Centennial Coal



STATEMENT OF ENVIRONMENTAL EFFECTS

Springvale Mine Extension Project
State Significant Development 5594
Modification 1

Volume 2: Part 2 Appendices I – L

July 2016

APPENDIX LIST

Appendix I:	**Groundwater Assessment** **Jacobs Australia Pty Limited**
Appendix J:	**Surface Water Assessment** **Jacobs Australia Pty Limited**
Appendix K:	**Due Diligence Ecological Assessment** **RPS East Australia Pty Limited**
Appendix L:	**Aboriginal Cultural Heritage Due Diligence Assessment** **RPS East Australia Pty Limited**

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Groundwater Assessment

APPENDIX – I

Springvale Mine

Springvale Coal Pty Ltd

Groundwater Assessment - SSD5594 Modification 1

IA097101/009c | C

6 July 2016

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Document history and status

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Springvale Mine

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Appendix A. CSIRO Groundwater Modelling Report

Executive Summary

The proposed Modification to current Conditions of Consent (SSD 5594) at Springvale Mine comprises:

- an increase in the workforce from the approved 310 full time equivalent (FTE), including contractors, to 450 FTE personnel
- an increase in run-of-mine (ROM) coal production from the approved 4.5 million tonnes per annum (Mtpa) to 5.5 Mtpa
- an increase in the existing ROM coal stockpile at the pit top from the approved 85,000 tonnes capacity to 200,000 tonnes capacity and an increase in the coal stockpile footprint (by 0.33 ha) northeast of the existing area.

Groundwater modelling indicates that the increase in mining rate does not lead to a significant difference in inflow to underground operations compared to that presented in the Groundwater Assessment of the Environmental Impact Statement for the Springvale Mine Extension Project (RPS, 2014a).

Accordingly, predictions of impacts to shrub swamps and hanging swamps on the Newnes Plateau are consistent with that presented in the Environmental Impact Statement or are less, although it is noted that there is currently an investigation underway into a water level trigger that has occurred at Carne West swamp.

Updated estimates of requirements for water access licences (groundwater) indicate current holdings by Springvale Coal Pty Ltd are sufficient. It is understood that licensing of groundwater-induced take from surface water sources, for this site, are being addressed through application for a zero share component water access licence (groundwater). Following successful application, a dealing to transfer entitlement from existing licences within relevant water sources to the new access licences would then be considered.

There are no presented changes to groundwater management or the groundwater monitoring network already in place at Springvale Mine and/or prescribed in the current Conditions of Consent (SSD 5594), as presented in Water Management Plan, in association with the proposed Modification to Consent.

Important note about your report

The sole purpose of this report and the associated services performed by Jacobs is to prepare a report on the expected impacts to groundwater of the proposed Modification to Consent (SSD 5594) at Springvale Mine, undertaken in accordance with the Scope of Services set out in the contract between Jacobs and the Client. That Scope of Services, as described in this report, was developed with the Client.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

This report has been prepared on behalf of, and for the exclusive use of, Jacobs's Client, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and the Client. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

1. Introduction

1.1 Overview

Springvale Mine is an underground coal mine located 15km northwest of Lithgow. The Springvale Mine is owned by Centennial Springvale Pty Limited (as to 50%) and Springvale SK Kores Pty Limited (as to 50%) as participants in the Springvale unincorporated joint venture. The Springvale mine is operated by Springvale Coal Pty Limited (Springvale Coal), for and on behalf of the Springvale joint venture participants.

Underground coal mining commenced at Springvale Mine in 1995 and development consent (SSD 5594) for extension of mining operations at Springvale Mine through to 31 December 2028 was granted on 21 September 2015 by the Planning Assessment Commission, under delegation of the Minister of Planning.

The Project Application Area (PAA) for SSD 5594 is presented in **Figure 1.1**, together with a topographic map.

Springvale Coal is currently seeking to modify the development consent SSD 5594 (the modification) to allow for increases in its coal production limit, workforce and the coal stockpile capacity at the pit top.

Jacobs Group (Australia) Pty Ltd has been engaged by Springvale Coal to prepare a Groundwater Assessment of the modification. This report has been prepared based on information current at the time of this report.

1.2 Proposed Modification

The modification application seeks to allow for:

- an increase in the workforce from the approved 310 full time equivalent (FTE), including contractors, to 450 FTE personnel
- an increase in run-of-mine (ROM) coal production from the approved 4.5 million tonnes per annum (Mtpa) to 5.5 Mtpa
- an increase in the existing ROM coal stockpile at the pit top from the approved 85,000 tonnes capacity to 200,000 tonnes capacity and an increase in the coal stockpile footprint (by 0.33 ha) northeast of the existing area.

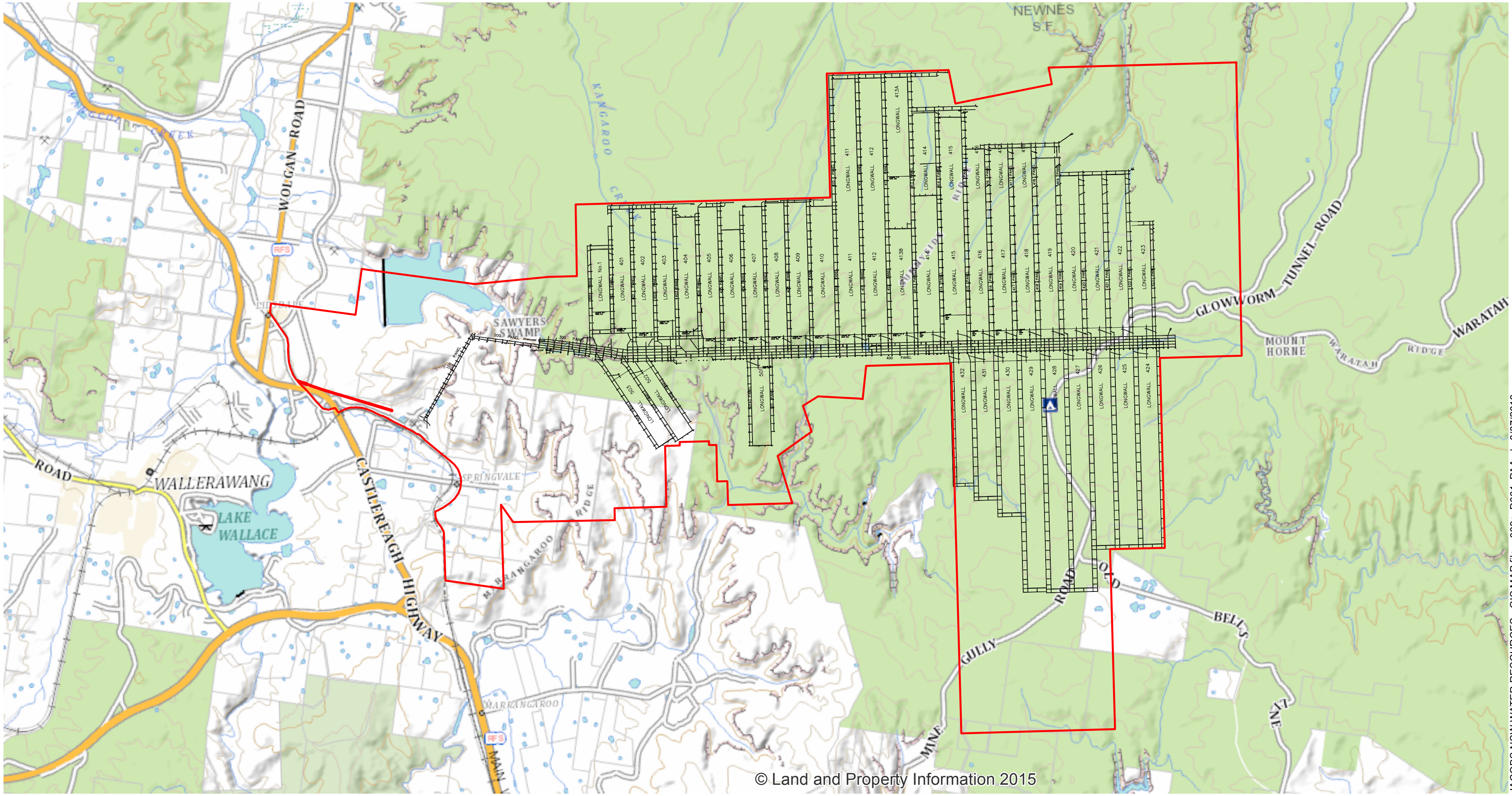
There is no proposal to change the approved longwall mining technique or the approved mine plan to achieve the proposed increase in production. The proposed modification does not include any additional physical works or significant changes to the existing underground mining operations. There are no major changes proposed to the surface infrastructure, other than an extension of the existing stockpile area to the northeast, into an area that is already heavily modified from previous surface activities. A diversion drain will be constructed around this stockpile extension area to divert surface run-off from the area to the existing dirty water system at the pit top. There is also no proposal to change the life of the consent or the hours of operation.

The proposed increase in production will be achieved through:

- the proposed increase in workforce
- the installation and operation of additional underground mining equipment
- improved equipment utilisation and availability.

1.3 Purpose and Scope of the Report

The purpose of this report is to present an assessment of the modification on the hydrogeological environment at Springvale Mine. Given that the Groundwater Assessment for the Springvale Mine Extension Project was only recently undertaken, this report draws heavily on information already presented in the Environmental Impact Statement (EIS) (Golder Associates, 2014) presented in support of the Springvale Mine Extension Project, as well as updated groundwater modelling.



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Project No. IA097101

Figure 1-1 | Springvale Mine Extension Project Project Application Area

Data sources
LPI Web Services 2016, Springvale Coal Pty Ltd

It is noted that the adjacent operation at Angus Place Colliery changed to Care and Maintenance in March 2015. The change in status at Angus Place Colliery occurred during the environmental impact assessment of the Springvale Mine Extension Project.

Updated groundwater modelling presented in this report incorporates the change in status at Angus Place Colliery, as well as the modification to mining rate proposed at Springvale Mine. The full report by Springvale Coal's groundwater modelling consultant, including appendices, is presented in **Appendix A**.

1.4 Layout of the Report

The layout of the report is as follows:

- Chapter 1 – presents an overview of the proposal, the objectives of this report and the layout of this report
- Chapter 2 – presents the governing legislation and relevant policies for the report
- Chapter 3 – presents the environmental setting and hydrogeological environment and summarises the existing hydrogeological data into a conceptual hydrogeological model
- Chapter 4 – presents the expected changes to the hydrogeological environment as a result of the modification
- Chapter 5 – presents the expected impacts on surrounding land use, groundwater dependent ecosystems, groundwater users, surface water/groundwater interaction as a result of the modification
- Chapter 6 – presents licensing, management and monitoring recommendations from the modification
- Chapter 7 – presents relevant references.

2. Regulation, Legislation and Policy

2.1 Commonwealth Legislation

2.1.1 Environment Protection and Biodiversity Conservation Act 1999

The *Environmental Protection and Biodiversity Conservation Act* 1999 (Cth) is the main Commonwealth environmental legislation that provides legal framework to protect and manage Matters of National Environmental Significance (MNES) including nationally and internationally important flora, fauna, ecological communities, cultural heritage and water resources.

As per the EIS, the shrub swamps and the hanging swamps mapped within the PAA are collectively referred to as the Temperate Highland Peat Swamps on Sandstone (THPSS). The THPSS are federally listed Endangered Ecological Communities (EECs) protected under the *Environmental Protection and Biodiversity Conservation Act* 1999.

2.2 NSW Legislation

2.2.1 Water Management Act 2000

The *Water Management Act* 2000 (NSW) presents the framework for sustainable and integrated water management in NSW and its objectives are as follows:

- *to apply the principles of ecologically sustainable development, and*
- *to protect, enhance and restore water sources, their associated ecosystems, ecological processes and biological diversity and their water quality, and*
- *to recognise and foster the significant social and economic benefits to the State that result from the sustainable and efficient use of water, including:*
  - *benefits to the environment, and*
  - *benefits to urban communities, agriculture, fisheries, industry and recreation, and*
  - *benefits to culture and heritage, and*
  - *benefits to the Aboriginal people in relation to their spiritual, social, customary and economic use of land and water,*
- *to recognise the role of the community, as a partner with government, in resolving issues relating to the management of water sources,*
- *to provide for the orderly, efficient and equitable sharing of water from water sources,*
- *to integrate the management of water sources with the management of other aspects of the environment, including the land, its soil, its native vegetation and its native fauna,*
- *to encourage the sharing of responsibility for the sustainable and efficient use of water between the Government and water users,*
- *to encourage best practice in the management and use of water.*

The primary instruments applied in NSW to achieve these objectives are Water Sharing Plans and the Aquifer Interference Policy (DPIWater, 2012).

2.2.2 Water Act 1912

The *Water Act* 1912 (NSW) is being progressively phased out across NSW and replaced by the *Water Management Act* 2000 (NSW). The *Water Act* 1912 (NSW) is relevant where there an activity leads to a take from a groundwater or surface water source not currently covered by a Water Sharing Plan. As a Water Sharing Plan has been developed for the project area, the *Water Act* 1912 (NSW) does not apply.

2.2.3 Water Sharing Plans

Water sharing plans, following the introduction of the *Water Management Act* 2000 (NSW), provide the basis for equitable sharing of surface water and groundwater between water users, including the environment.

The majority of NSW is now covered by Water Sharing Plans. If an activity leads to a take from a groundwater or surface water source covered by a Water Sharing Plan, then an approval and/or licence is required.

In general, the *Water Management Act* 2000 (NSW) requires:

- a water access licence to take water
- a water supply works approval to construct a work
- a water use approval to use the water.

For groundwater, the Springvale Mine Extension Project lies on the boundary of the Sydney Basin Coxs River Groundwater Source and the Sydney Basin Richmond Groundwater Source of the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Source* 2011. The Sydney Basin Coxs River Groundwater Source has been designated by DPIWater to be a Less Productive Groundwater Source (Porous Rock) and the Sydney Basin Richmond Groundwater Source has been designated as a Highly Productive Groundwater Source (Porous Rock).

For surface water, the Springvale Mine Extension Project lies on the boundary of the Upper Nepean and Upstream Warragamba Water Source (Wywandy Management Zone) and the Hawkesbury and Lower Nepean Rivers Water Source (Colo River Management Zone) of the Water Sharing Plan for Greater Metropolitan Region Unregulated River Water Sources 2011.

Details of licensing requirements from the abovementioned water sources, including groundwater-induced changes to modelled groundwater contribution to surface watercourses, are presented in **Chapter 6**.

2.3 NSW Policy

2.3.1 NSW Aquifer Interference Policy

The Aquifer Interference Policy (NSW Office of Water, 2012) presents the requirements of assessment of aquifer interference activities administered by the *Water Management Act* 2000 (NSW). Key components to the policy are:

- all water taken must be properly accounted for
- the activity must address minimal impact considerations with respect to water table, water pressure and water quality
- planning measures in the event that actual impacts are greater than predicted, including making sure there is sufficient monitoring in place.

Level 1 Minimal Harm Considerations for the Sydney Basin Coxs River Groundwater Source and the Sydney Basin Richmond Groundwater Source comprise:

- water table
  - less than or equal to 10% cumulative variation in the water table, allowing for typical climatic “post-water sharing plan” variations, 40m from any high priority groundwater dependent ecosystem or high priority culturally significant site listed in the Schedule of the relevant water sharing plan
  - a maximum of a 2m decline cumulatively at any water supply work
- water pressure
  - a cumulative pressure head decline of not more than a 2m decline, at any water supply work
- water quality

- any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40m from the activity.

3. Hydrogeological Setting

3.1 Environmental Setting

3.1.1 Climate

The climate at Springvale Mine is typical of a cool temperate mountain climate, characterised by cold winters and warm summers. The highest temperatures occur throughout December, January and February, with the coolest temperatures occurring in July. Snow and/or sleet are common in winter months.

Rainfall

Rainfall throughout the year is relatively uniform; however, rainfall is higher during the months of October through to March. Summer months are generally the wettest months. It is noted that the intensity of the rainfall is locally affected by the orographic influence of the Great Dividing Range.

A number of Bureau of Meteorology (BoM) weather stations are located in the vicinity of Springvale Mine. BOM Station No. 063062 (Lithgow (Newnes Forest Centre)) represents the most complete historical rainfall dataset with respect to the Newnes Plateau (elevation above 1,000mAHD). Monitoring at this station ceased in 1999.

The distribution of the average monthly rainfalls through the year is shown in **Table 3.1**.

Table 3.1 : Distribution of Average Monthly Rainfall at the Newnes Plateau (mm/month)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
BOM Station No. 063132 (Lidsdale (Maddox Lane)) (1959 to present)													
Mean	85.1	78.7	64.2	42.4	51.1	48.8	51.6	65.5	53.7	68.4	73.4	72.9	766
Lowest	8.6	5.6	3.8	1.2	2.6	2.6	2.7	1.8	3.4	2.4	7.6	0.0	330
Highest	214	270	270	203	131	229	214	364	123	228	165	217	1260
BOM Station No. 063062 (Lithgow (Newnes Forest Centre)) (1938 to 1999)													
Mean	121	114	102	79.9	81.3	83.0	68.3	83.5	67.9	91.5	89.0	90.4	1070
Lowest	18.8	5.6	5.1	6.2	11.0	0.0	2.0	4.6	0.0	6.4	4.7	2.6	496
Highest	281	339	519	299	287	320	241	412	207	267	209	303	1890
Springvale (New Prison Farm) (2004 to present)													
Mean	89.8	140.0	88.0	70.0	42.4	82.2	46.1	55.2	52.0	68.5	111.5	101	986
Lowest	19.5	36.5	29.5	10.5	14.6	21.5	18.0	19.0	12.5	13.0	33.5	37.5	572
Highest	153	273	196	202	105	254	100	107	92.2	144	196	207	1290

Evapotranspiration

Daily Pan A evaporation has been recorded at the Bathurst Agricultural Station (BOM Station 63005) from 1966 to current. The average monthly evaporation rate is presented in **Table 3.2**. The annual average daily Pan A evaporation rate is 3.7mm/day. The Bathurst Agricultural Station is the closest monitoring station to Springvale Mine and is 47km to the west.

