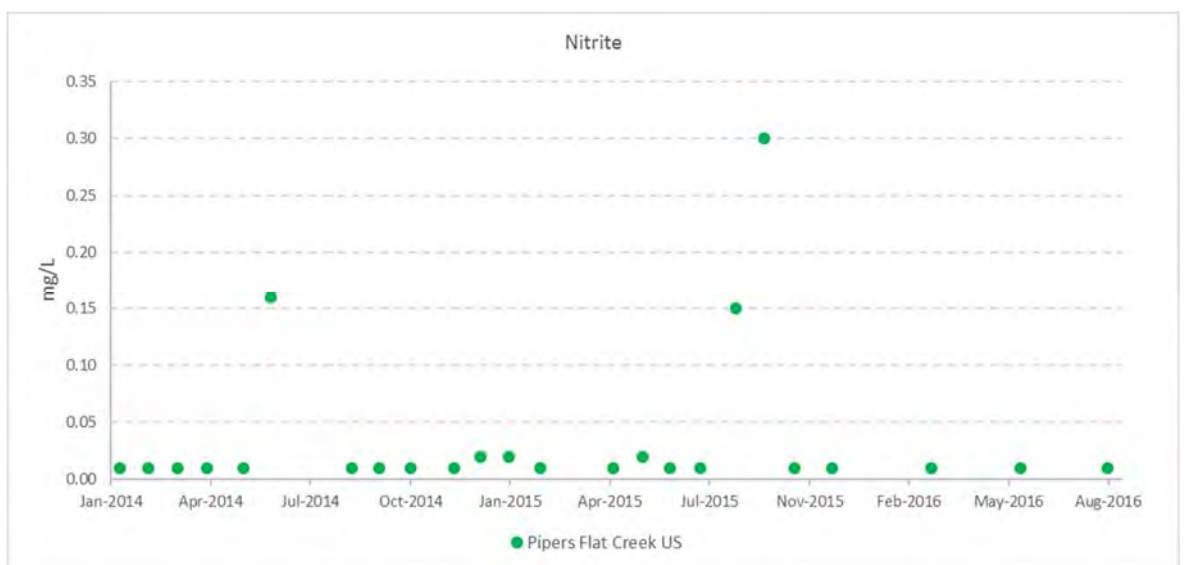
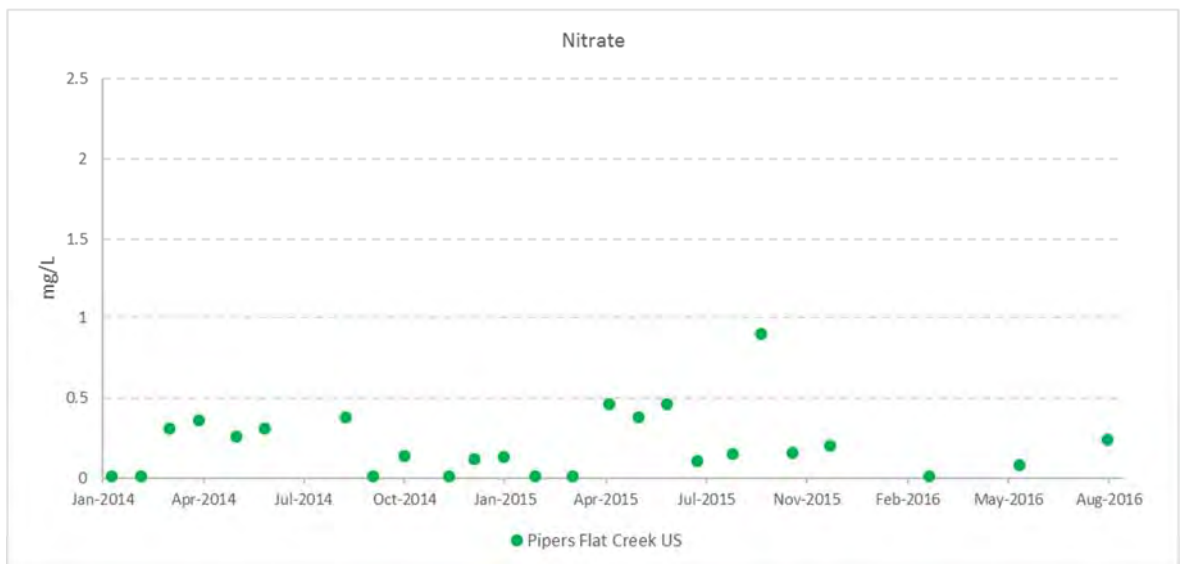
C.2 Pipers Flat Creek