Pan A evaporation is usually used for estimating evaporation losses from open water surfaces of sediment ponds and dams. In forested areas, evaporation tends to be low compared to Pan A evaporation, but this is offset by increased transpiration. Analysis of flow gauging at Sunnyside Swamp on the Newnes Plateau suggest actual evaporation may be 35% of Pan A evaporation.

Table 3.2 : Average Daily Pan A Evaporation (BOM Station No. 063005, Bathurst Agricultural Station) (mm/day)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	6.8	5.8	4.5	2.9	1.7	1.1	1.2	1.8	2.8	4.0	5.2	6.5	3.7

3.1.2 Topography

The topography above Springvale Mine comprises narrow gorges formed through the Newnes Plateau. Elevation of the Newnes Plateau is typically 1,100 to 1,200mAHD. To the north of the Springvale Mine is the Wolgan Valley, a steeply incised valley with sandstone cliffs. Elevation in the Wolgan Valley is 500 to 600mAHD. To the southwest of Springvale Mine is the Coxs River, with an elevation of approximately 870mAHD. The Coxs River resides within an open and relatively flat valley (refer to **Figure 1.1**).

The Pit Top is located on the footslopes of the Newnes Plateau. The elevation at Pit Top is approximately 920mAHD.

3.1.3 Hydrology

The majority of the land surface above Springvale Mine's operations lies within the Newnes Plateau, which forms part of the divide between the Wolgan and Coxs River catchments. The Wolgan River, of which Carne Creek is a tributary, eventually feeds into the Colo River and then the Hawkesbury River. The Coxs River is one of the tributaries of Lake Burrogorang. Lake Burrogorang discharges into the Nepean River and then the Hawkesbury River. Lake Burrogorang is the main drinking water supply catchment for Sydney.

Swamps occur on the Newnes Plateau within the headwaters of narrow gorges. As presented in the EIS, these swamps occur coincident with presence of low permeability aquitard plies of the uppermost geological unit on the Newnes Plateau.

There is no direct extraction or discharge to surface watercourses on the Newnes Plateau by Springvale Mine or others. All mine water make from Springvale Mine is currently discharged to the Coxs River via a licensed discharge point located in Sawyers Swamp Creek, adjacent the Sawyers Swamp Creek Ash Dam. The licensed discharge point is referred to as Springvale LDP009 on Springvale Mine's EPL 3607.

Figure 3.1 presents the hydrological setting above Springvale Mine, including the Strahler Order.

3.1.4 Geology

Springvale Mine is located in the southwest corner of the NSW Western Coalfields. The Illawarra Coal Measures are relatively thin in this area, with an average thickness of 110m from the Katoomba to the Lithgow Seam. Above the coal measures, the Narrabeen Group is the only member of the Triassic sequence present in the area, having a maximum thickness of 340m. Depth of cover to the Lithgow Seam generally ranges between 350m and 420m, hence, the upper Narrabeen Group comprises the surface strata above the existing and future workings at Springvale Mine.

The sedimentary strata (Illawarra Coal Measures and Narrabeen Group) lies above older Silurian and Devonian Proterozoic rocks of the Lachlan Fold Belt. The Lithgow Coal Seam at Angus Place Colliery and Springvale Mine is stratigraphically the lowest economic seam, with the depth to the older basement strata beneath this seam being shallow, up to 100m, compared to other parts of the Sydney Basin, which can be many hundreds of metres. The Lithgow Seam ranges in thickness from less than one metre (where only the lower ply of the Lithgow Seam is present) to up to 9m (where it coalesces with the overlying Lidsdale Seam) with some thin carbonaceous or tuffaceous claystone layers present in the upper half of the seam. The Lithgow Seam generally dips at 1 - 2 degrees to the east northeast. The Katoomba and other seams at Springvale Mine (and Angus Place Colliery) are too thin to be viably extracted.

Non coal-bearing Triassic strata directly overlie the Illawarra Coal Measures. These strata comprise the Narrabeen Group of rocks which have the following sequence of rock formations in descending order:

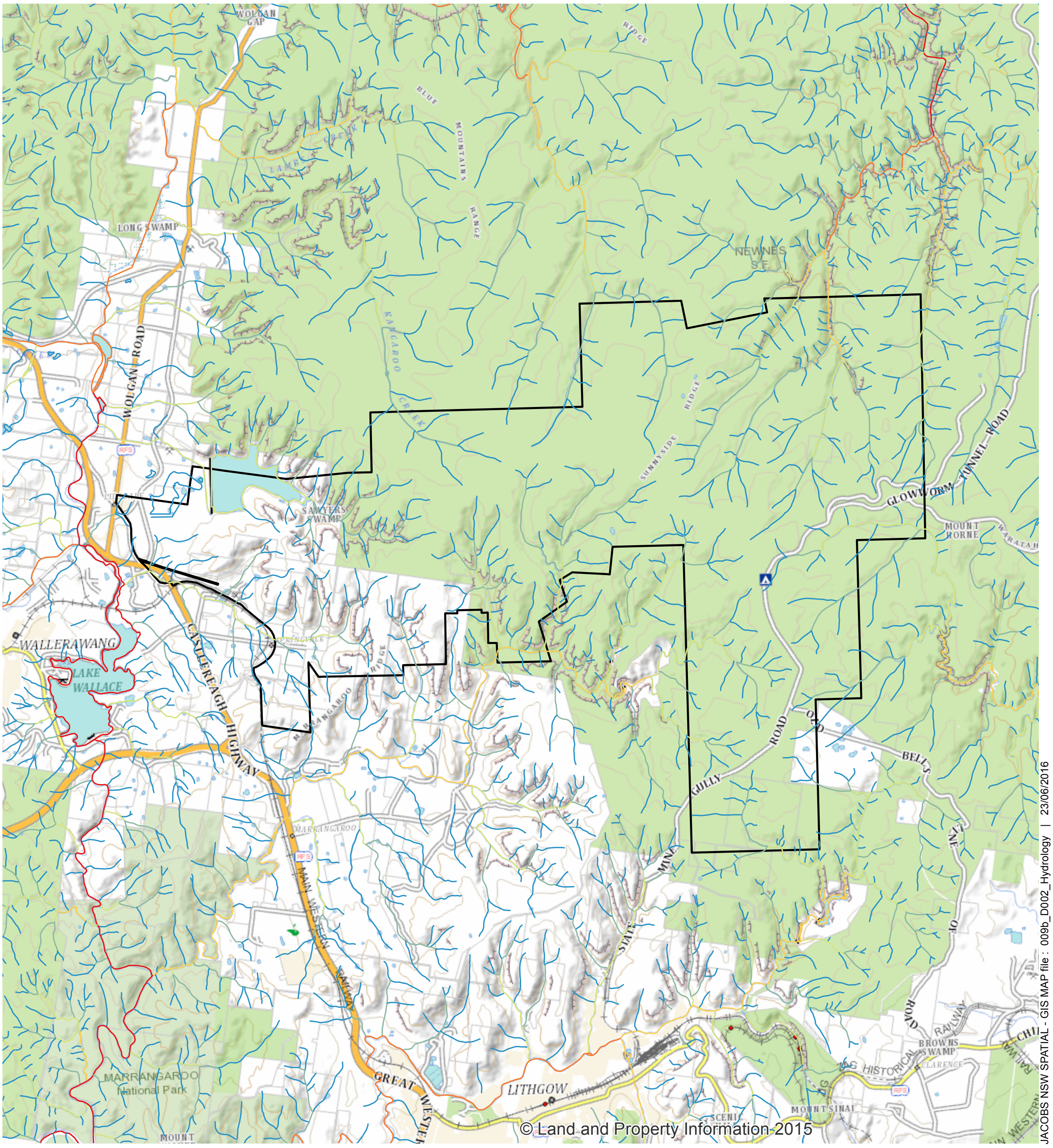

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Figure 3-1 | Hydrological Layout

Data sources
NSW LPI Web Services 2016

- Burralow Formation
- Banks Wall Sandstone
- Mount York Claystone
- Burra-Moko Head Sandstone
- Caley Formation.

These formations comprise interbedded siltstone, sandstone and conglomeratic sandstone, with occasional claystone bands, as observed in the characteristic cliffs that occur throughout the area.

Within the Narrabeen Group of rocks, the Burralow Formation and the Mount York Claystone are key stratigraphic horizons in terms of their hydrogeological significance.

3.1.5 Ecology

Temperate Highland Peat Swamps on Sandstone

Newnes Plateau shrub swamps and hanging swamps occur above the Springvale Mine area of activity. Shrub swamps occupy the bases of valleys whereas hanging swamps develop higher up on the flanks of the valleys.

The shrub swamps are listed as an EEC under the *Threatened Species and Conservation Act* 1995 (NSW) (TSC Act) and provide important habitat for a range of plants and animals. The shrub swamps and the hanging swamps are referred to collectively as the Temperate Highland Peat Swamps on Sandstone (THPSS) in accordance with the *Environment Protection and Biodiversity Conservation Act* 1999 (Cth).

3.2 Hydrogeological Environment

3.2.1 Conceptual Hydrogeological Model

The key elements of the hydrogeological system are shown on **Figure 3.2** and comprise:

- stacked and segregated groundwater systems recharged by rainfall – locally in the case of shallow and perched systems and regionally in the case of the deeper systems
- deep regional flow essentially isolated from the shallow and perched groundwater systems
- perched water systems, supported on low permeability aquitard layers
- shrub swamps fed partially by groundwater originating from the perched groundwater systems and partially from surface water run-off
- the Mount York Claystone acting as a significant regional aquitard isolating the shallow and perched groundwater systems from the deep groundwater system
- the deep interbedded and interbanded aquitard (mudstones) and aquifer (sandstone and coal) units present beneath the Mount York Claystone strongly influence the deep regional groundwater flow pattern at depth
- groundwater flow is dominated by both porous media flow (dominantly horizontal) and to a much lesser extent, fracture flow associated with the joint, fracture and fault conduits
- variably enhanced groundwater flow through the lithological pile affected by subsidence induced permeability zones
- extensive aquifer interference in the deep regional groundwater system aquifers due to subsidence induced goaf formation, collapse and fracturing affects. These observed aquifer impacts do not extend above the Mount York Claystone
- shallow formation sagging, induced by subsidence, gives rise to enhanced horizontal permeability in the shallow groundwater system (permeability enhancements decreasing closer to the ground surface)

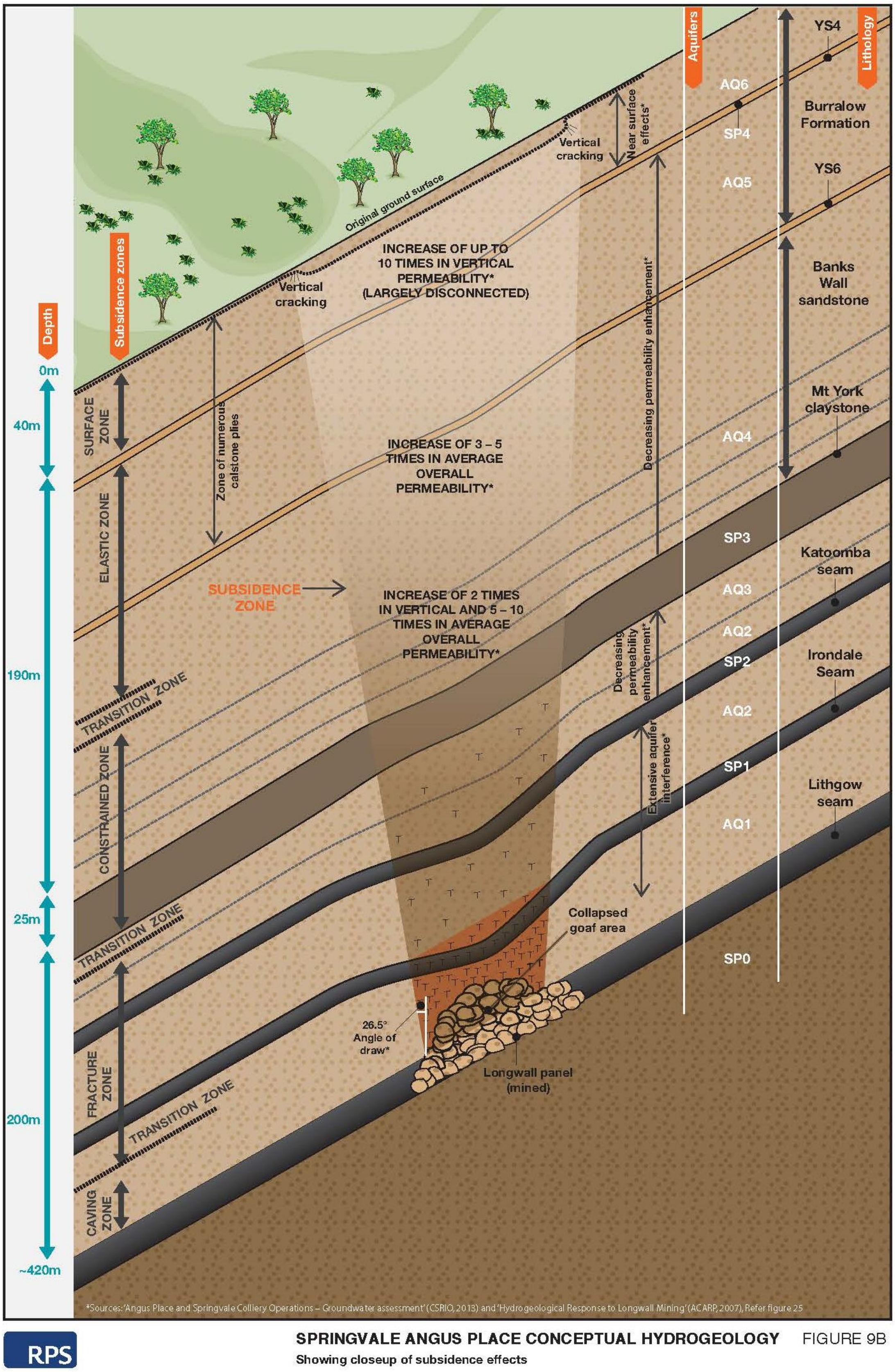


Figure 3.2 : Conceptual Hydrogeological Model

- disconnected vertical permeability enhancements are inferred in the shallow surface zones.

Within these sequences, a number of key hydrostratigraphic units underlie the site. The aquifer units are identified as AQ1 – AQ6 and aquitard units are identified as SP0 – SP4, including YS4 and YS6 within the Burralow Formation. These units have been incorporated into the groundwater numerical model developed for Springvale, and are shown on **Figure 3.2**.

A brief summary of the identified aquifers and aquitards is provided as follows:

- Weathered section – this is a 10 m thick layer of weathered material which is assumed to cover the top surface of the Springvale area.
- AQ6 – This aquifer is located in the upper part of the Narrabeen Group sandstone. This is an unconfined aquifer and only appears near the top of the Newnes Plateau.
- SP4 - A thin semi-permeable layer located in the Burralow Formation and comprises claystone (YS4) and sandstone/ siltstone. It is noted that the numerical model includes YS4 and YS6, however, there are six (6) clay aquitard plies identified in the Burralow Formation (McHugh, 2013).
- AQ5 – This aquifer is located in the Burralow Formation.
- YS6 – A thin semi-permeable claystone layer separates AQ4 and AQ5.
- AQ4 – This aquifer is located in the Banks Wall Sandstone (Narrabeen Group).
- SP3 - A semi-permeable claystone layer (Mount York Claystone) separates aquifers AQ3 and AQ4.
- AQ3 - Aquifer AQ3 can be identified in the sandstone of the Burra Moko Head Formation and the Caley Formation and located below the Mount York Claystone. It is hydraulically connected with the Katoomba Seam.
- SP2 - A semi-permeable layer with coal, siltstone and mudstone is the boundary between aquifers AQ2 and AQ3. This semi-permeable layer is assumed to occur just below the Katoomba Seam.
- AQ2 – This aquifer contains sandstone with laminated siltstone and Middle River Coal Member.
- SP1 - Aquifer AQ1 is separated from aquifer AQ2 by a semi-permeable layer (SP1) located within the Baal Bone/Denman Formation and comprises mudstone, siltstone and claystone.
- AQ1 – This aquifer is found to include Lidsdale / Lithgow Coal Seam which is hydraulically connected with the laminated siltstone (Berry Siltstone) and sandstone of the Marrangaroo Formation underneath, and the sandstone and siltstone of the Long Swamp Formation and Irondale Coal Seam above.

In summary, regional groundwater flow is to the northeast toward the Wolgan Valley, consistent with the regional dip of the target coal seams, with water quality reflecting interaction with the Permian Coal Measures. In contrast, the perched aquifer system reflects the local topography, eventually discharging to rivers and creeks of the Wolgan River and Coxs River. It has been established through the extensive groundwater monitoring program at Springvale Mine that water quality of the perched and shallow groundwater systems is very fresh.

3.2.2 Surrounding Land Use

Springvale Mine underlies the Newnes State Forest and to the northeast of the Newnes State Forest is the Wollemi National Park. The distance from LW419 to the boundary of the Wollemi National Park is 7.5km. Birds Rock Flora Reserve is located within the Newnes State Forest and is 4.5km northeast of LW419. The Ben Bullen State Forest lies to the west of the Upper Coxs River and is approximately 6.5km to the northwest of LW401 and is approximately 10.5km to the northwest of LW419. The Gardens of Stone National Park is located north of Ben Bullen State Forest and is approximately 17km to the northwest of LW419.

To the west of the previously mined longwalls at Springvale Mine is Sawyers Swamp Creek Ash Dam (SSCAD), located within Sawyers Swamp Creek. To the southwest of LW401 is the Springvale Mine portal, located off Castlereagh Highway and further southwest is Wallerawang Power Station. Wallerawang Power Station is approximately 4km southwest of LW401, of which Lake Wallace is the water supply reservoir.

The southern longwalls, LW424 to LW432 and LW501 to 503 also underlie the Newnes State Forest. To the southwest of LW432 and to the south of LW501 is Marrangaroo Creek.

3.2.3 Groundwater Dependent Ecosystems

There are no high priority groundwater dependent ecosystems listed in the schedule of the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources* 2011 with respect to the Sydney Basin Richmond Groundwater Source. There are also no springs listed in the Water Sharing Plan for the Richmond Groundwater Source.

There is a potential karst environment listed in the schedule of the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources* 2011 with respect to the Sydney Basin Coxs River Groundwater Source, however, this is located a significant distance from Springvale and is not considered further. There are no springs listed in the Water Sharing Plan with respect to the Coxs River Groundwater Source.

Whilst not identified as high priority groundwater dependent ecosystems in the Water Sharing Plan, the Newnes Plateau shrub swamps are listed as an ECC under the TSC Act and in accordance with the EPBC Act, the shrub swamps and hanging swamps are collectively referred to as the THPSS.

The location of the Newnes Plateau shrub swamps and hanging swamps are presented in **Figure 3.3**.

The shrub swamps that are located above future longwalls at Springvale Mine include:

- Carne West Swamp (LW419)
- Gang Gang Swamp South West and Gang Gang Swamp East (LW420, 421 and 422)
- Pine Swamp (LW424)
- Pine Swamp Upper Swamp (LW425, 426 and 427)
- Paddys Creek Swamp (LW424)
- Marrangaroo Creek Swamp (LW428, 429, 430, 431 and 432)
- Marrangaroo Creek Upper Swamp (LW429).

The hanging swamps that are located above future longwalls at Springvale Mine include:

- hanging swamp on western slope above Gang Gang Swamp East (LW419)
- hanging swamp on southwestern slope above Pine Swamp Upper Swamp (LW426)
- hanging swamps above Marrangaroo Creek Swamp (LW430, 432 and 432)
- hanging swamp (unnamed) (LW503).

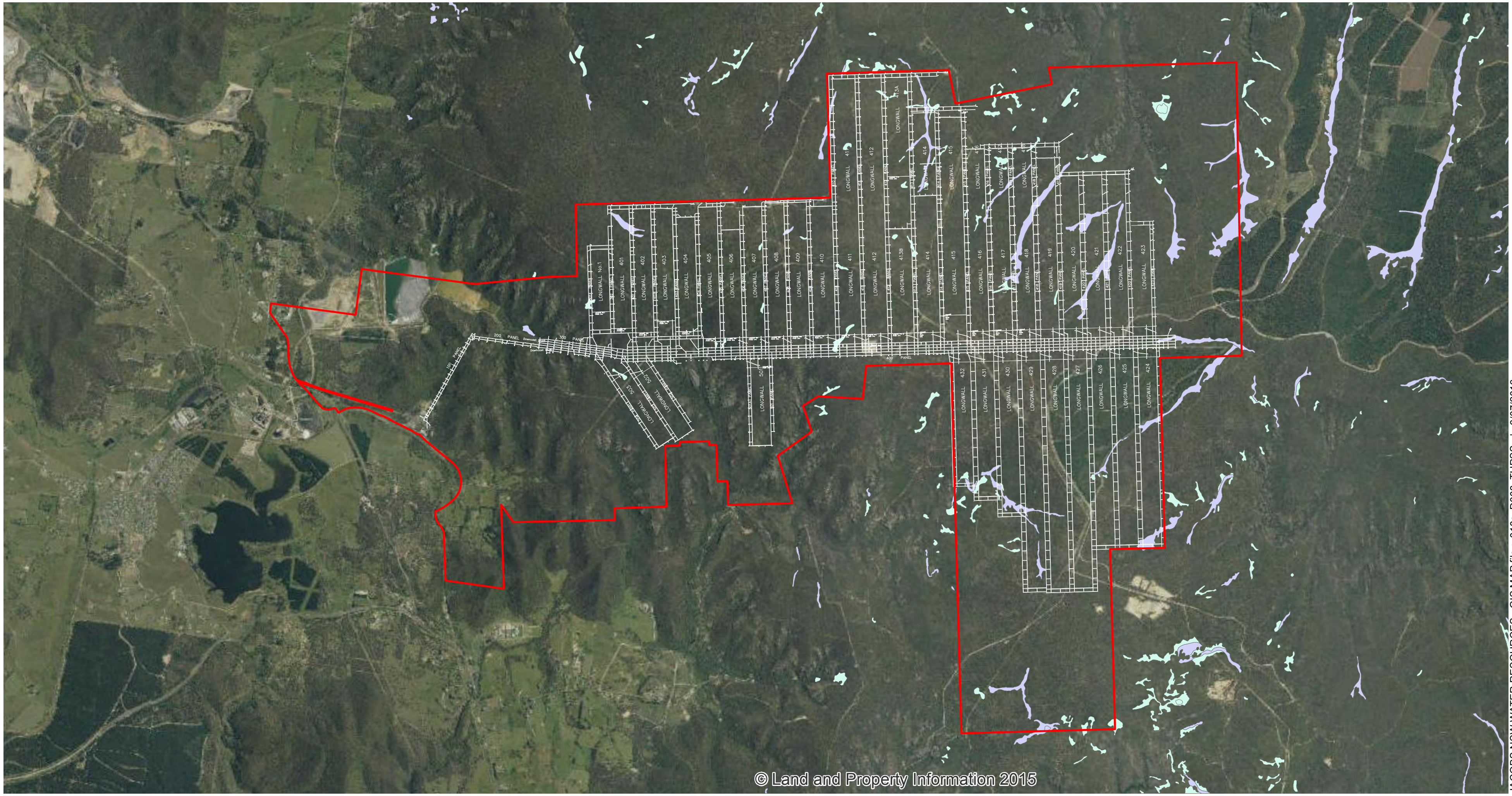
3.2.4 Groundwater Users

As identified in the Groundwater Assessment of the EIS (RPS, 2014a), the majority of groundwater works within a 10km radius of Springvale Mine and Angus Place Colliery are monitoring piezometers, exploration boreholes or dewatering shafts.

Table 3.3 presents water access licences (WALs) (groundwater) in the Sydney Basin Coxs River Groundwater Source within 10km of the PAA, assessed as 10km radial distance from the centre of LW414.

From **Table 3.3**, there are several non-mining water supply works at distance from the PAA. The works associated with these WALs are discussed in order of radial distance from the centre of LW414.

- WAL24356 is an industrial water supply at Lithgow Correctional Facility and is installed into fractured basalt and is presumed to intersect the underlying Lachlan Fold Belt.



JACOBS NSW WATER RESOURCES - GIS MAP file : 010c_D003_THPSS | 6/07/2016

Legend

- Project Application
- Shrub Swamp
- Hanging Swamp

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Project No. IA097101

Data sources
LPI Web Services 2016, Springvale Coal Pty Ltd

Figure 3-3 | Location of Newnes Plateau Shrub Swamps and Hanging Swamps

Table 3.3 : Groundwater Users (WALs) in the Sydney Basin Coxs River Groundwater Source

WAL No.	Licence Class and Entitlement	Works Approval No.	Lot/DP	Owner Type and Use	Groundwater Works No.	Description	Radial distance from centre of LW414	Comment
36443	Aquifer (585ML)	10WA118754 Collector System	125/751651	Private (Mining, Dewatering (Groundwater))	GW111026	Not stated but is mine dewatering shaft	Site	Springvale Coal
36446	Aquifer (3300ML)	10WA118752 1 Bore	n/a	Private (Not stated but is Mining, Dewatering (Groundwater))	n/a	Not stated but is mine dewatering shaft	Site	Springvale Coal
36445	Aquifer (2701ML)	10WA118748 Collector System	340/751636	Private (Mining, Dewatering (Groundwater))	GW111021	Not stated but is mine dewatering shaft	8km northwest	Centennial Angus Place
24356	Aquifer (19ML)	10WA116387 1 Bore	1/787242	Government (Industrial, Recreation (Groundwater))	GW039443	168mm open hole well from 5mBGL to 70mBGL in basalt	8km southwest	Corrective Services Lithgow
24364	Aquifer (19ML)	10WA116401 1 Bore	101/1033592	Private Domestic	GW105294 (SWL 3.0mBGL; Yield 0.126L/s)	125mm cased well to 16mBGL, screen at 8 to 16mBGL in decomposed granite	9km northwest	
24363	Aquifer (18ML)	10WA116383 2 Bores, 1 Well	1/1098480	Private (Industrial (Mineral Water Extraction))	GW103224 (SWL 3.5mBGL; 1.67L/s)	Not stated but depth of work is 7.6mBGL	9km south	Lithgow Valley Springs / Old Zig Zag Brewery
36480	Aquifer (200ML)	10WA118780 Excavation	135/1188105	Private (Not stated but is Mining)	GW111334	400mm to 300mm open hole well from 0mBGL to 12mBGL in coal/sandstone	10.5km west northwest	Pine Dale Coal Mine
24362	Aquifer (8.5ML)	10WA116403 1 Bore	1/252472	Private (Test Bore)	GW110520 (SWL 1.2mBGL; Yield 0.5L/s)	160mm cased well to 16mBGL, with screen at 2 to 8mBGL in gravel/sand	10km west	Centennial Lidsdale Siding

WAL No.	Licence Class and Entitlement	Works Approval No.	Lot/DP	Owner Type and Use	Groundwater Works No.	Description	Radial distance from centre of LW414	Comment
24359	Aquifer (63ML)	10CA116393 1 Bore	1/840412	Private (Recreation (Groundwater), Irrigation)	GW060112 (SWL 12.2mBGL; Yield 9.1L/s)	150mm cased well to 30mBGL, screen at 17 to 30mBGL in conglomerate	10km southwest	Lithgow Golf Course
24360	Aquifer (2ML)	10WA116397 1 Bore	2/1033269	Private (Test Bore)	GW063721 (SWL 10mBGL; Yield 0.5L/s)	165mm cased well to 21.9mBGL, with screen at 21.6 to 21.9mBGL, then open hole well to 39.6mBGL?	11km southwest	Lithgow Tourist and Van Park
24365	Aquifer (19ML)	10WA116389	16/751650	Private (Industrial (Mineral Water Extraction))	GW071914 (SWL 16mBGL; Yield 0.8L/s)	165mm cased well to 90mBGL, with screen 48 to 60mBGL) in ?	11km southeast	? Clarence House
24366	Aquifer (12ML)	10WA116395	134/751650	Private (Recreation (Groundwater), Industrial)	GW103909	110mm cased well to 40.6mBGL, with screen from 30 to 40.6mBGL in sandstone	11km southeast	Zig Zag Railway

- WAL24364 is a domestic water supply work located 9km northwest of LW414 and is a shallow work installed into what is described in the PINENNA database as decomposed granite. The work is located adjacent Lambs Creek.
- WAL243363 is a shallow industrial (mineral water extraction) work located at Oakey Park. Details of the groundwater work is not available, however, has a depth of 7.6mBGL and is located at the outlet of a steep-sided gully adjacent an unnamed perennial surface watercourse.
- WAL24362 is a water supply work at Centennial's Lidsdale Siding and is assumed to be used for dust suppression.
- WAL24359 is an irrigation supply for Lithgow Golf Course installed into basalt.
- WAL24360 is a 2ML entitlement for Lithgow Tourist and Van Park installed to 40mBGL. It is presumed it is used for industrial purposes such as washdown.
- WAL24365 is an industrial mineral water extraction work at Clarence and is a 90m deep work, presumed to be installed into sandstone.
- WAL24366 is an industrial water supply for Zig Zag Railway and is a 40m deep work in sandstone.

Table 3.4 presents the identified groundwater users in the Sydney Basin Richmond Groundwater Source within 10km of the PAA.

From **Table 3.4**, there is one non-mining related water supply work.

- WAL24440 is a non-mining access licence, however, is located at a large scale quarry operated by Hanson. It is interpreted that the WAL accommodates the water supply reservoir on-site that, presumably, is used for industrial processes (washing of aggregate) as well as dust suppression.

Figure 3.4 presents the location of groundwater users in the vicinity of the PAA.

3.2.5 Surface Water – Groundwater Interaction

The Upper Coxs River lies to the west of Springvale Mine and flows in a southerly direction toward Lake Wallace, which is a water supply reservoir for the Wallerawang Power Station. Overflow from Lake Wallace flows south to Lake Lyell, which is a water supply reservoir for Wallerawang Power Station and the Mount Piper Power Station. It is noted that Wallerawang Power Station ceased operation in April 2014.

Within the Wolgan River catchment, Carne Creek and several of its tributaries overlie LW419 to LW422. These surface watercourses flow in a northeasterly direction toward the Wolgan Valley, eventually discharging to the Colo River.

As indicated in the Surface Water Assessment (RPS, 2014b), Nine Mile Creek, Paddy's Creek and Bungleboori Creek flow in an easterly direction and eventually discharge to the Colo River.

To the southwest of LW432, Marrangaroo Creek flows in a westerly and then southerly direction and discharges to the Coxs River between Lake Wallace and Lake Lyell.

Within these watercourses there are several EECs. As will be presented below, modelled change to groundwater contribution to these surface watercourses will be presented with respect to each of these tributaries and the estimated licensing volume will be provided. It is highlighted that calculated take from surface watercourses is essentially identical to that presented in the Groundwater Assessment of the EIS (RPS, 2014a).

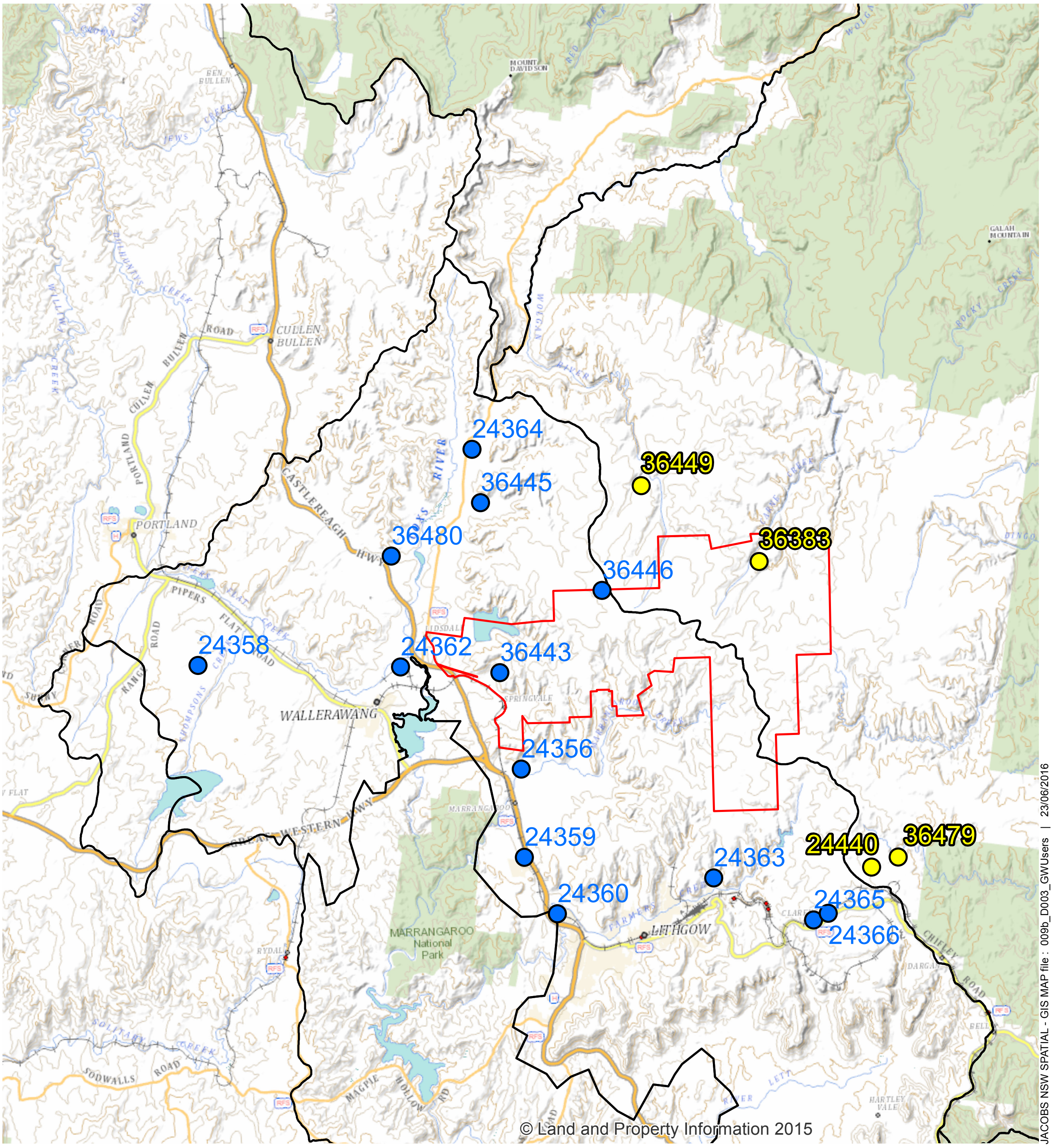
3.3 Hydrogeological Investigation

A summary of the program of investigation at Springvale Mine conducted at the time of the EIS is presented below. Further detail is presented in RPS (2014a).