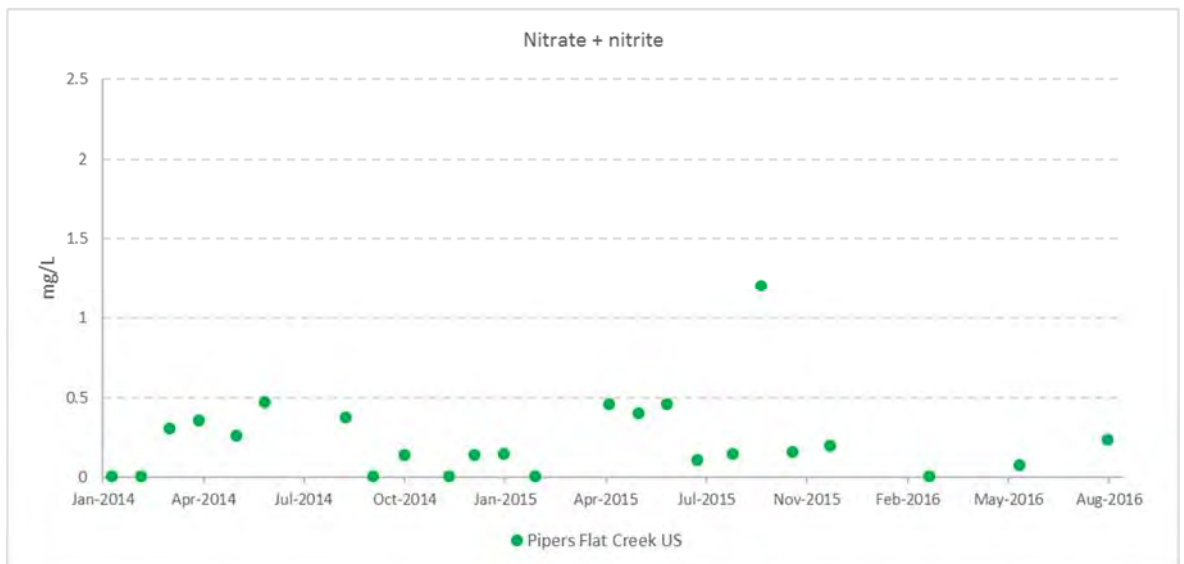
C.2.1 Physicochemical parameters



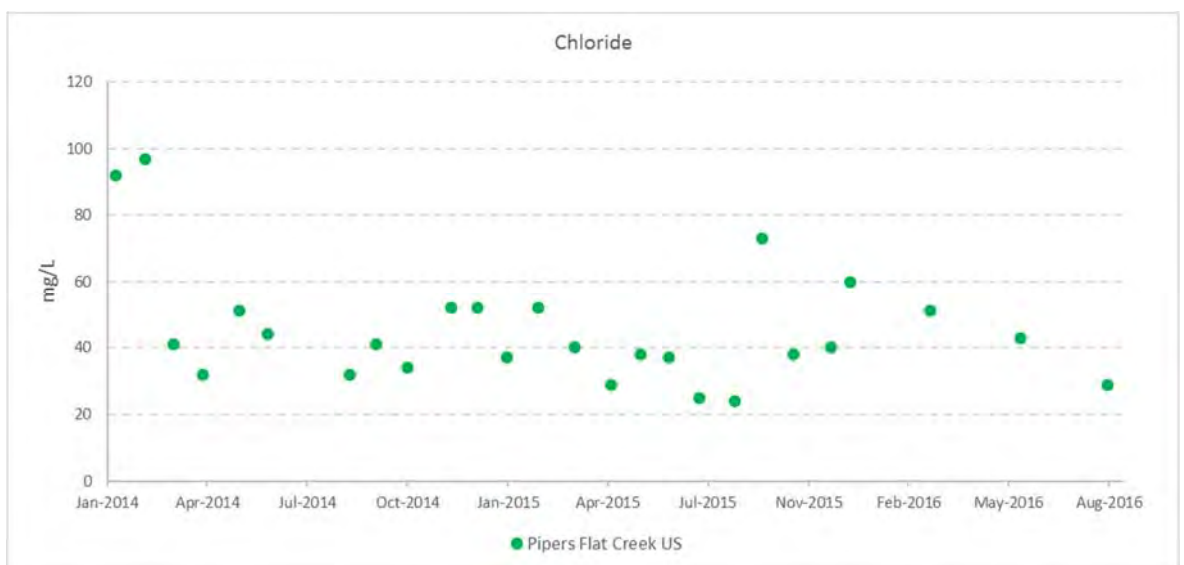
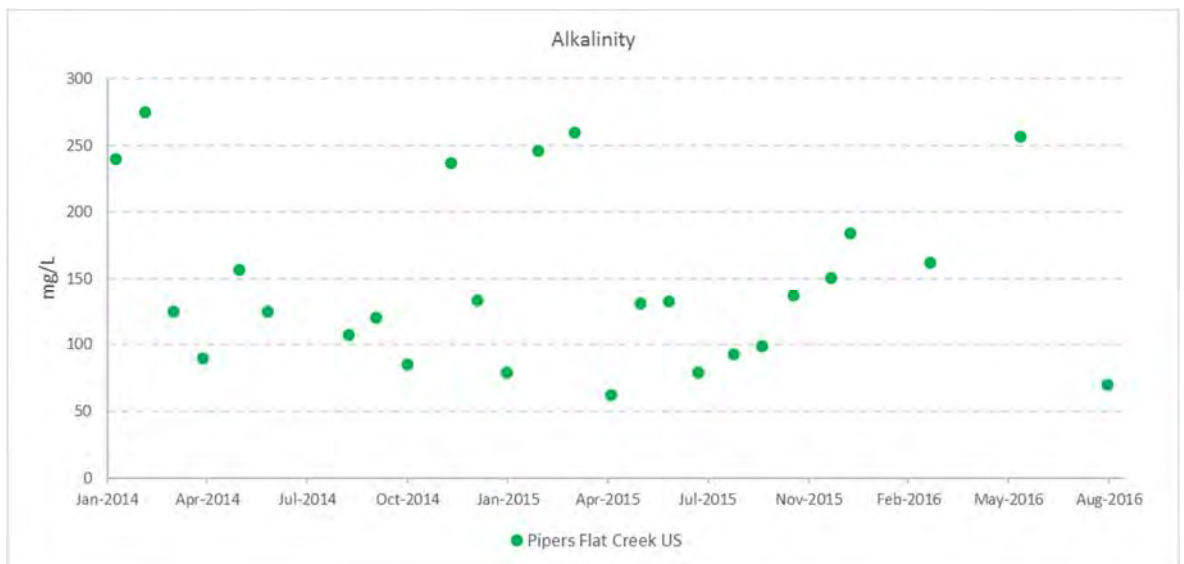


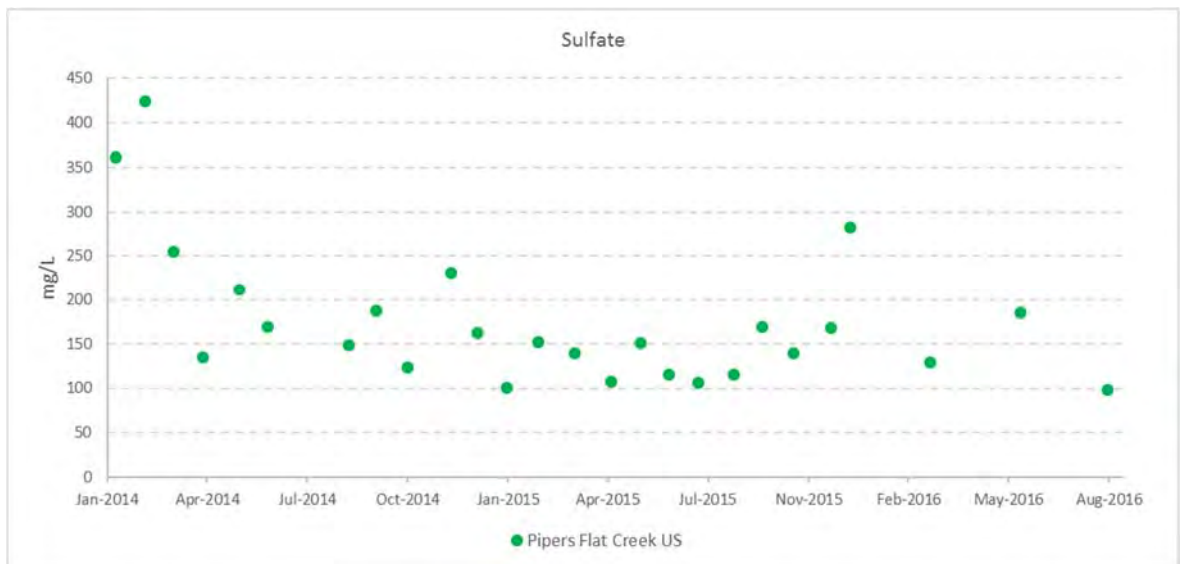
C.2.2 Nutrients



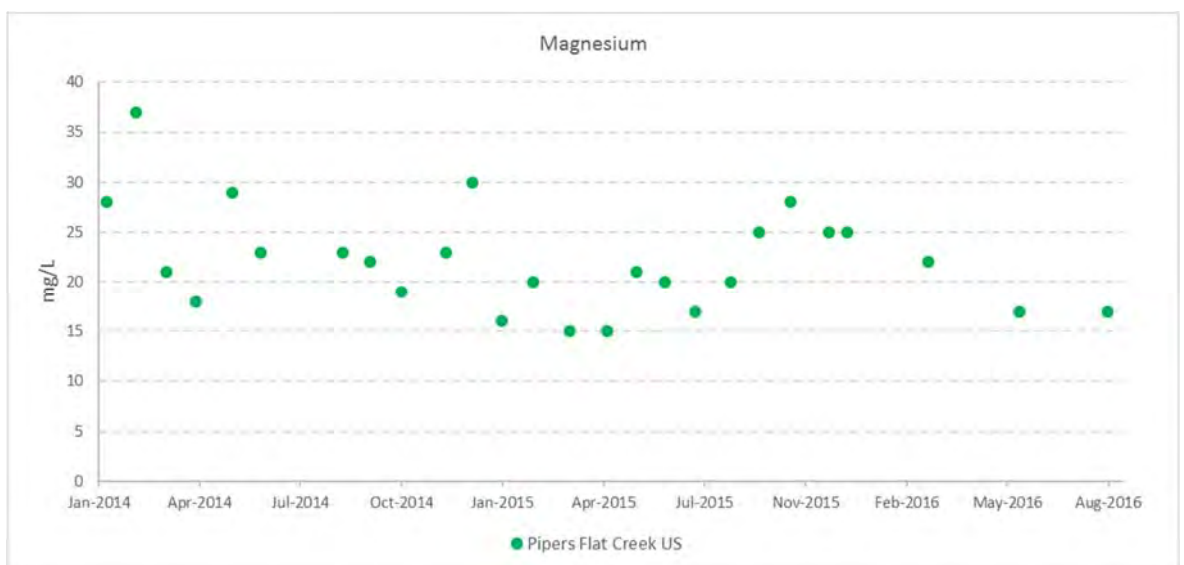
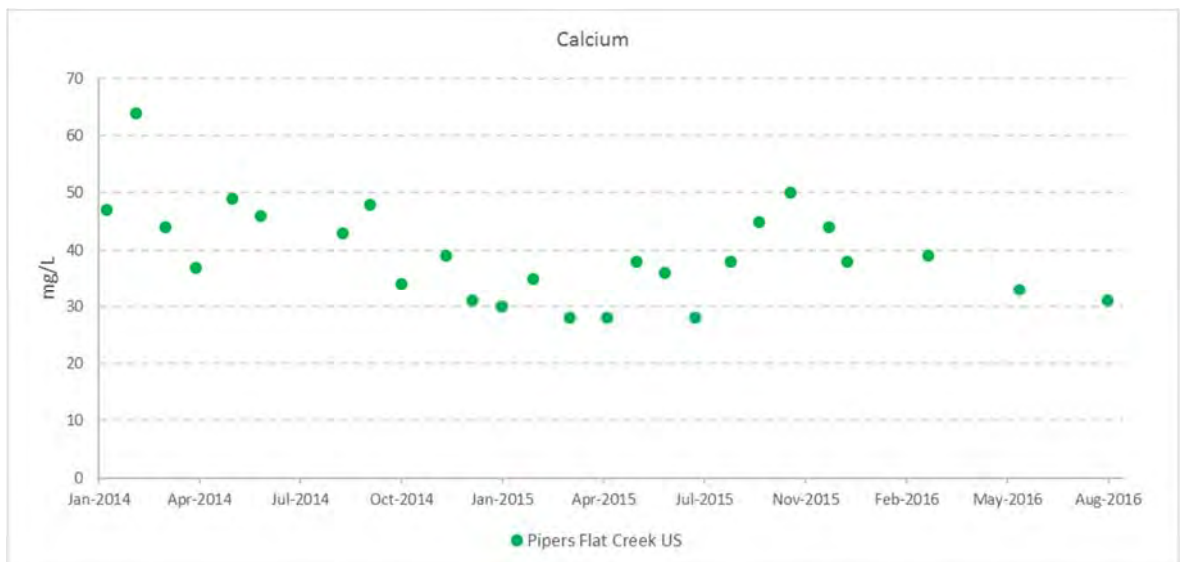