- swamp water table monitoring (water quality and water level)

Table 3.4 : Groundwater Users (WALs) in the Sydney Basin Richmond Groundwater Source

WAL No.	Entitlement	Works Approval No.	Lot/DP	Owner Type and Use	Groundwater Works No.	Description	Radial distance from centre of LW414	Comment
36383	Aquifer (5958ML)	10WA118719 4 Bores	n/a	Private (Test Bore, but is Mining, Dewatering (Groundwater))	GW113102	918mm to 457mm cased well to 422mBGL, screen at 365 to 375mBGL in coal	Site	Springvale Coal
36449	Aquifer (2523ML)	10WA118750 2 Bores	n/a	Private (Mining, Dewatering (Groundwater))	GW111022	Not stated but is mine dewatering shaft	4.5km northwest	Centennial Angus Place
36479	Aquifer (6623ML)	10WA118758 3 Bores	25/7511631	Private (Mining, Dewatering (Groundwater))	GW112526	150mm open hole well to 108mBGL	10km southeast	Centennial Clarence
24440	Aquifer (41ML)	10WA107423 Excavation – Groundwater	7021/1075970	Private (Industrial – Sand & Gravel)	GW106646 (SWL 27mBGL; 20L/s)	Excavation (200m x 100m x 30m deep)	10km southeast	Hanson Constructions



Legend

- Project Application
- Sydney Basin Coxs River
- Sydney Basin Richmond
- Greater Metropolitan Region Groundwater Sources 2011

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Project No. IA097101

Data sources
NSW LPI Web Services 2016, Springvale Coal Pty Ltd

Figure 3-4 | Groundwater Users in the vicinity of the PAA

- shallow groundwater level monitoring (water level)
- deep groundwater level monitoring (water level)
- geological exploration (boreholes)
- hydraulic testing (on-going)

Since the time of the EIS, it is noted that groundwater quality monitoring has commenced in the shallow groundwater system via pre-existing standpipe piezometers located on topographic ridgelines, as prescribed in the Conditions of Consent. It is also understood that the monitoring network is in the process of being reviewed, during consultation with the Department of Planning and Environment associated with the current Extraction Plan for LW419.

4. Numerical Analysis

4.1 Overview

The numerical groundwater model at Springvale Mine was constructed in COSFLOW, which is a fully implicit solution to Darcy-Richards equation (variably saturated flow) and is therefore capable of simulating the formation of multiple phreatic surfaces. It is noted that COSFLOW was built to simulate multi-component, multi-phase fluid and heat flow, coupled with mechanical deformation, however, for the EIS and this Groundwater Assessment (Modification to Consent), the model was used in single component, flow only mode. Mechanical deformation was, however, represented directly in the model using a time-varying RAMP function, wherein height-varying changes to hydraulic properties were applied, based on longwall progression. As noted in RPS (2014a), COSFLOW also accounts for goaf formation, including consolidation of the goaf after a set period.

The model was calibrated to steady-state as well as in transient and included transient validation at the time of the EIS. Details of model calibration are presented in RPS (2014a).

Figure 4.1 presents the layout of streams and swamps included in the model. **Table 4.1** presents the nomenclature used in **Figure 4.1**.

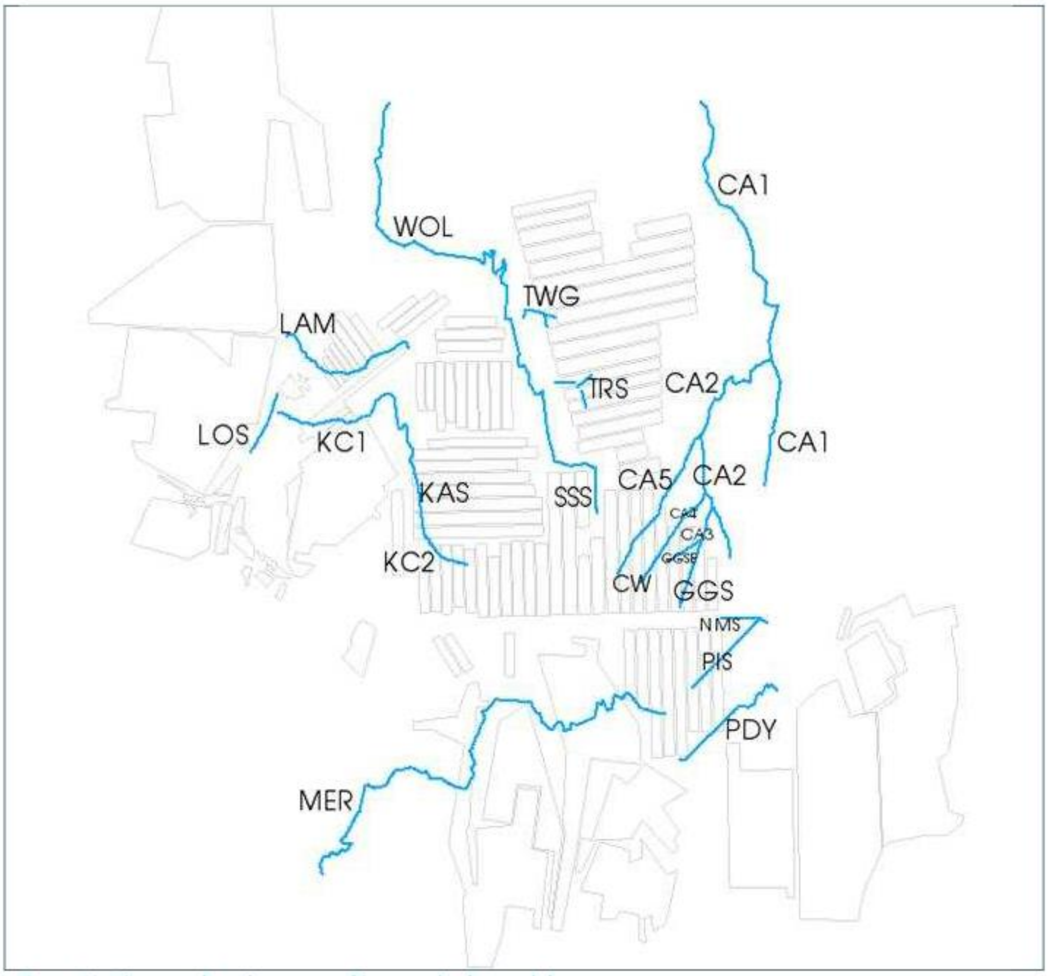


Figure 4.1 : Swamps and Streams in the COSFLOW Model (after Figure C1 of Adhikary and Wilkins, 2013)

Table 4.1 : Configuration of Swamps and Streams in the COSFLOW Model (after Table C1 of Adhikary and Wilkins, 2013)

Notation	Rivers and swamps	Boundary conditions		Notation	Rivers and swamps	Boundary conditions
CA1	Carne Creek, main branch which flows north	Perennial		LAM	Lamb Creek	Ephemeral
CA2	Carne Creek, central branch which flows from east of LW431 and into CA1	Perennial		LOS	Long Swamp	Perennial
CA3	Carne Creek, branch which flows from GGSE and GGS to CA2	Perennial		MER	Marrangaroo Creek	Perennial
CA4	Carne Creek, branch flows from CW to CA2	Perennial		NMS	Nine-Mile Swamp	Perennial
CA5	Carne Creek, western branch which flows from above LW415 to CA2	Perennial		PDY	Paddy's Creek	Ephemeral
CW	Carne West Swamp, which flows to CA4	Ephemeral		PIS	Pine Swamp	Ephemeral
GGSE	Gang-Gang Swamp east which flows to CA3	Perennial		TRS	Tri-Star Swamp	Ephemeral
GGS	Gang-Gang Swamp south, which flows to CA3	Perennial		TWG	Twin-Gully Swamp	Ephemeral
KC1	Kangaroo Creek, downstream of KAS	Perennial		SSS	Sunnyside Swamp, which flows into WOL	Perennial
KC2	Kangaroo Creek, upstream of KAS	Ephemeral		WOL	Wolgan River	Perennial
KAS	Kangaroo Swamp	Ephemeral				

4.2 Model Prediction

4.2.1 Model Setup

The prediction simulation presented in the EIS (Golder Associates, 2014) was updated by CSIRO in 2015 to account for:

- the change in status at Angus Place Colliery
- the change in mining rate at Springvale Mine.

Details are presented in the CSIRO modelling report provided as **Appendix A**, however, it is noted that whilst LW423 and LW501 to 503 were not included in the updated prediction simulation, these longwalls continue to be part of the current and approved mine plan. As will be shown below, model results are essentially identical to that presented in the EIS and the impact of the omission of LW423 and LW501 to 503 from the simulation is not consequential.

It is noted that, following completion of operations at Springvale Mine, dewatering was turned off in the updated model and the mined panels were allowed to flood with water. In the EIS, dewatering at Springvale Mine was maintained through to end of mining at Angus Place Colliery in the model, which was a conservative assumption.

Details of mass balance error during prediction simulation is presented in **Appendix A**.

4.2.2 Model Results

4.2.2.1 Modelled Change to Flow

Mine Inflow

Predicted inflow to underground workings at both Springvale Mine and Angus Place Colliery, including Angus Place East, is presented in **Figure 4.2**. It is noted that the simulation 'Base Case', as per RPS (2014a), represents continuation of mining concurrently at Springvale and Angus Place, including the Angus Place Mine Extension Project (referred to as Angus Place East in Adhikary and Wilkins (2013, 2015)). The 'SPR then APE' simulation, as presented in **Appendix A,** represents sequential implementation of mining at Springvale and Angus Place. i.e. following completion of mining at Springvale in 2023, mining will commence in the Angus Place Mine Extension Project in 2024, subject to approval.

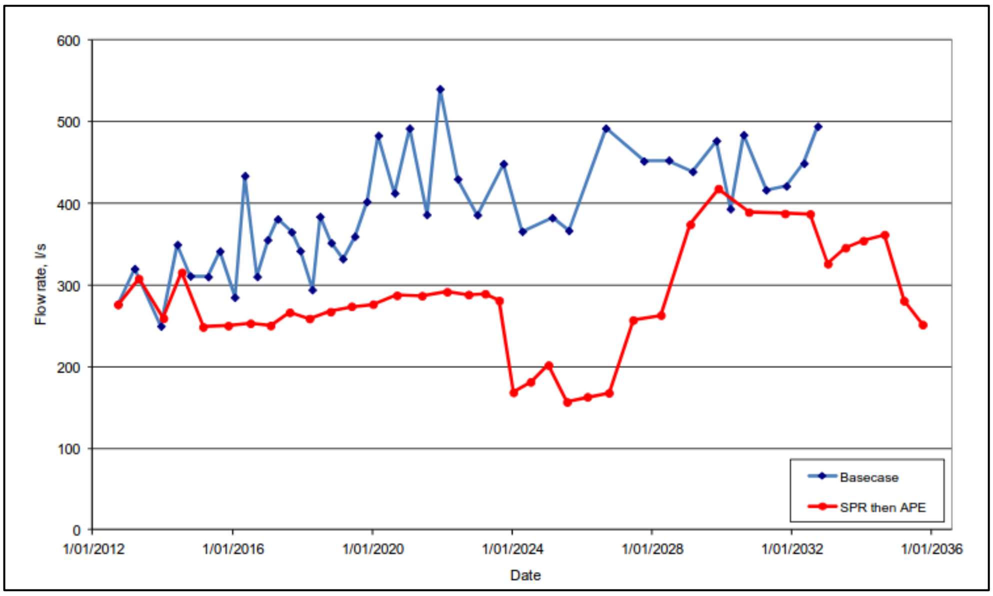


Figure 4.2 : Inflow to Underground Workings (Springvale and Angus Place) (L/s) (after Figure G3 of Adhikary and Wilkins, 2015)

From **Figure 4.2**, inflow to underground workings is relatively steady at 300L/s (26ML/d) through to completion of modelled mining at Springvale in 2023. Following completion of mining at Springvale, dewatering will cease, Springvale Mine will be allowed to flood, and groundwater levels will commence recovering. It is highlighted that whilst this application seeks to modify the rate of mining at Springvale, the duration of mining operations in the current consent (to 31 December 2028) is not proposed to change.

Following completion of modelled mining at Springvale, inflow to underground workings is expected to decrease to approximately 200L/s and then increase to 400L/s by 2030. In general, modelled inflow to underground workings is less than that presented in the Groundwater Assessment of the EIS (RPS, 2014a).

Modelled inflow to underground workings at Springvale Mine only is presented in **Figure 4.3**.

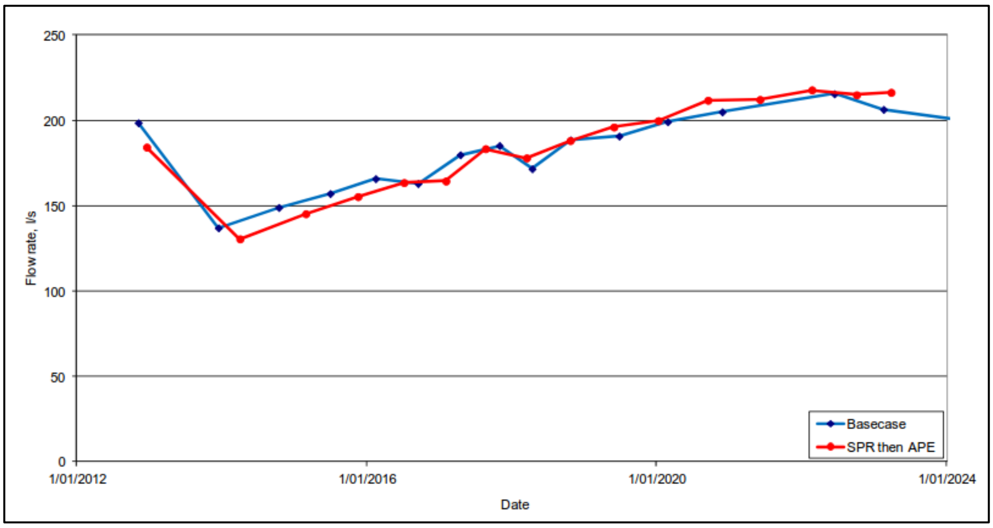


Figure 4.3 : Inflow to Underground Workings (Springvale only) (L/s) (after Figure G4 of Adhikary and Wilkins, 2015)

From **Figure 4.3**, the change in mining rate at Springvale Mine has negligible impact on modelled inflows to the underground. Modelled inflow rate to Springvale Mine workings rises from 140L/s (~12ML/d in 2014) to 220L/s (19ML/d in 2023). In the EIS (RPS, 2014b), the predicted maximum inflow was ~210L/s (19ML/d) in 2022. From **Figure 4.2**, inflow to workings at both Springvale Mine and Angus Place Colliery is 300L/s (26ML/d) in 2016. Discharge of mine water make to Sawyers Swamp Creek via Springvale Coal's LDP009 currently ranges between 250 and 315L/s (22 and 27ML/d), reflecting transfer from Angus Place Colliery to Springvale Mine, as well as inflows to Springvale Mine's workings themselves.

For the purpose of completeness, **Figure 4.4** presents modelled inflow to underground workings of the Angus Place Mine Extension Project, Angus Place East panels.

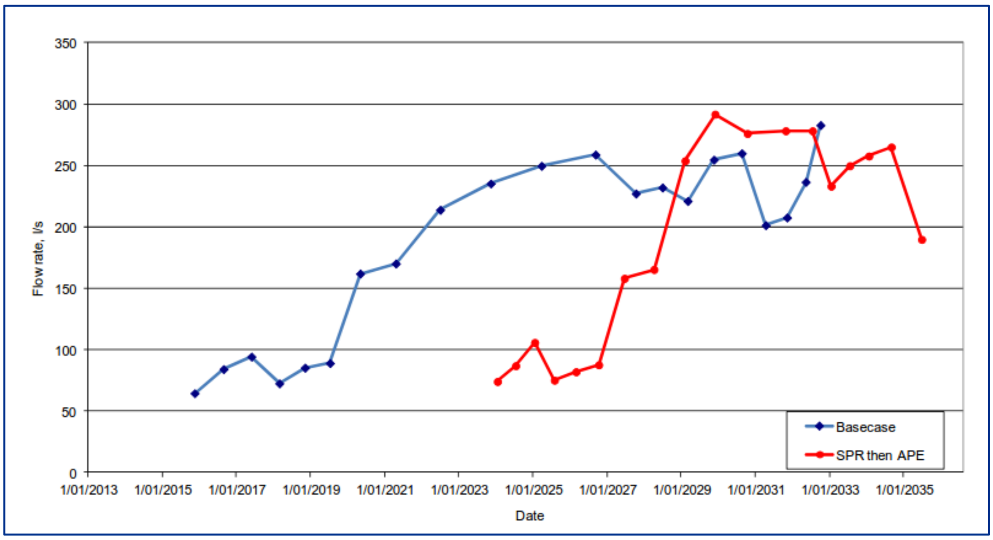


Figure 4.4 : Inflow to Underground Workings (Angus Place East only) (L/s) (after Figure G5 of Adhikary and Wilkins, 2015)

From **Figure 4.4**, the change in schedule of mining of the Angus Place East panels is self-evident, with inflows commencing in late 2023. Modelled inflows are comparable to that presented in the EIS (Golder Associates, 2014) and the Groundwater Assessment (RPS, 2014a).

Groundwater Contribution to Surface Watercourses and Swamps

As presented in RPS (2014a), swamps and streams are represented by a number of finite element nodes in the model. **Figure 4.1** presents the nomenclature adopted in the COSFLOW model. Modelled groundwater contribution to these surface water features is presented in **Table 4.2** below and the modelled change to groundwater contribution is presented in **Table 4.3**. Predicted changes in groundwater contribution to surface watercourses are presented graphically in **Appendix B** (Appendix H of Adhikary and Wilkins, 2015).

Sunnyside East Swamp

Sunnyside East is included as part of model segment, CA5, of Carne Creek. Whilst not listed in **Table 4.2** and **Table 4.3**, Figure H6 of Adhikary and Wilkins (2015) (provided in **Appendix B**) presents modelling that indicates a decline in groundwater contribution from approximately 0.3ML/d in 2012 to a minimum of 0.05ML/d (0.5L/s) in 2023, with recovery to 0.15ML/d. Results presented are consistent with that presented in the EIS.