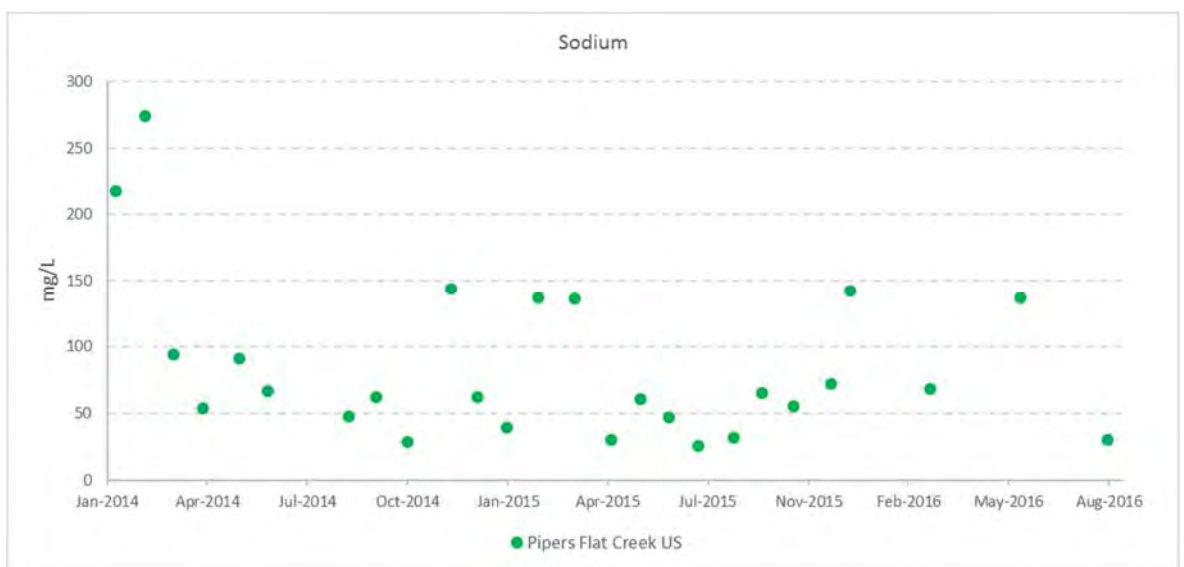
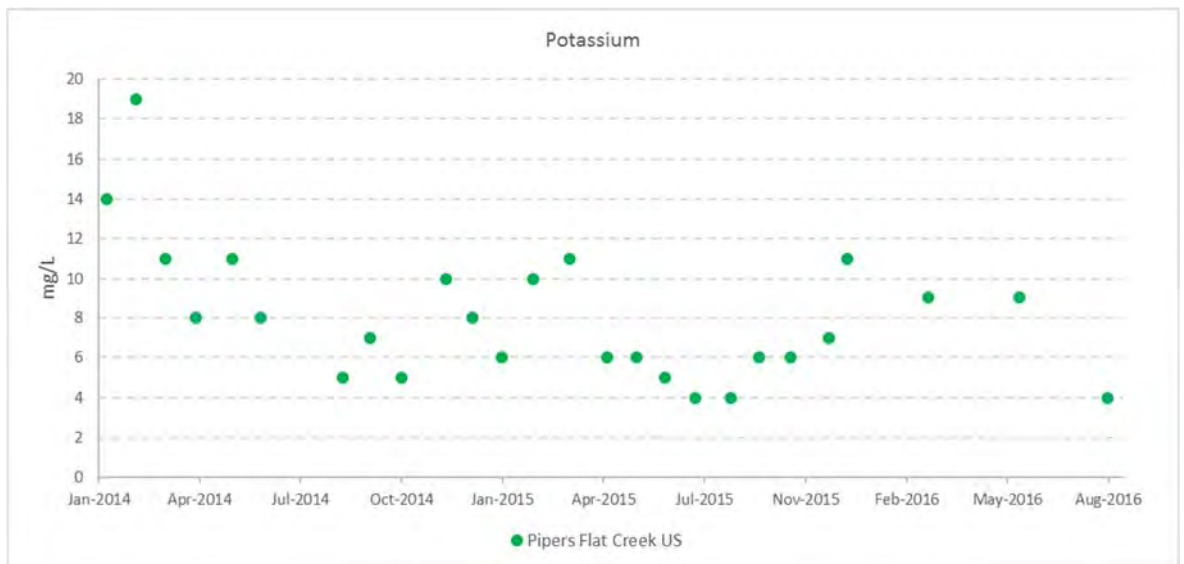
C.2.3 Anions



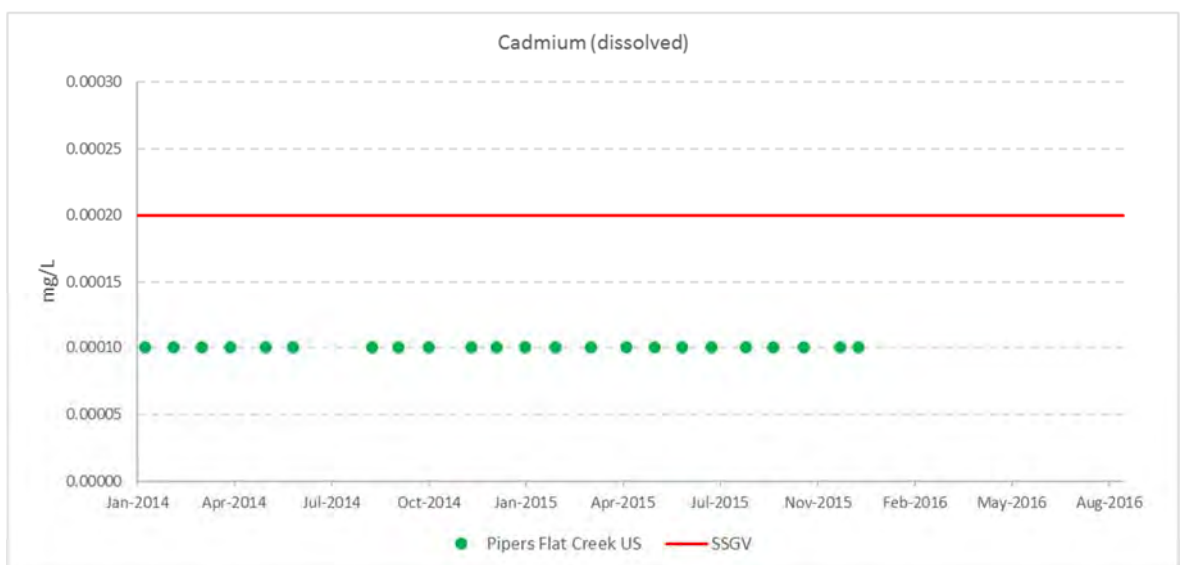


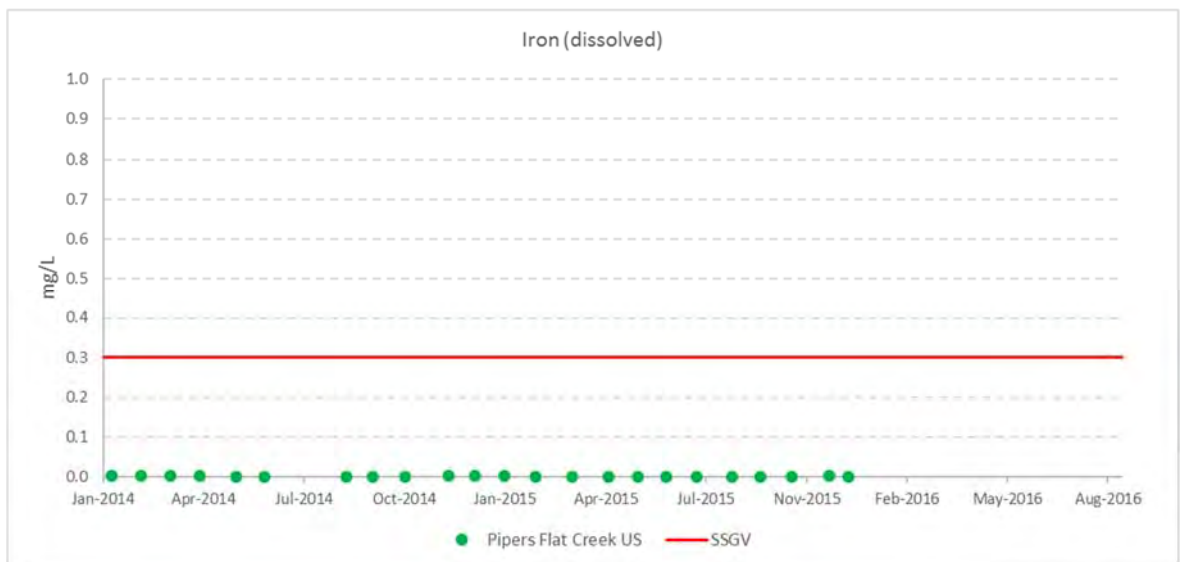