Carne West Swamp

From **Table 4.2**, as presented in the Groundwater Assessment in the EIS, there is a predicted increase in baseflow to Carne West Swamp due to assumed change in horizontal hydraulic conductivity applied via the RAMP function. As noted in Section 7.3.3 of RPS (2014a), if the groundwater levels were below the level of the swamp, then the opposite response would be observed, with increased hydraulic conductivity leading to increased leakage from the swamp.

Table 4.2 : Modelled Groundwater Contribution to Simulated Swamps and Streams (after Table G10 of Adhikary and Wilkins, 2015)

Swamps and streams simulated in this study	Groundwater discharge (ML/day)						
	Pre-mining	Dec 2012	Seasonal variation	2024	2036	2064	Minimum
CA2 (includes Carne Central Swamp)	1.30	1.14	0.14	1.101	0.972	1.101	0.960
Carne West Swamp	0.02	0.02	0.01	0.052	0.045	0.041	0.019
Carne Creek Total	6.44	5.91	0.96	5.883	5.802	6.162	5.688
Gang Gang South East	-0.05	-0.06	0.02	-0.220	-0.225	-0.222	-0.226
Gang Gang Swamp South	-0.05	-0.06	0.02	-0.055	-0.072	-0.072	-0.073
Kangaroo Swamp	0.01	0.02	0.00	0.015	0.014	0.013	0.011
Kangaroo Creek (KC1)	0.30	0.00	0.24	-0.071	-0.116	-0.050	-0.138
Kangaroo Creek (KC2)	0.07	0.11	0.24	0.114	0.096	0.081	0.074
Lamb Creek	0.17	0.17	0.02	0.113	0.093	0.120	0.083
Long Swamp	-0.07	-0.07	0.01	-0.067	0.119	-0.067	-0.078
Marrangaroo Creek	0.93	0.72	0.30	0.752	0.674	0.643	0.643
Nine Mile Swamp	0.02	0.01	0.01	0.017	0.017	0.017	0.011
Paddy's Creek	0.17	0.16	0.01	0.163	0.165	0.169	0.162
Pine Swamp	0.09	0.09	0.01	0.197	0.165	0.152	0.086
Tri-Star Swamp	0.05	0.04	0.01	0.044	0.118	0.065	0.006
Twin Gully Swamp	0.08	0.07	0.01	0.073	0.091	0.065	0.044
Sunnyside Swamp	0.10	0.10	0.01	0.105	0.100	0.094	0.093
Wolgan River Total	1.34	1.29	0.55	1.330	1.268	1.034	0.974

Table 4.3 : Modelled Change to Groundwater Contribution to Simulated Swamps and Streams (after Table G10 of Adhikary and Wilkins, 2015)

Swamps and streams simulated in this study	Maximum reduction in baseflow		Comments
	(ML/day)	%	
CA2 (includes Carne Central Swamp)	0.176	15	
Carne West Swamp	Increase in baseflow		Very small volume
Carne Creek Total	0.268	4.5	Small change
Gang Gang South East	0.17	288	Leaky swamp (increase in leakage)
Gang Gang Swamp South	0.01	20	Leaky swamp (increase in leakage); very small volume
Kangaroo Swamp	0.004	24	very small volume
Kangaroo Creek (KC1)	0.145	Division by a small number	very small volume
Kangaroo Creek (KC2)	0.03	32	very small volume
Lamb Creek	0.047	36	very small volume
Long Swamp	0.000	0.000	No change
Marrangaroo Creek	0.078	11	
Nine Mile Swamp	Increase in baseflow		Very small volume
Paddy's Creek	0.001	0.5	Very small change
Pine Swamp	0.000	0.0	No change
Tri-Star Swamp	0.04	86	very small volume
Twin Gully Swamp	0.029	40	very small volume
Sunnyside Swamp	0.003	3.5	Small change
Wolgan River Total	0.33	25.5	

Carne West, as modelled, has a groundwater contribution of 0.02ML/d (0.25L/s) and this is predicted to increase to 0.052ML/d (0.6L/s) in 2024.

Carne Central Swamp

For Carne Creek, where CA2 includes Carne Central Swamp, there is a modelled decrease in groundwater contribution to surface water of 15% (0.18ML/d or 2.1L/s). As presented in **Table 4.2**, modelled groundwater contribution in 2012 is 1.14ML/d (13.2L/s). The results presented indicate a reduction in modelled change to groundwater contribution for the “SPR then APE” simulation compared to the “Base Case” simulation.

Gang Gang Swamp

For Gang Gang Swamp South West (referred to as Gang Gang Swamp South East in Adhikary and Wilkins, 2013 and 2015), there is a significant change to modelled groundwater contribution. From **Table 4.2**, modelled groundwater contribution is a loss from surface water to groundwater and is -0.06ML/d (0.7L/s) and this loss is predicted to increase to -0.225ML/d (2.6L/s) at maximum. Modelled change in loss from surface water to groundwater is equivalent to that presented in the EIS.

For Gang Gang Swamp East (referred to as Gang Gang South in Adhikary and Wilkins, 2013 and 2015), modelled groundwater contribution is a loss from surface water to groundwater, which is predicted to increase by 0.01ML/d (0.1L/s). Model results presented are consistent with that presented in the EIS.

Nine Mile Swamp and Pine Swamp

For Nine Mile Swamp, there is an increase in groundwater contribution to surface water predicted and there is minimal change in Pine Swamp. It is noted that Pine Swamp in Adhikary and Wilkins (2013, 2015) refers to both Pine Swamp and Pine Swamp Upper.

Marrangaroo Creek

Marrangaroo Creek Swamp is incorporated into stream element Marrangaroo Creek in COSFLOW. The Marrangaroo Creek element extends to near to the downstream junction with Coxs River below Lake Lyell. From **Table 4.2**, modelled groundwater contribution to surface water of this segment is 0.72ML/d (8.3L/s) in 2012 and this is predicted to decrease by 0.078ML/d (0.9L/s) and recover to 2012 levels in time.

Coxs River

As explained in the Groundwater Assessment of the EIS (RPS, 2014a), the Coxs River was not specifically identified in COSFLOW, rather was incorporated, along with all other surface watercourses via a 'Drain' equivalent boundary condition and applied to all surface nodes at the top of the model. An exception to application of this 'Drain' type boundary condition was where perennial nodes were allocated, as per **Table 4.1**.

Adhikary and Wilkins (2015) indicate that the Coxs River could be categorized as a leaking river and modelled change in groundwater level of less than 1cm would lead to additional recharge to groundwater of 0.1L/s/m width of river. The modelled additional loss from surface water to groundwater is considered insignificant, however, compared to the median flow in the Coxs River of 12.2ML/d (as presented in Table 3.8 of RPS, 2014b).

4.2.2.2 Modelled Change in Level

Regional Groundwater Levels

Figure 4.5 presents the modelled drawdown in the Lithgow Seam (target coal seam) in 2020 compared to pre-mining groundwater conditions. The equivalent output in 2025 and 2036 is also presented in **Figure 4.5**.

It is noted that the modelled condition at 2020, 2025 and 2036 were selected by CSIRO and do not correspond with particular project milestones.

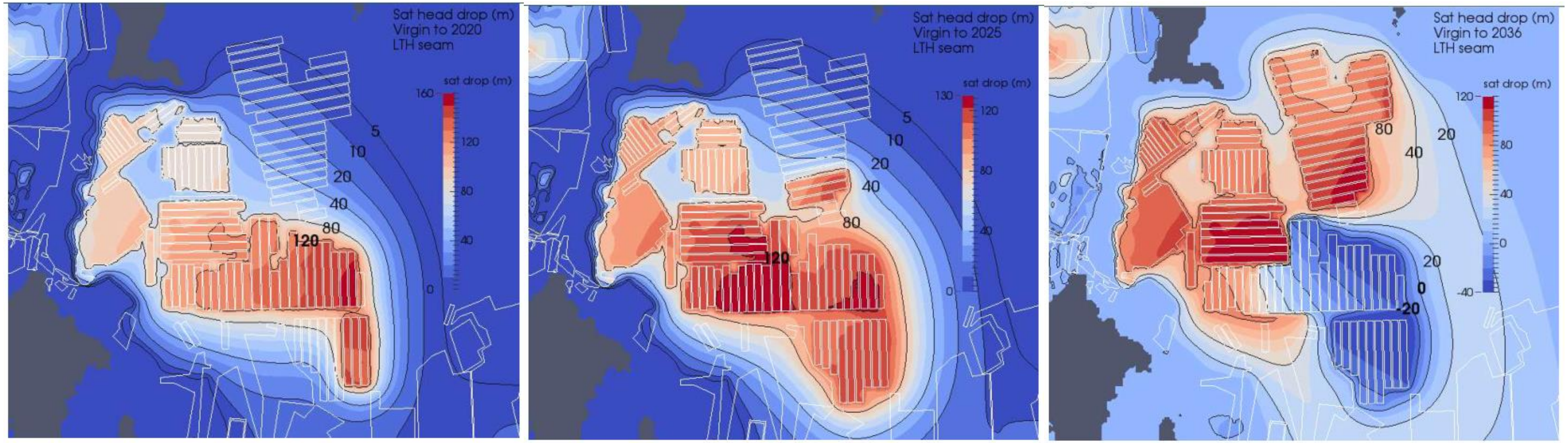


Figure 4.5 : Modelled Change in Saturated Groundwater Level at 2020, 2025 and 2036 Compared to Pre-Mining Conditions (after Figure G9, G10 and G11 of Adhikary and Wilkins (2015))

Ground Surface

Figure 4.6 presents the modelled change in saturated level at the top of the model compared to 2013 conditions.

Modelling indicates the change in groundwater level at ground surface is generally of the order of tens of centimetres.

Phreatic Surfaces

Figure 4.7 presents the location of cross-sections from where time-series phreatic surfaces were extracted.

From **Figure 4.8**, modelling indicates that dewatering of the Lithgow Seam (LTH) leads to an increase in the extent of the unsaturated zone within the Burra-Moko Head and Caley Formation. This enhanced unsaturated zone diminishes progressively following mining. From **Figure 4.8**, the drop in level of the uppermost phreatic surface beneath topographic ridges reflects the assumed RAMP function insofar as, in the model, an increase in horizontal and vertical hydraulic conductivity is applied from the coal seam through to surface zone to represent the potential effect of subsidence on overlying strata. The model is conservative in this respect, since observation of groundwater level beneath topographic ridges have not declined. It is noted, however, that there is currently an investigation underway into a water level trigger that has occurred at Carne West swamp.

Groundwater Users

As noted in Section 3.2.4, there are some non-mining related water supply works in the vicinity of Springvale Mine, however, these are of sufficient distance from the mine that there is no expected change to groundwater elevation at these WALs due to mining.

Table G13 of **Appendix A** (Appendix G of Adhikary and Wilkins (2015)) presents the modelled change in groundwater elevation at all groundwater works, however, as noted, the majority of these works are monitoring piezometers, exploration boreholes or large mine dewatering works.

Groundwater Dependent Ecosystems

Table 4.4 presents the modelled groundwater level above ground surface at each swamp and stream included in the model.

Table 4.5 presents the maximum change in modelled groundwater level in swamps and streams in comparison to 2012 levels. The results of modelling presented in the EIS are also provided in **Table 4.5**.

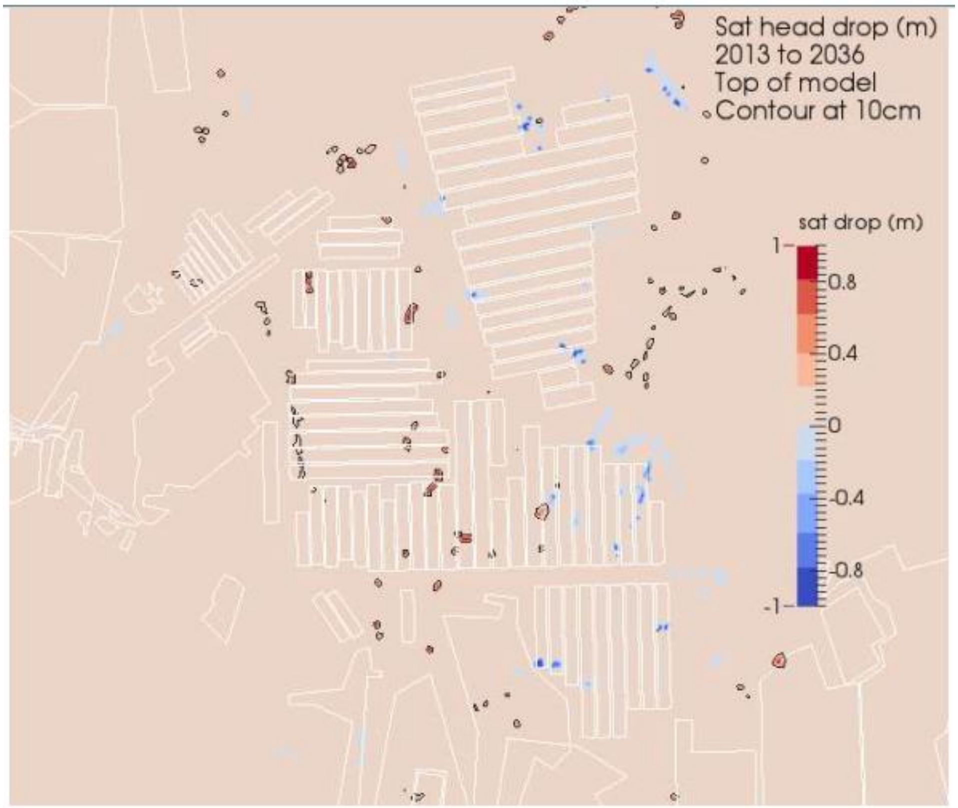


Figure 4.6 : Modelled Change in Saturated Head in 2036 compared to 2013 groundwater levels (after Figure G13 of Adhikary and Wilkins (2015))

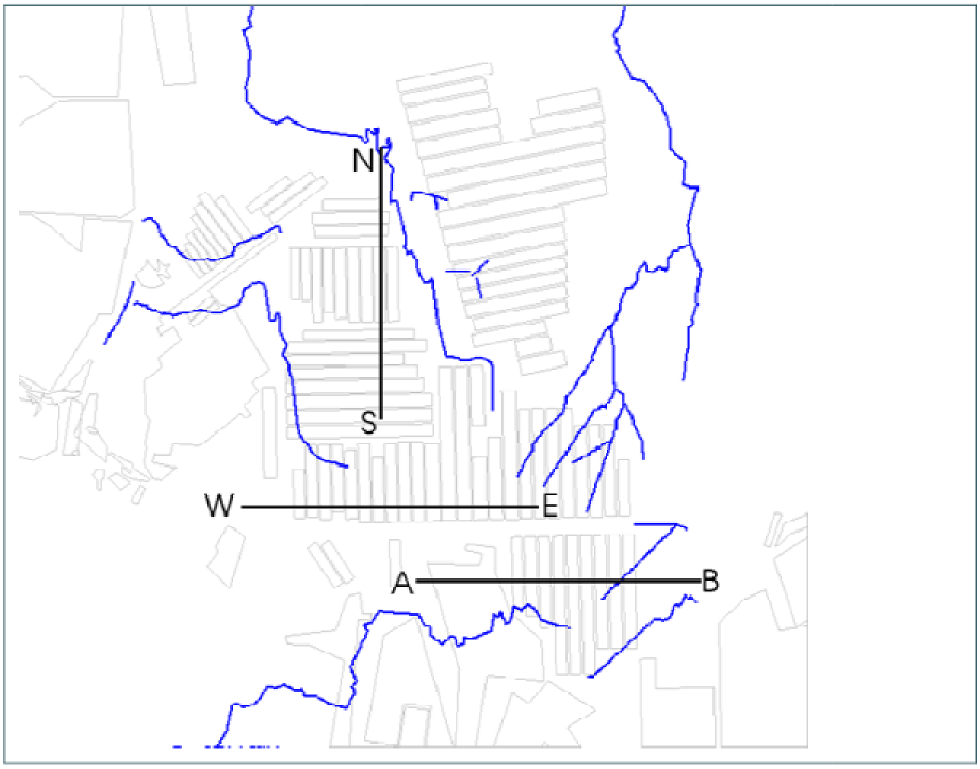
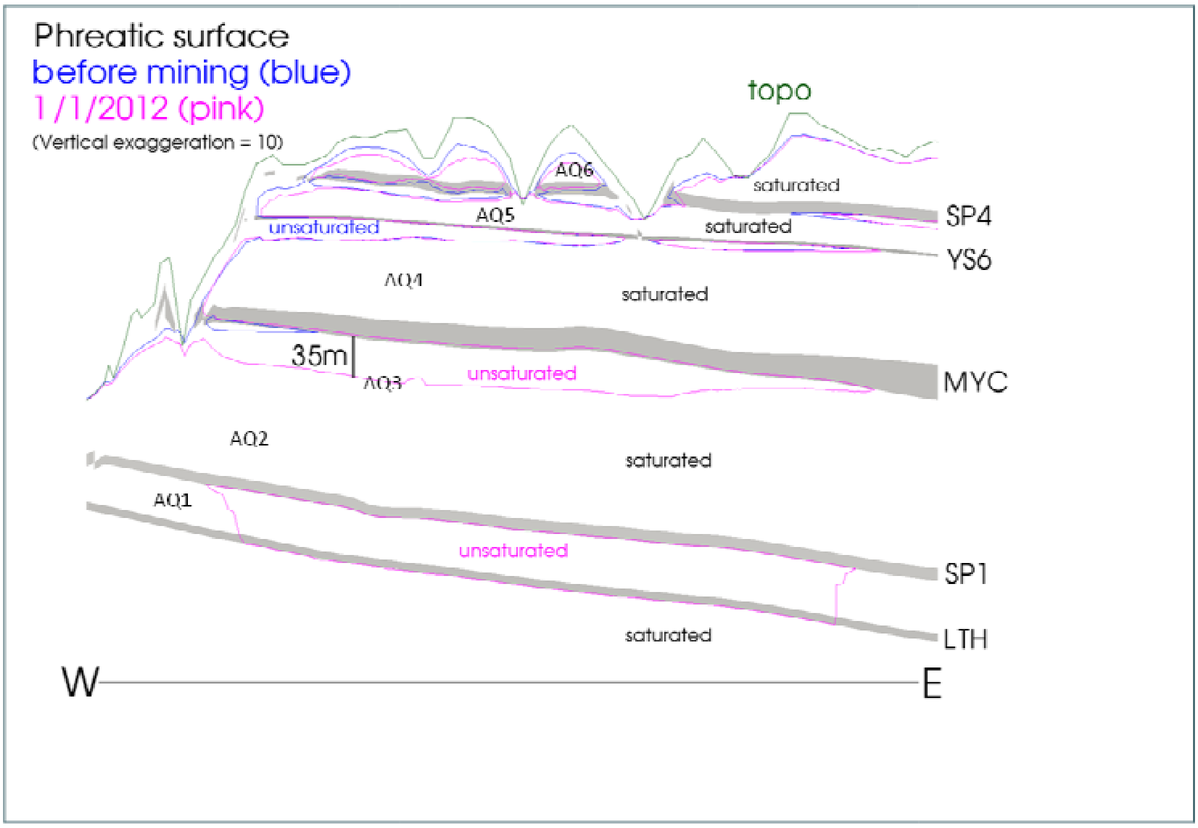


Figure 4.7 : Location of Phreatic Surfaces (after Figure 61 of Adhikary and Wilkins (2013))



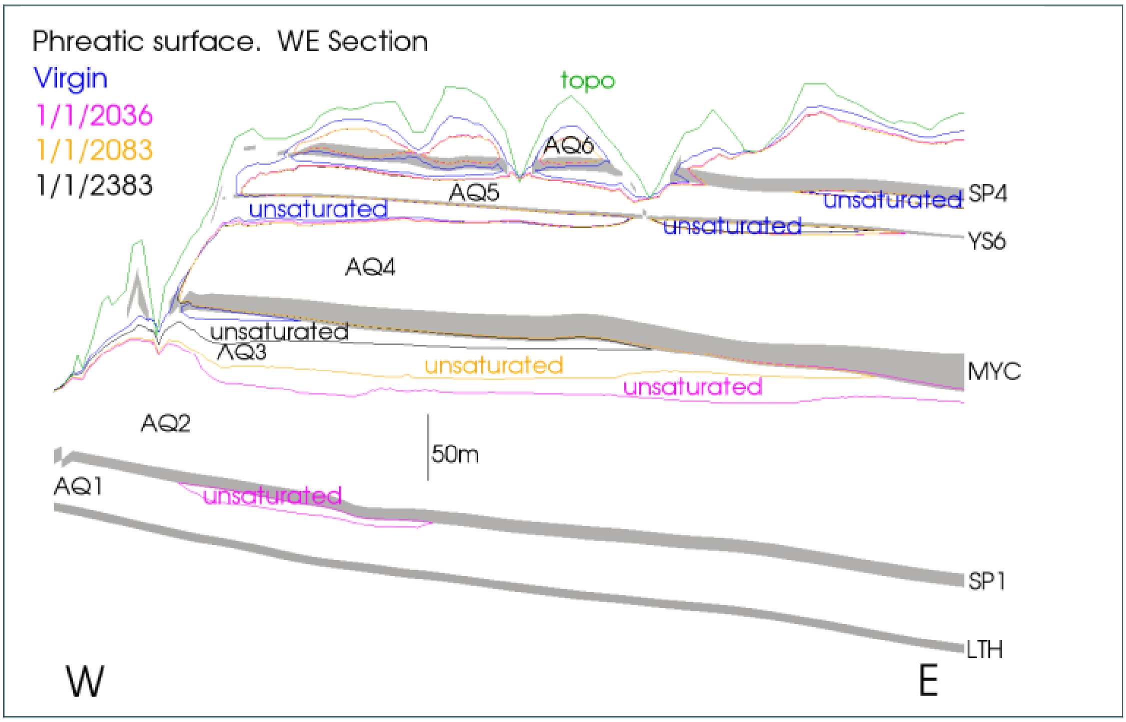


Figure 4.8 : Phreatic Surfaces – prior to mining (blue), mining in 2012 (pink) (after Figure 62 of Adhikary and Wilkins (2013)) [above] and Phreatic Surfaces - prior to mining (blue), post-mining in 2035 (pink), in 2083 (yellow) and at 2383 (black) (after Figure G15 and G17 of Adhikary and Wilkins (2015)) [below]

Table 4.4 : Predicted Groundwater Level in Simulated Swamps and Streams (after Table G11 of Adhikary and Wilkins (2015))

Swamps and streams simulated in this study	Predicted average head above the ground surface (m)					Predicted average head drop from pre-mining (m)				Predicted average head drop since 2012 (m)		
	Pre-mining	2012	2024	2036	2064	2012	2024	2036	2064	2024	2036	2064
CA2 (includes Carne Central Swamp)	0.499	0.435	0.422	0.372	0.422	0.064	0.077	0.127	0.077	0.014	0.063	0.013
Carne West Swamp	0.027	0.025	0.071	0.061	0.056	0.002	-0.043	-0.034	-0.029	-0.045	-0.036	-0.031
Carne Creek Total	0.558	0.516	0.510	0.503	0.534	0.042	0.048	0.055	0.024	0.006	0.013	-0.018
Gang Gang Swamp South East	-0.106	-0.121	-0.458	-0.469	-0.463	0.015	0.352	0.363	0.357	0.337	0.348	0.342
Gang Gang Swamp South	-0.065	-0.082	-0.074	-0.097	-0.097	0.017	0.009	0.032	0.032	-0.008	0.014	0.015
Kangaroo Swamp	0.179	0.386	0.376	0.353	0.330	-0.207	-0.197	-0.174	-0.151	0.010	0.033	0.057
Kangaroo Creek (KC1)	0.116	0.003	-0.027	-0.045	-0.019	0.113	0.143	0.161	0.135	0.030	0.047	0.022
Kangaroo Creek (KC2)	0.067	0.104	0.109	0.092	0.077	-0.037	-0.042	-0.025	-0.010	-0.005	0.013	0.027
Lamb Creek	0.102	0.078	0.068	0.056	0.072	0.024	0.034	0.046	0.030	0.010	0.022	0.006
Long Swamp	-0.101	-0.118	-0.101	0.179	-0.101	0.017	0.000	-0.280	0.000	-0.017	-0.297	-0.017
Marrangaroo Creek	0.148	0.115	0.120	0.108	0.103	0.033	0.028	0.040	0.045	-0.005	0.008	0.012
Nine Mile Swamp	0.037	0.024	0.039	0.038	0.038	0.012	-0.002	-0.001	-0.002	-0.015	-0.014	-0.014
Paddy's Creek	0.120	0.114	0.115	0.116	0.119	0.006	0.006	0.004	0.001	0.000	-0.002	-0.005
Pine Swamp	0.087	0.083	0.191	0.161	0.148	0.005	-0.104	-0.073	-0.060	-0.108	-0.078	-0.065
Tri-Star Swamp	0.097	0.087	0.086	0.232	0.128	0.010	0.010	-0.135	-0.032	0.001	-0.145	-0.042
Twin Gully Swamp	0.130	0.124	0.126	0.155	0.111	0.006	0.005	-0.025	0.020	-0.001	-0.031	0.014
Sunnyside Swamp	0.181	0.176	0.193	0.183	0.173	0.005	-0.011	-0.001	0.009	-0.017	-0.007	0.003
Wolgan River Total	0.187	0.183	0.186	0.178	0.145	0.004	0.001	0.010	0.043	-0.003	0.006	0.038

Note: Positive values indicate head drops and negative value indicate head increases.

Table 4.5 : Predicted Maximum Change in Groundwater Level in Simulated Swamps and Streams (after Table G12 of Adhikary and Wilkins (2015))

Swamps and streams simulated in this study	Base Model (m)	"SPR then APE" model (m)
CA2 (includes Carne Central Swamp)	0.103	0.068
Carne West Swamp	Small head increase	0.000
Carne Creek Total	0.027	0.023
Gang Gang Swamp South East	0.364	0.349
Gang Gang Swamp South	0.030	0.016
Kangaroo Swamp	0.095	0.093
Kangaroo Creek (KC1)	0.129	0.056
Kangaroo Creek (KC2)	0.035	0.034
Lamb Creek	0.047	0.028
Long Swamp	0.017	0.000
Marrangaroo Creek	0.020	0.013
Nine Mile Swamp	Small head increase	Small head increase
Paddy's Creek	0.001	0.001
Pine Swamp	0.000	0.000
Tri-Star Swamp	0.081	0.075
Twin Gully Swamp	0.051	0.050
Sunnyside Swamp	0.013	0.006
Wolgan River Total	0.050	0.047

From **Table 4.5**, predicted changes in groundwater level are consistent with that presented in the EIS (RPS, 2014a). The most significant predicted change in the EIS was with respect to Gang Gang Swamp South West (referred to as Gang Gang Swamp South East in Adhikary and Wilkins (2013, 2015)). The updated modelling indicates a minor decrease in predicted impact compared to that presented in the EIS (RPS, 2014a). As noted above, there is currently an investigation underway into a water level trigger that has occurred at Carne West swamp.

4.2.2.3 Expected Change to Quality

The numerical groundwater model at Springvale Mine considers groundwater flow only. Modelling indicates that depressurisation of the Lithgow Seam induces a change in storage within AQ3 (Burro-Moko Head and Caley Formation) and SP3 (Mt York Claystone), which following cessation of mining, is replenished via recharge. **Figure 4.9** presents the modelled change in volume in time, including recovery.

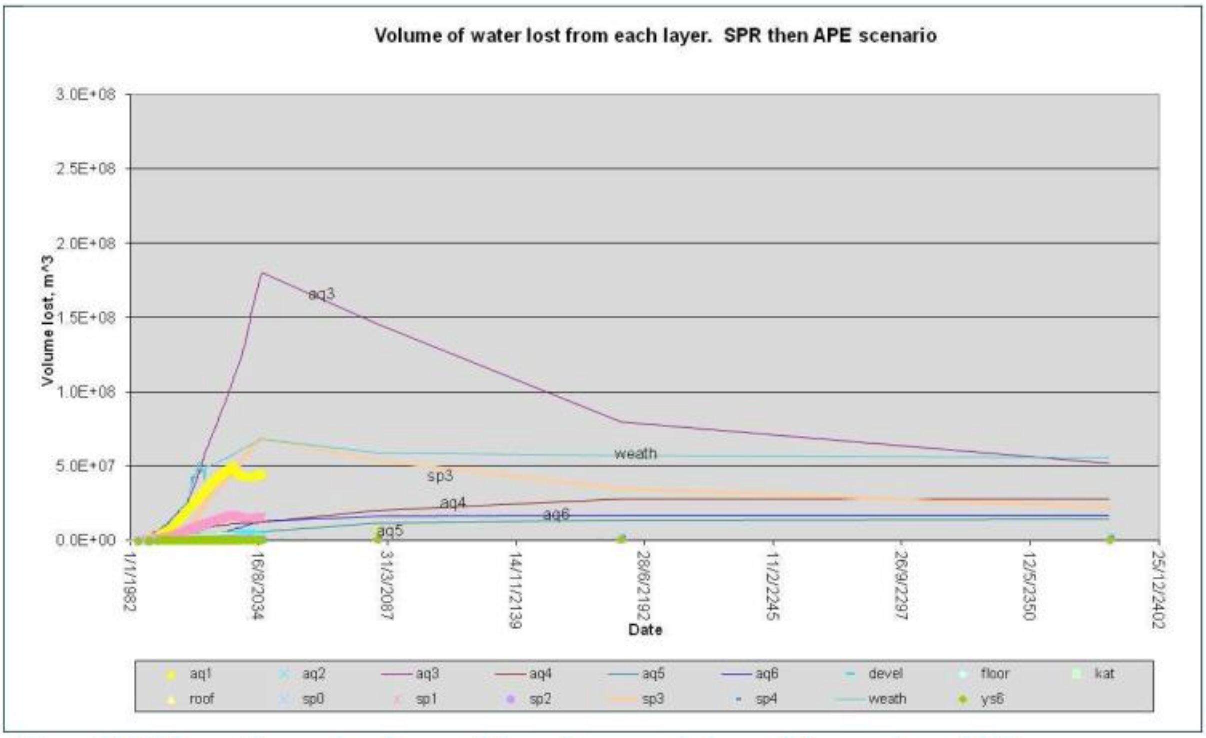


Figure 4.9 : Modelled Change in Groundwater Volume Compared to Pre-Mining Conditions (after Figure G26 of Adhikary and Wilkins (2015))

From **Figure 4.9**, the decrease in groundwater storage in the Weathered layer (weath) is due to the assumed RAMP function, insofar modelled change to hydraulic conductivity (both horizontal and vertical) leads to a decline in water stored in that layer.

Groundwater flow direction is vertically downwards from ground surface through to the Lithgow Seam. As identified in RPS (2014a), the conceptual model is that the deep groundwater system is hydraulically separated from the shallow groundwater system due to formation of the unsaturated zone beneath the Mt York Claystone (SP3). In contrast, the perched groundwater system reflects surface infiltration, with lateral transmission due to presence of sequence of low permeability aquitard plies of the Burralow Formation.

There is no mine water discharge to the Newnes Plateau as part of the current operations at Springvale Mine. Groundwater quality in the Banks Wall Sandstone is very fresh and is similar to water quality observed in peat / clay matrix of the shrub swamps. Groundwater quality of the Permian Coal Measures is only fresh, with near neutral pH and electrical conductivity (EC) of approximately 1,200µS/cm, though ranges up to 1,400µS/cm. It is highlighted that salinity of groundwater in the Coal Measures is expected to be higher in a northeasterly direction, down dip, reflecting increased water-rock interaction associated with increasing distance from point of recharge at outcrop.

Vertical hydraulic gradient is vertically downward, even through the unsaturated zone. There is therefore no expected impact to groundwater quality in the shallow and perched groundwater system as a result of mining. As noted in the EIS, near surface cracking may lead to minor additional water-rock interaction, however, the extensive record of observation at shrub swamps at Springvale Mine does not suggest this process is significant with respect to water quality.

5. Impact Assessment

5.1 Significant Impact Guidelines for Coal Seam Gas and Large Coal Mines

Table 5.1 presents an assessment of the Proposal against the Significant Impact Guidelines for Coal Seam Gas and Large Coal Mines (DoE, 2013).

Table 5.1 : Impact Assessment against Significant Impact Guidelines (DoE, 2013)

Impact Guideline	Compliant	Comment
Hydrological Characteristics		
A significant impact on the hydrological characteristics of a water resource may occur where there are, as a result of the action: a) changes in the water quantity, including the timing of variations in water quantity	Yes	As presented in the EIS, mine dewatering leads to depressurisation in the deep groundwater system and is initially replenished from storage, mostly from the bottom of the Mt York Claystone and in the very long term from recharge from the Coxs River. The modelled impact to the Coxs River is, however, imperceptible, as presented in the EIS. Impact to the perched groundwater system, upon which the THPSS reside, is shown by modelling presented in the EIS to depend on assumed RAMP function. The RAMP function, in the model, is the assumed change in hydraulic properties with height above the coal seam. In accordance with the conceptual model there is not direct hydraulic connection between mine depressurisation and the perched groundwater system. As presented in **Section 4.2.2.1**, magnitude of modelled change to groundwater contribution to surface water flow in shrub swamps is relatively small, although the percentage change can be significant. The changes at specific swamps due to the modification are presented in **Table 5.6** below. It is noted that there is currently an investigation underway into a water level trigger that has occurred at Carne West swamp.
b) changes in the integrity of hydrological or hydrogeological connections, including substantial structural damage (e.g. large scale subsidence)	Yes (Partial)	The conceptual model presented in the EIS is the perched groundwater system, upon which the THPSS reside, reflects lateral transmission of infiltration rainfall due to presence of sequences of low permeability aquitard plies identified within the Burralow Formation. As noted above, there is currently an investigation underway into a water level trigger at Carne West swamp.
c) changes in the area or extent of a water resource	N/A	Not applicable in a groundwater context. Refer to Surface Water Assessment accompanying this application for

Impact Guideline	Compliant	Comment
		modification for details of surface water impact.
Water Quality		
A significant impact on a water resource may occur where, as a result of the action: a) there is a risk that the ability to achieve relevant local or regional water quality objectives would be materially compromised, and as a result the action: i. creates risks to human or animal health or to the condition of the natural environment as a result of the change in water quality	Yes	There no expected change to groundwater quality presented in the EIS for the project and the modification will not lead to a change in that prediction. As stated in **Section 3.2.1**, recent groundwater sampling of standpipe piezometers installed into topographic ridgelines indicates water quality of the shallow groundwater system is very fresh. Groundwater quality of the shallow groundwater system is consistent with that obtained from the peat/clay matrix of the shrub swamps and therefore there is no expected change to groundwater quality in the shrub swamps as a result of subsidence-induced effects. It is noted subsidence effects remain unchanged from the predictions provided in the Springvale Mine Extension Project EIS and MSEC (2013) and are not influenced by the proposed increase in extraction rate included in the modification.
ii. substantially reduces the amount of water available for human consumptive uses or for other uses, including environmental uses, which are dependent on water of the appropriate quality	Yes	There is no expected change to groundwater quality within THPSS as a result of the project and the modification will not lead to a change in that prediction.
iii. causes persistent organic chemicals, heavy metals, salt or other potentially harmful substances to accumulate in the environment	Yes	There is no expected change to groundwater quality within THPSS as a result of the project and the modification will not lead to a change in that prediction. For the deep groundwater system, groundwater quality will decrease in a northeasterly direction, reflecting increasing recharge flowpath length. The consequence of the small increase in salinity with mine progression is presented in the Surface Water Assessment accompanying this application for modification to consent.
iv. seriously affects the habitat or lifecycle of a native species dependent on a water resource, or	N/A	Outside of the scope of the Groundwater Assessment
v. causes the establishment of an invasive species (or the spread of an existing invasive species) that is harmful to the ecosystem function of the water resource, or	Yes	N/A
b) there is a significant worsening of local water quality (where current local water quality is superior to local or regional water quality objectives), or	Yes	As indicated above, there is no expected change to groundwater quality within THPSS as a result of the project and the modification will not result in a change to that prediction.
c) high quality water is released into an ecosystem which is adapted to a lower quality of water.	Yes	N/A

5.2 Minimal Harm Criteria Assessment

Table 5.2 presents the Level 1 minimum harm criteria for less productive and highly productive porous rock.