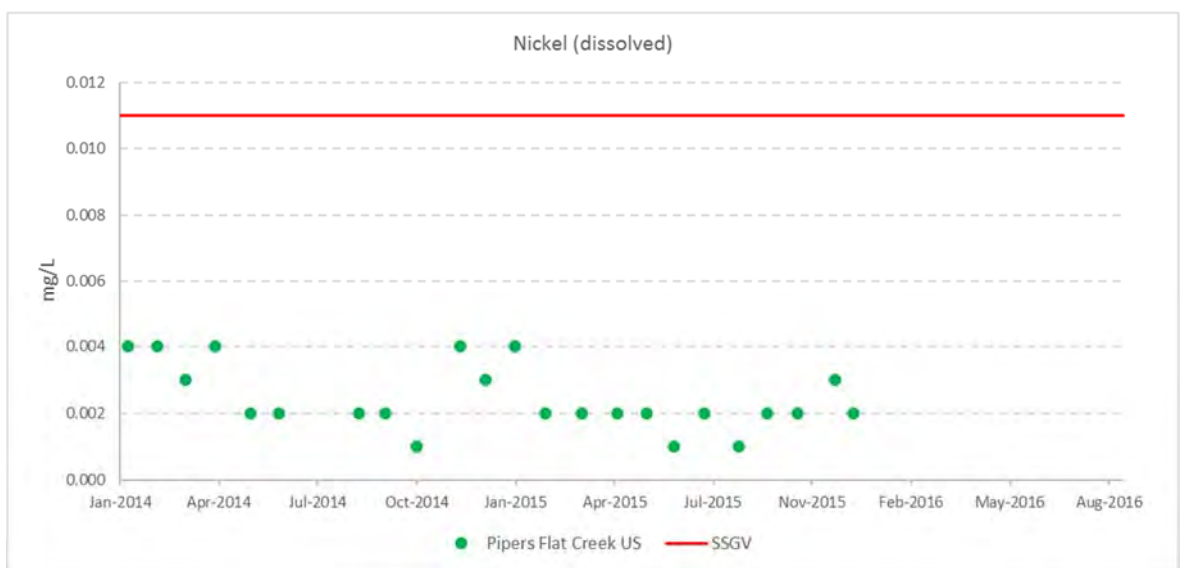
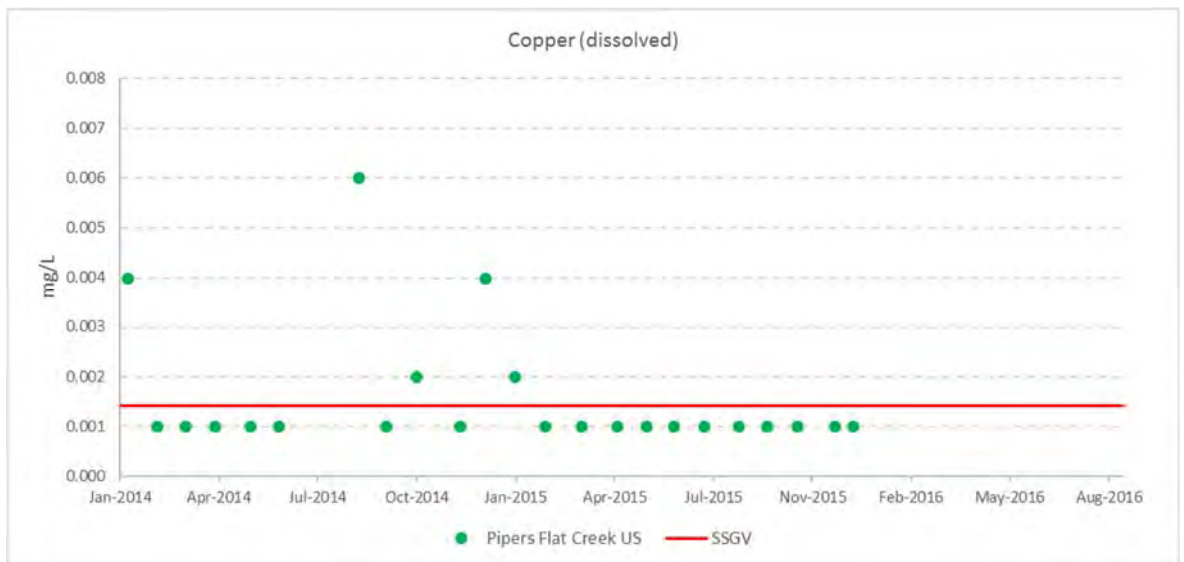
C.2.4 Cations