Table 5.2 : Level 1 Minimal Impact Consideration (DPIWater, 2012)

Level 1 Minimal Impact Consideration	Compliant	Assessment
Water table Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic 'post-water sharing plan' variations, 40 metres from any: • high priority groundwater dependent ecosystem or • high priority culturally significant site listed in the schedule of the relevant water sharing plan. **OR** A maximum of a 2 metre water table decline cumulatively at any water supply work.	Yes	There are no high priority GDEs or high priority culturally significant sites listed in the Schedule of the Water Sharing Plans, however, the Newnes Plateau shrub swamps and hanging swamps are listed under the EPBC Act 1999 (Cth) and the shrub swamps are listed as EEC under the TSC Act 1995 (NSW). The most significant predicted change in the EIS was with respect to Gang Gang Swamp South West (referred to as Gang Gang Swamp South East in Adhikary and Wilkins (2013, 2015)). The updated modelling (**Table 4.5**) indicates a minor decrease in predicted impact compared to that presented in the EIS (RPS, 2014a). As noted above, results of updated modelling are consistent with impacts presented in the EIS of the Current Consent. There are no non-mining related water supply works in the vicinity of Springvale Mine.
Water pressure A cumulative pressure head decline of not more than a 2 metre decline, at any water supply work.	Yes	There are no non-mining related water supply works in the vicinity of Springvale Mine.
Water quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity.	Yes	Mine depressurisation leads to capture of inflows to underground workings, with discharge to surface water via Springvale Mine's licensed discharge point, LDP009, located on Sawyers Swamp Creek. As noted in **Section 4.2.2.3**, subsidence effects in the near surface zone may lead to enhanced water-rock interaction, however, this has not been observed at Springvale Mine and therefore this process may not be significant with respect to water quality.

More detailed discussion of the impact of the Modification is presented below.

5.3 Compliance with Rules of the Water Sharing Plan

Rules for granting access licences, managing access licences, water supply works approvals and access licence dealings are provided in the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011 and the Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011.

Table 5.3 presents a summary of the rules of the Water Sharing Plans as applicable to Springvale Mine in regard to Groundwater.

Table 5.4 presents a summary of the results of the Water Sharing Plan as applicable to Surface Water.

Table 5.3 : Project compliance with relevant rules of the Water Sharing Plan (Groundwater)

Rule	Compliant	Comments
Part 8 - Rules for managing access licences		
Part 8 – Division 1 Water allocation account management rules	Yes	Water Access Licences are already held, with sufficient entitlement, to account for predicted groundwater take in any one water year.
Part 8 – Division 2 Daily access rules	N/A	Water supply works are more than 40m from the top of a high bank of a river.
Part 9 - Rules for water supply work approvals		
Part 9 – 39 Distance restrictions to minimise interference between water supply works	Yes	Water supply works are: • more than 400m from another work (other access licence) • more than 100m from another work (basic landholder rights) • more than 50m from the property boundary • more than 1000m from another work (local water or major utility access licence) • more than 200m from a Department monitoring piezometer
Part 9 – 40 Rules for water supply works located near contamination sources	N/A	There are no contamination sources in the vicinity of Springvale Mine.
Part 9 – 41 Rules for water supply works located near sensitive environmental areas	Yes	Water supply works are: • at a distance specified by the Minister that is more than 200m from a high priority GDE (assumed also relevant to EEC and/or THPSS) due to drawdown at the perimeter of the GDE • more than 500m from a high priority karst GDE • more than 40m from any 1st order or higher stream • more than 100m from the top of an escarpment
Part 9 – 42 Rules for water supply works located near groundwater dependent culturally significant sites	N/A	There are no groundwater dependent culturally significant sites within the vicinity of Springvale Mine.
Part 9 – 44 Rules for water supply works located within distance restrictions	N/A	Not applicable since compliant with Part 9 – Clause 39.

Table 5.4 : Project compliance with relevant rules of the Water Sharing Plan (Surface Water)

Rule	Compliant	Comments
Part 9 - Rules for managing access licences		
Part 9 – Division 1 Water allocation account management rules	Yes	Water Access Licences are in the process of being obtained, with sufficient entitlement, to account for predicted groundwater-induced take in any one water year. Refer to Section 6.1 for details.
Part 9 – Division 2 Flow classes and daily access rules	N/A	Surface water take is due to aquifer interference activity and therefore cease to pump threshold can't be applied.
Part 10 - Rules for water supply work approvals	N/A	There are no surface water supply works currently used at Springvale Mine and there are no new works proposed as part of this modification.

5.4 Impacts to Surrounding Land Uses

Table 5.5 presents the expected impact to surrounding land uses.

Table 5.5 : Impacts to Surrounding Land Uses due to the Modification

Land Use	Location Compared to Springvale Mine	Predicted or Expected Change	Expected Impact due to the Modification
Newnes State Forest	Longwalls underlie the Newnes State Forest.	(Predicted changes to EECs are dealt with below) Negligible predicted drawdown on perched and shallow groundwater system outside of PAA. There are no non-mining related groundwater works in the vicinity.	Negligible change in impact due to the modification.
Wollemi National Park	7.5km north of LW419.	Negligible change to groundwater level, flow or groundwater quality of perched or shallow groundwater system outside of PAA.	Negligible change in impact due to the modification.
Garden of Stone National Park	~17km northwest of LW419.	Negligible change in groundwater level, flow or quality outside of PAA.	Negligible change in impact due to the modification.
Birds Rock Flora Reserve	4.5km northwest of LW419, within Newnes State Forest.	Negligible change in groundwater level, groundwater flow or quality outside of PAA.	Negligible change in impact due to the modification.
Sawyers Swamp Creek Ash Dam (SSCAD)	1.5km west of LW401.	Mine portal lies adjacent to SSCAD, however, these are established workings. LW502 and 503 are located 1.6km from SSCAD, however, as presented in **Figure 4.5**, modelled impact of previous workings at Angus Place are such that future mining expected to lead to negligible change to level and flow.	Negligible change in impact due to the modification.

5.5 Impacts to Groundwater Dependent Ecosystems

Table 5.6 presents the expected impact to GDEs.

Table 5.6 : Impacts to Groundwater Dependent Ecosystems due to the Modification

GDE	Predicted or Expected Change to Level	Predicted or Expected Change to Flow	Predicted or Expected Change to Quality	Expected Impact due to Modification
Sunnyside East Swamp (included within CA5 in groundwater model)	Negligible change compared to EIS	Negligible change compared to EIS	Negligible change compared to EIS	Negligible change in impact due to the modification.
Carne West	Negligible change compared to EIS	Negligible change compared to EIS	Negligible change compared to EIS	Negligible change in impact due to the modification.
Gang Gang Swamp South West	Negligible change compared to EIS	Negligible change compared to EIS	Negligible change compared to EIS	Negligible change in impact due to the modification.
Gang Gang Swamp East	Negligible change compared to EIS	Negligible change compared to EIS	Negligible change compared to EIS	Negligible change in impact due to the modification.
Carne Central Swamp (included within CA2 in groundwater model)	Negligible change compared to EIS	Negligible change compared to EIS	Negligible change compared to EIS	Negligible change in impact due to the modification.

GDE	Predicted or Expected Change to Level	Predicted or Expected Change to Flow	Predicted or Expected Change to Quality	Expected Impact due to Modification
Nine Mile Swamp	Negligible change compared to EIS	Negligible change compared to EIS	Negligible change compared to EIS	Negligible change in impact due to the modification.
Pine Swamp and Upper Pine Swamp	Negligible change compared to EIS	Negligible change compared to EIS	Negligible change compared to EIS	Negligible change in impact due to the modification.
Marrangaroo Creek Swamp	Negligible change compared to EIS	Negligible change compared to EIS	Negligible change compared to EIS	Negligible change in impact due to the modification.

5.6 Impact to Groundwater Users

As established in the Surface Water Assessment attached to the EIS (RPS, 2014b), there is a net excess of water at Springvale and at adjacent operation at Angus Place Colliery. Accordingly, modification to consent does not impact demand for water of surrounding mining operations.

Table 5.7 presents the expected impact to groundwater users in the vicinity of the PAA.

Table 5.7 : Impacts to Groundwater Users due to the Modification

WAL No.	Predicted or Expected Change to Level	Predicted or Expected Change to Flow	Predicted or Expected Change to Quality	Expected Impact due to Modification
Sydney Basin Coxs River Groundwater Source				
36443	N/A due to being the mine dewatering work at Springvale Mine.	N/A	N/A	N/A
36446	N/A due to being the mine dewatering work at Springvale Mine.	N/A	N/A	N/A
36445	N/A due to being the mine water dewatering work at adjacent operation at Angus Place.	N/A	N/A	N/A
24356	No change due to modification. No change due to project due to work being installed into basalt basement.	No change due to modification. No change due to project.	No change due to modification. No change due to project.	Negligible change in impact due to the modification.
24364	No change due to modification. No change because of project due to work being shallow and installed adjacent Lambs Creek.	No change due to modification. No change due to project.	No change due to modification. No change due to project.	Negligible change in impact due to the modification.
24363	No change due to modification. No change because of project due to work being shallow and installed alongside perennial watercourse at outlet of gully.	No change due to modification. No change due to project.	No change due to modification. No change due to project.	Negligible change in impact due to the modification.
36840	No change due to modification. No change due to project since relatively shallow work located adjacent Wangcol Creek.	No change due to modification. No change due to project.	No change due to modification. No change due to project.	Negligible change in impact due to the modification.
24362	No change due to modification.	No change due to modification.	No change due to	Negligible change in

WAL No.	Predicted or Expected Change to Level	Predicted or Expected Change to Flow	Predicted or Expected Change to Quality	Expected Impact due to Modification
	No change due to project since relatively shallow work located adjacent Pipers Flat Creek.	No change due to project.	modification. No change due to project.	impact due to the modification.
24359	No change due to modification. No change due to project since relatively shallow work located adjacent Coxs River.	No change due to modification. No change due to project.	No change due to modification. No change due to project.	Negligible change in impact due to the modification.
24360	No change due to modification. No change due to project since relatively shallow work located adjacent Coxs River.	No change due to modification. No change due to project.	No change due to modification. No change due to project.	Negligible change in impact due to the modification.
24365	No change due to modification. No change predicted due to project.	No change due to modification. No change due to project.	No change due to modification. No change due to project.	Negligible change in impact due to the modification.
24366	No change due to modification. No change due to project since relatively shallow work located adjacent Browns Swamp.	No change due to modification. No change due to project.	No change due to modification. No change due to project.	Negligible change in impact due to the modification.
Sydney Basin Richmond Groundwater Source				
36383	N/A due to being the mine dewatering work at Springvale Mine	N/A	N/A	N/A
36449	N/A due to being the mine water dewatering work at adjacent operation at Angus Place.	N/A	N/A	N/A
36479	N/A due to being the mine water dewatering work at neighbouring operation at Clarence.	N/A	N/A	N/A
24440	No change due to modification. No changed due to project due to relatively shallow work (excavation).	No change due to modification. No change due to project.	No change due to modification. No change due to project.	Negligible change in impact due to the modification.

5.7 Impact to Surface Water / Groundwater Interaction

Table 5.8 presents the impact to surface watercourses in the vicinity of Springvale Mine.

Table 5.8 : Impacts to Surface Water / Groundwater Interaction

Watercourse	Predicted or Expected Change to Level	Predicted or Expected Change to Flow	Predicted or Expected Change to Quality	Expected Impact due to the Modification
Wolgan River	Negligible change compared to EIS	Negligible change compared to EIS	Negligible change compared to EIS	Negligible change in impact due to the modification.
Carne Creek	Negligible change compared to EIS	Negligible change compared to EIS	Negligible expected change to quality.	Negligible change in impact due to the modification.
Coxs River	Negligible change compared to EIS	Negligible change compared to EIS	Negligible expected change to quality.	Negligible change in impact due to the modification.

6. Licensing, Management, Mitigation and Monitoring

6.1 Licensing

Licensing is governed by the *Water Management Act* 2000 (NSW) since Water Sharing Plans have commenced in the vicinity of Springvale Mine.

6.1.1 Groundwater

Current groundwater licences (WALs) held by Springvale Coal are presented in **Table 6.1**. The licence holding from the Sydney Basin Coxs River Groundwater Source is 3,885ML/y and the licence holding in the Sydney Basin Richmond Groundwater Source is 5,958ML/y.

Table 6.1 : Water Access Licences (Groundwater[1]) held by Springvale Coal

Current Licence	Works Approval No.	Sydney Basin Coxs River	Sydney Basin Richmond
WAL36443	10WA118754	585ML/y	-
WAL36446	10WA118752	3300ML/y	-
WAL36383	10WA118719	-	5958ML/y

Note 1. Refer to **Table 6.3** for details of zero share component holdings in the Groundwater Source.

Table 6.2 presents the estimated licence requirement with time. It is noted, given the predicted inflow to underground workings is not segregated into relevant water sources in COSFLOW, the requirement presented in **Table 6.2** is an estimate based on proportional spatial area.

Table 6.2 : Water Access Licence (Groundwater) Requirements (ML/y)

Water Year	Groundwater Extraction (ML/y)	Sydney Basin Coxs River Groundwater Source (ML/y)	(%)	Sydney Basin Richmond Groundwater Source (ML/y)	(%)	Comment
2016/2017	5,617	2,679	48%	2,938	52%	LW419, LW420
2017/2018	5,870	2,540	43%	3,330	57%	LW421, LW421
2018/2019	6,248	2,421	39%	3,827	61%	LW423, LW424
2019/2020	6,659	2,383	36%	4,276	64%	LW425, LW426
2020/2021	6,848	2,381	35%	4,467	65%	LW427, LW428
2021/2022	6,943	2,599	37%	4,344	63%	LW429
2022/2023	6,785	2,701	40%	4,084	60%	LW430, LW431
2023/2024	6,785	2,902	43%	3,882	57%	LW432, LW501, LW502, LW503
2024/2025	0			0		n/a
2025/2026	0			0		n/a
2026/2027	0			0		n/a
2027/2028	0			0		n/a
2028/2029	0			0		n/a
	Maximum Take	2,902	Maximum Take	4,467		

From **Table 6.2**, peak water licensing requirement for Springvale Coal occurs in water year 2023/2024 for the Sydney Basin Coxs River Groundwater Source at 2,902ML/y and in water year 2020/2021 for the Sydney Basin Richmond Groundwater Source at 4,467ML/y. Comparing **Table 6.2** with **Table 6.1**, Springvale Coal holds sufficient water access licences to cover project requirements.

6.1.2 Surface Water

Due to indirect change to groundwater contribution to surface watercourses as a result of mine activity, there is also a requirement for water access licences from surface water sources. In accordance with advice received from DPIWater to Springvale Coal (DPIWater, 2015), in limited circumstances, a zero share licence from the relevant groundwater source can be obtained and, upon application, will be considered by DPIWater with respect to licensing of estimated take from overlying intersected surface water source. As it is understood, these zero share water access licence (groundwater) applications were submitted by Springvale Coal to DPIWater on 7 October 2015, and are in the process of being obtained. It is also understood, from DPIWater (2015) that upon granting of those licences, application for a dealing can be lodged to transfer entitlement from the relevant Springvale Coal existing water access licences (groundwater) to the new licences.

As per the approach adopted in the Groundwater Assessment of the EIS (RPS, 2014a), and subsequent correspondence (Jacobs, 2015), swamps and streams included in the model were assigned to relevant water sources (refer to **Figure 6.1**) and time-series licensing requirements calculated.