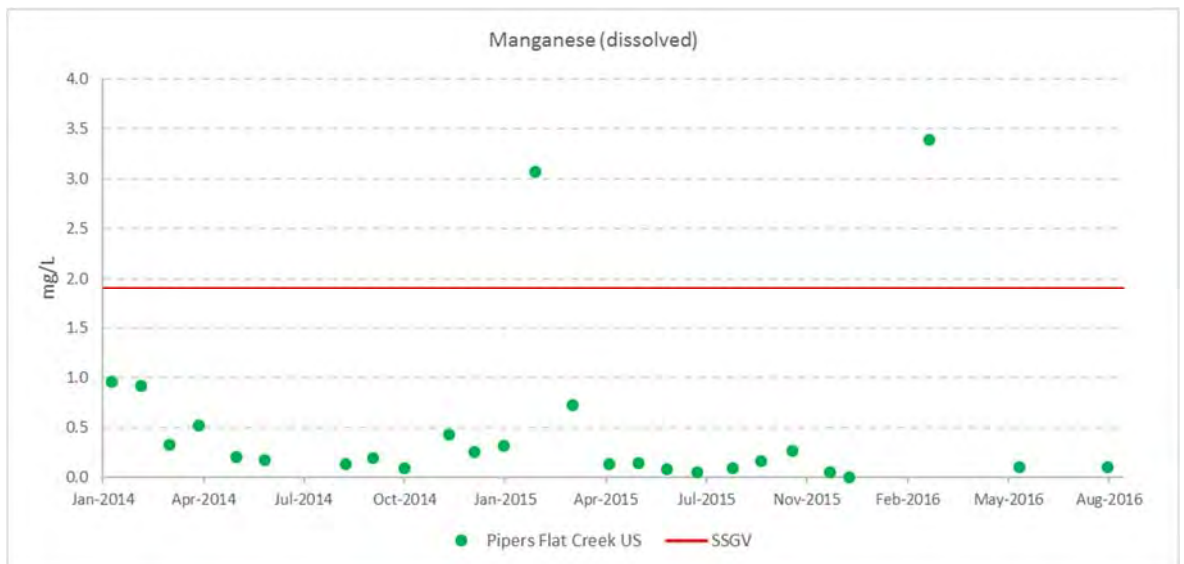




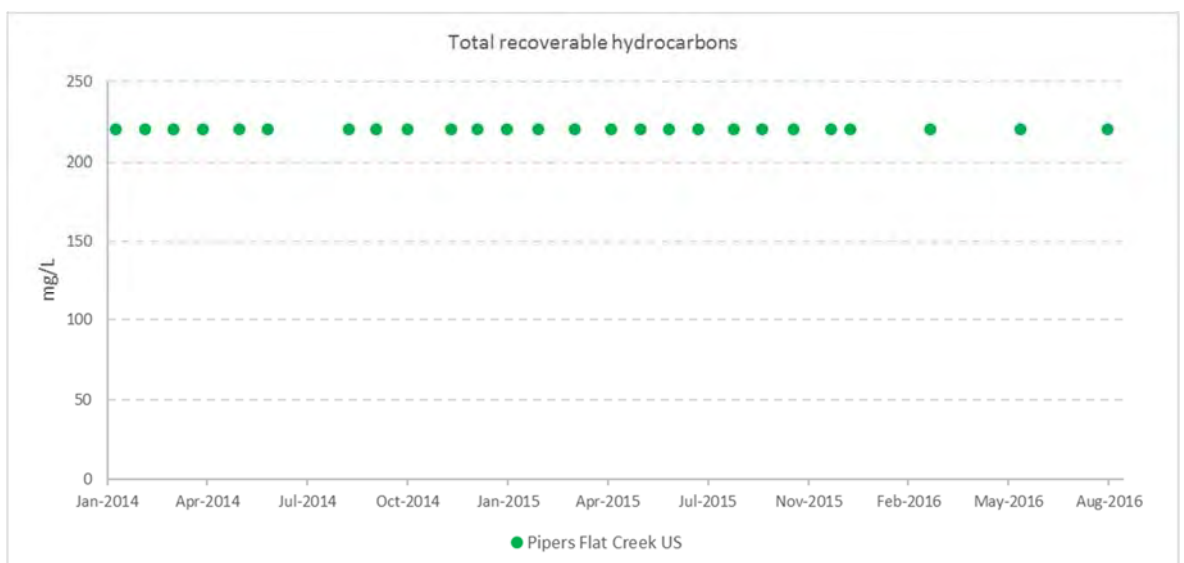
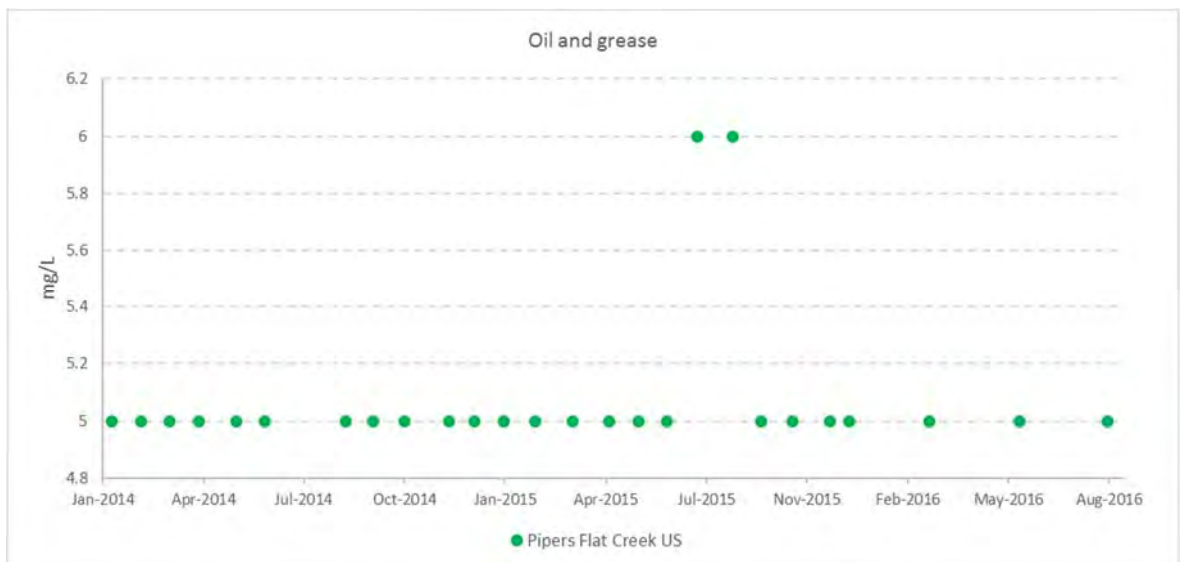
C.2.4 Metals

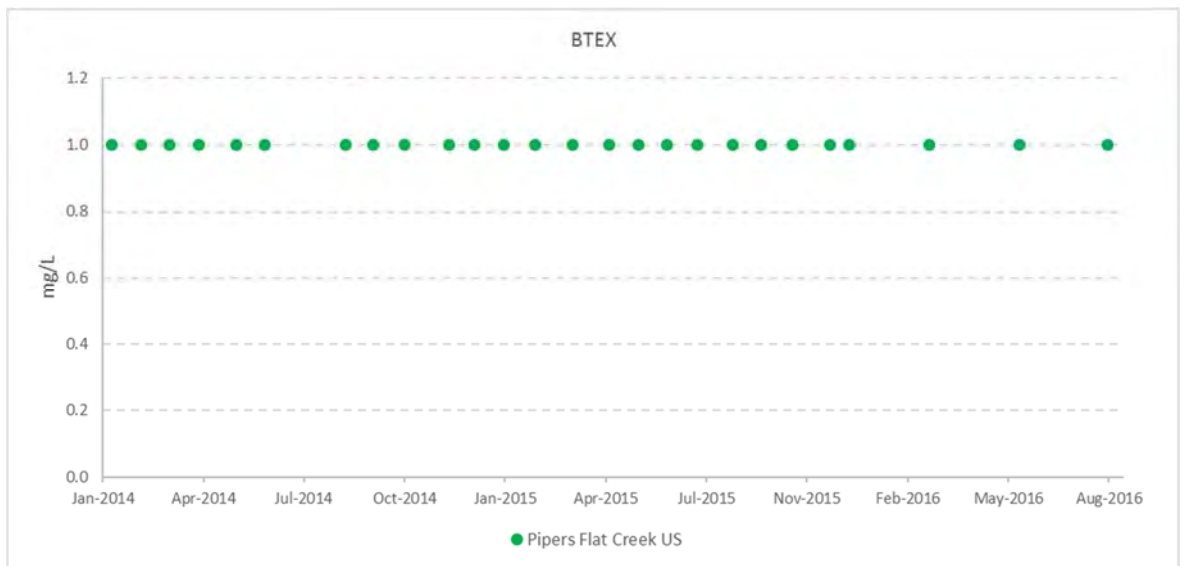






C.2.5 Other





Appendix D – Fish data collected at Thompsons Creek Reservoir

<i>Philypnodon grandiceps</i>		<i>Oncorhyncus mykiss</i>		<i>Salmo trutta</i>	
No.	Length (mm)	No.	Length (mm)	No.	Length (mm)
1	130	1	522	1	460
2	65	2	480	2	510
3	65	3	400	3	480
4	127	4	481	4	575
5	86	5	324	5	468
6	89	6	455	6	351
7	81	7		7	477
8	101	8		8	452
9	90	9		9	301
10	66	10		10	
11	111	11		11	
12	104	12		12	
13	100	13		13	
14	79	14		14	
15	91	15		15	
16	88	16		16	
17	89	17		17	
18	103	18		18	
19	40	19		19	
20	70	20		20	
Total	139	Total	6	Total	9

This report has been prepared by GHD for Springvale Coal/EnergyAustralia and may only be used and relied on by Springvale Coal/EnergyAustralia for the purpose agreed between GHD and the Springvale Coal/EnergyAustralia as set out in Section 1 of this report.

GHD otherwise disclaims responsibility to any person other than Springvale Coal/EnergyAustralia arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer Section 1 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Springvale Coal/EnergyAustralia and others who provided information to GHD (including Government authorities)], which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

Climate change is an emerging issue and the effects are, at this stage, complex to quantify.

The following assumption about projected climate change conditions have been made during preparation of this report, whilst no specific risk assessment has been undertaken to quantify climate change effect on the outcomes of the assessment, the assessment utilised a climate data set for a period as long as available. It is recognised that there may be other impacts from climate change that have not been fully assessed in this process due to the limitations of the assessment.

GHD

Level 3, GHD Tower

24 Honeysuckle Drive

T: 61 2 4979 9999 F: 61 2 4979 9988 E: ntlmail@ghd.com

© GHD 2016

This document is and shall remain the property of GHD. The document may only be used for the purpose for which it was commissioned and in accordance with the Terms of Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

2218589-2887/G:\21\25109\Document Transfer\Outgoing\GHD Sydney\2016_12_23 - TCR Rev0\212510922-REP_SWTP-TCROptionR4.docx

Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	T Davies/L Hammersley	S Gray		S Gray		23/12/2016

www.ghd.com