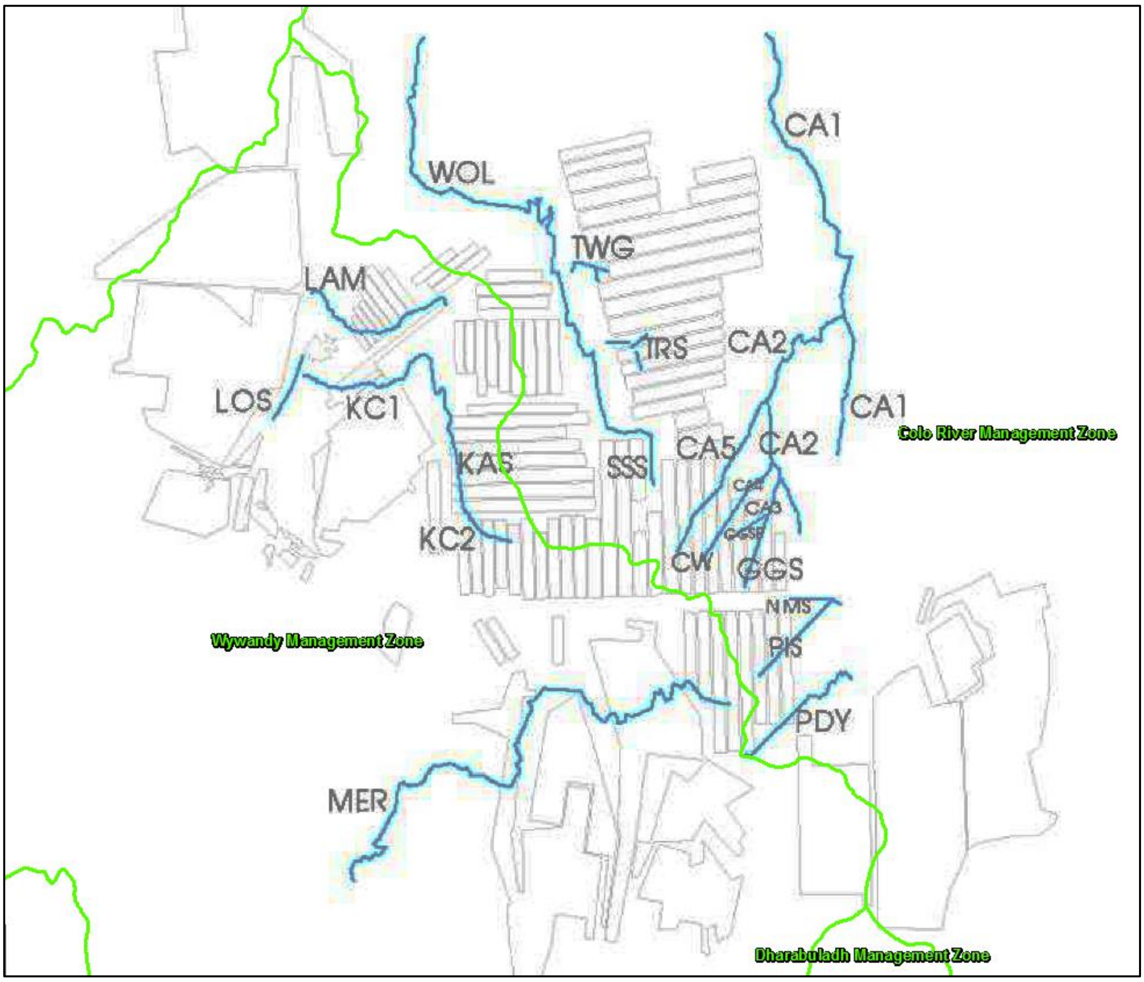


Figure 6.1 : Allocation to Water Source of Swamps and Streams in the COSFLOW Model (after Jacobs, 2015)

Current water licences (surface water take assigned to groundwater source, in accordance with advice received from DPIWater (2015)) held by Springvale Coal are presented in **Table 6.3**.

The licence holding in the Sydney Basin Coxs River Groundwater Source is assigned to the estimated take from the Upper Nepean and Upstream Warrangamba Water Source (Wywandy Management Zone) is expected to be a 0ML/y share, with a subsequent dealing to transfer entitlement from relevant water access licence (groundwater) presented in **Table 6.1**.

Table 6.3 : Water Access Licences (Surface Water[1]) held by Springvale Coal

Current Licence	Works Approval No.	Sydney Basin Coxs River Groundwater Source (assigned to modelled take from Upper Nepean and Upstream Warragamba Water Source (Wywandy Management Zone)	Sydney Basin Richmond Groundwater Source (assigned to modelled take from Hawkesbury and Lower Nepean Rivers Water Source (Colo River Management Zone)
TBA	TBA	0ML/y and then updated	-
TBA	TBA	-	0ML/y and then updated

Note 1. Water Access Licence held in relevant Groundwater Source to be used to accommodate modelled take from intersecting surface water source/s.

Similarly, the licence holding in the Sydney Basin Richmond Groundwater Source is assigned to the estimated take from the Hawkesbury and Lower Nepean Rivers Water Source (Colo River Management Zone) is expected to be 0ML/y, with a subsequent dealing to transfer entitlement from Springvale Coal's current water access licence (groundwater) presented in **Table 6.1**.

Table 6.4 presents the time-series take from the relevant water sources (Wywandy Management Zone of the Upper Nepean and Upstream Warragamba Water Source and the Colo River Management Zone of the Hawkesbury and Lower Nepean Rivers Water Sources).

Table 6.4 : Water Access Licence (Surface Water[1]) Requirements (ML/y)

Water Year	Sydney Basin Coxs River Groundwater Source (assigned to modelled take from Upper Nepean and Upstream Warragamba Water Source)			Sydney Basin Richmond Groundwater Source (assigned to modelled take from Hawkesbury and Lower Nepean Rivers Water Source)		
	Null(ML)	SPRthenAPE (ML)	Difference SPRthenAPE (ML)	Null(ML)[1]	SPRthenAPE (ML)	Difference SPRthenAPE (ML)
Pre 2016	n/a	n/a	0	n/a	n/a	**-3**
2016	334	328	-6	2395	2398	3
2017	333	325	-8	2396	2442	46
2018	331	321	-10	2396	2461	64
2019	330	318	-12	2397	2486	90
2020	335	320	-15	2443	2531	89
2021	328	310	-17	2395	2469	74
2022	327	314	-12	2395	2455	60
2023	326	305	-21	281	376	95
2024	325	319	-5	280	360	80
2025	324	315	-9	279	348	69

Water Year	Sydney Basin Coxs River Groundwater Source (assigned to modelled take from Upper Nepean and Upstream Warragamba Water Source)			Sydney Basin Richmond Groundwater Source (assigned to modelled take from Hawkesbury and Lower Nepean Rivers Water Source)		
	Null(ML)	SPRthenAPE (ML)	Difference SPRthenAPE (ML)	Null(ML)[1]	SPRthenAPE (ML)	Difference SPRthenAPE (ML)
2026	329	315	-14	283	349	66
2027	322	304	-18	277	335	58
2028	322	300	-22	277	329	52
2029	322	296	-26	279	322	43
2030	322	293	-29	279	317	37
2031	322	291	-31	279	313	33
2032	328	294	-34	285	315	30
2033	353	314	-39	307	335	28
2034	323	284	-39	280	301	21
2035	323	282	-41	281	299	19
2036	324	281	-43	281	298	17
2037	324	280	-44	281	297	15
2038	324	278	-46	282	295	14
2039	325	277	-48	282	294	12
2040	325	276	-49	282	293	11
2041	325	275	-50	282	292	10
2042	326	274	-51	282	292	10
2043	326	273	-53	282	291	9
2044	326	272	-54	283	291	9
2045	327	272	-55	283	291	8
2046	327	271	-56	283	291	8
2047	327	270	-57	283	291	7
2048	328	270	-58	283	290	7
2049	328	269	-59	283	290	7
2050	328	269	-60	283	291	7
2051	329	268	-61	284	291	7
2052	329	268	-61	284	291	7
2053	329	267	-62	284	291	7
2054	330	267	-63	284	291	7
2055	330	266	-63	284	291	7
2056	330	266	-64	284	291	7
2057	330	266	-65	285	292	7
2058	331	266	-65	285	292	7

Water Year	Sydney Basin Coxs River Groundwater Source (assigned to modelled take from Upper Nepean and Upstream Warragamba Water Source)			Sydney Basin Richmond Groundwater Source (assigned to modelled take from Hawkesbury and Lower Nepean Rivers Water Source)		
	Null(ML)	SPRthenAPE (ML)	Difference SPRthenAPE (ML)	Null(ML)[1]	SPRthenAPE (ML)	Difference SPRthenAPE (ML)
2059	331	265	-66	285	292	7
2060	331	265	-66	285	292	7
Post 2060	n/a	n/a	**<-79**	n/a	n/a	<7
	Maximum Take		79ML/y in 2105	Maximum Take		3ML/y in 2012

1. For *SPRthenAPE*, from 2012 to 2022, Carne Creek reaches CA1 and CA2 were included in the licensable take from Springvale, since the Angus Place extension had not commenced at that stage.

From **Table 6.4**, based on current groundwater modelling, Springvale Coal will be required to obtain additional licences in the Wywandy Management Zone (potentially addressed by a zero share component licence in the Sydney Basin Coxs River Groundwater Source and subsequent dealing with respect to transfer of entitlement from existing water access licence (groundwater)). Based on current groundwater modelling, there is no predicted net take from the Colo River Management Zone.

6.2 Management

Water management at Springvale Mine is governed by the Water Management Plan, as specified in Schedule 4, Condition 14, of the current Conditions of Consent (SSD 5594).

In addition, there is a Water Management Plan component, including Biodiversity Management Plan and Swamp Monitoring Program with respect to each Extraction Plan, as specified in Schedule 3, Condition 10 of the current Conditions of Consent.

The Water Management Plan (both Whole of Operation and the Extraction Plan for LW419) presents the monitoring network, establishes trigger levels on expected impacts as well as presents the Trigger Action Response Plan.

The program for offset of greater than predicted impact to shrub swamps is presented in the Conditions of Consent, Schedule 3, Condition 4 with respect to Sunnyside East and Carne West and Schedule 3, Condition 5, with respect to Gang Gang South West, Gang Gang East, Pine, Pine Upper, Paddys, Marrangaroo Creek or Marrangaroo Creek Upper Swamp. It is highlighted; however, as specified in Schedule 3, Condition 2, the program of offset of greater than predicted impact does not apply with respect to Sunnyside and Nine Mile shrub swamps. The program of offset also does not apply to any hanging swamps.

There are no presented changes to groundwater management already in place at Springvale Mine and/or prescribed in the current Conditions of Consent (SSD 5594), as presented in Water Management Plan, in association with the proposed Modification to Consent.

6.3 Monitoring

The monitoring network at Springvale Mine comprises:

- swamp / perched groundwater levels and quality (standpipe piezometers)
- swamp surface water flows and quality (grab sample monitoring locations within swamps)
- surface water flows and quality (rivers and creeks) (hydraulic structure-based monitoring locations)
- shallow / ridge groundwater levels and quality (standpipe piezometers installed on topographic ridgelines)
- shallow and deep groundwater levels (multi-level vibrating wire piezometers)

- dewatering wells or collector system quality (grab samples at dewatering points)
- underground inflows (calculated via metering of underground transfers and metering of discharge at Licensed Discharge Points).

Further detail of the monitoring network at Springvale Mine is presented in RPS (2014a) and the current Water Management Plan.

Compared to the currently approved project, due to the expected negligible change to flow, level and quality, there are no presented changes to groundwater monitoring at Springvale Mine associated with the Modification.

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Appendix A. CSIRO Groundwater Modelling Report

Appendix G
Alternative Mine Schedule

Angus Place and Springvale Colliery Operations
Groundwater Assessment

D P Adhikary and A Wilkins
Report No EP15346
January 2015

Angus Place Colliery and Springvale Colliery

Citation

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Copyright and disclaimer

Important disclaimer

Executive Summary

An alternative mining schedule (i.e. “SPR then APE”) provided to CSIRO by Centennial Coal in December 2014 is studied using the numerical model. In contrast to the original schedule (as described in the main report), where the Springvale and Angus Place panels were mined simultaneously, in this alternative schedule the Springvale panels LW417 to LW422, and LW424 to LW432 will be mined during the period 2015 to 2023, and then the Angus Place Extension panels 1 to 16 and 910, will be mined between 2023 and 2036. Analysis of the modelling results shows that this alternate schedule has slightly less impact on the groundwater system than the original schedule.

The differences between the “SPR then APE” and the “Base case – original schedule” are discussed here. By almost all measures, the “SPR then APE” has less impact than the Base case, and this is primarily because in the “SPR then APE” case the new SV panels and the APE panels are mined sequentially and the Springvale mine is allowed to flood after completion of LW432 in October 2023. This means that in comparison to the Base case, approximately 10 years less of groundwater pumping occurs in Springvale.

A summary of the results of the numerical simulations with alternative mining schedule are as follows:

Drawdown of water levels

- The drawdown of saturated heads at the ground surface for the alternative mining schedule is very similar (or slightly smaller) compared to the Base case scenario. Over the entire top surface, the mean of the absolute magnitude of the porepressure differences between these two scenarios is around 0.016m.
- As for the Base case model, the drawdown of saturated water heads at the ground surface over the proposed extensions is very similar to that already experienced above the currently-mined longwall panels. The maximum saturated drawdown experienced is of the order of centimetres.
- A maximum drawdown of 160m is predicted around the SV longwalls in year 2020, and 120m around the APE longwalls in year 2036.
- The magnitude of depressurization gradually decreases away from the SPR_LW423 region; 5m drawdown contour can be seen to extend about 5km from SV (just outside the eastern boundary of the Clarence Colliery). As the Springvale pump is tuned off in 2023, water heads in the SV mined voids start to increase gradually.
- During recovery after mining completes, the time taken for pressure heads at the ground surface to reach virtual steady-state is less than 50 years.

Impact on swamps/streams

- Similar to the Base case model the discharge/recharge to/from most of the streams and swamps modelled in this study does change when undermined.
- The SPR then APE schedule has an identical or slightly less impact on the baseflows and leakages to and from streams and swamps compared with the Base case model.
- As in the Base case model, the YS6 layer is found to be the most important aquitard. The swamps and streams lying above the YS6 layer are much less impacted by mining than the swamps and creeks that are unsupported by the YS6 layer underneath.
- The simulation results are presented in Tables GS1 and GS2 below. Undermining of streams/swamps causes an average water head change of a few centimetres; a projected maximum water head drop of 0.35m is predicted for the Gang Gang South East Swamp.

Table GS1 Maximum predicted loss in baseflow to the simulated swamps and streams with respect to baseflow at 2012

Swamps and streams simulated in this study	Maximum reduction in baseflow		Comments
	(ML/day)	%	
CA2 (includes Carne Central Swamp)	0.176	15	
Carne West Swamp	Increase in baseflow		Very small initial volume
Carne Creek Total	0.268	4.5	Small change
Gang Gang South East	0.17	288	Leaky swamp (increase in leakage)
Gang Gang Swamp South	0.01	20	Leaky swamp (increase in leakage); very small volume
Kangaroo Swamp	0.004	24	very small
Kangaroo Creek (KC1)	0.145	Division by a small number	very small initial volume
Kangaroo Creek (KC2)	0.03	32	very small initial volume
Lamb Creek	0.047	36	very small initial volume
Long Swamp	0.000	0.000	No change
Marrangaroo Creek	0.078	11	
Nine Mile Swamp	Increase in baseflow		Very small initial volume
Paddy's Creek	0.001	0.5	Very small change
Pine Swamp	0.000	0.0	No change
Tri-Star Swamp	0.04	86	very small initial volume
Twin Gully Swamp	0.029	40	very small initial volume
Sunnyside Swamp	0.003	3.5	Small change
Wolgan River Total	0.33	25.5	

Table GS2 Predicted maximum drop in the average standing groundwater levels in the simulated swamps with respect to the groundwater levels in December 2012

Swamps and streams simulated in this study	Base Model (m)	'SPR then APE' model (m)
CA2 (includes Carne Central Swamp)	0.103	0.068
Carne West Swamp	Small head increase	0.000
Gang Gang Swamp South East	0.364	0.349
Gang Gang Swamp South	0.030	0.016
Kangaroo Swamp	0.095	0.093
Long Swamp	0.017	0.000
Nine Mile Swamp	Small head increase	Small head increase
Pine Swamp	0.000	0.000
Tri-Star Swamp	0.081	0.075
Twin Gully Swamp	0.051	0.050
Sunnyside Swamp	0.013	0.006

Impact on private bores

- The effect of mining on private bores within 10km of AP and SV is tabulated. In 2036, the median effect of these mines on private bores of depth less than 50m was 1.1cm; however, some deeper bores suffer substantial drawdown. The median of the differences in drawdowns between the "SPR then APE" scenario and the Base case is 2%, or around 1mm.

Impact on Cox's River

The drawdowns due to mining "SPR then APE" are very small and very similar to those in the Base case; net drawdowns at Cox's River are in the order of millimetres.

Mine water inflow

The average mine water inflow is predicted to remain under 300 l/s during the extraction of SV panels, fall to around 200 l/s during 2024 to 2026, then gradually increase and peak at around 400 l/s in 2029, and then gradually fall afterwards.

Water Balance

The water balance within the groundwater system seems to remain fairly consistent throughout the validation and predictive periods except for the mine inflows which increase from about 29 ML/day (2006 to 2012) to 29 ML/day (2015 to 2018), 32 ML/day (2019-2024), 34 ML/day (2024-2032) and 35.4 ML/day (2033-2036). The groundwater recharge fluctuates around 132 to 133 ML/day and evapotranspiration fluctuates around low to mid 95 ML/day. The discharge to swamps/stream remains virtually steady at around 15 ML/day and leakage from streams/swamps averages around 6 ML/day.

Recovery

- Similar to the Base case, the proposed 'SPR then APE" mining causes the aquifer containing the Lithgow seam to become unsaturated above the longwall panels. This unsaturated region fills with water by around 50 years after mine completion.
- The Mt York claystone is the main aquitard in the region. Based on current geological information, this layer is continuous and thick over the entire region. Mining causes a 15-70m thick unsaturated region to develop in the aquifer below the Mt York claystone layer. This aquifer partially fills after mine completion and, in all scenarios, reaches virtual steady-state after 350 years. As in the Base case, the water content of this aquifer is then approximately 96% of its pre-mining water content.
- The aquifers above the Mt York claystone also slightly desaturated. These aquifers suffer a loss of approximately 3% of their water content above the longwall mines, and this loss remains during recovery.

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Acknowledgments

This work was conducted at the request of Mr Peter Corbett (Regional Technical Services Manager, Centennial Coal West) and is jointly funded by Angus Place and Springvale Collieries.

1 Background

In December 2014 Centennial Coal requested that CSIRO build a numerical model containing an alternative mining schedule. This alternative schedule contains updated information regarding the Springvale panels 415 to 417, and the Angus Place panels 980 and 900_west, which have been mined since the original analysis. More importantly, in contrast to the original schedule, where the Springvale and Angus Place panels were mined simultaneously, in this schedule the Springvale panels LW417 to LW422, and LW424 to LW432 mined during the period 2015 to 2023, and then the Angus Place Extension panels 1 to 16, and 910, are mined between 2023 and 2036.

In this report the model with this alternative mining schedule will be called "**SPR then APE**".

1.1 Revised mine schedule

Table G1 lists all the mining panels and areas used in the model. It refers to mining regions by labels which are defined in Figure G1 and Figure G2.

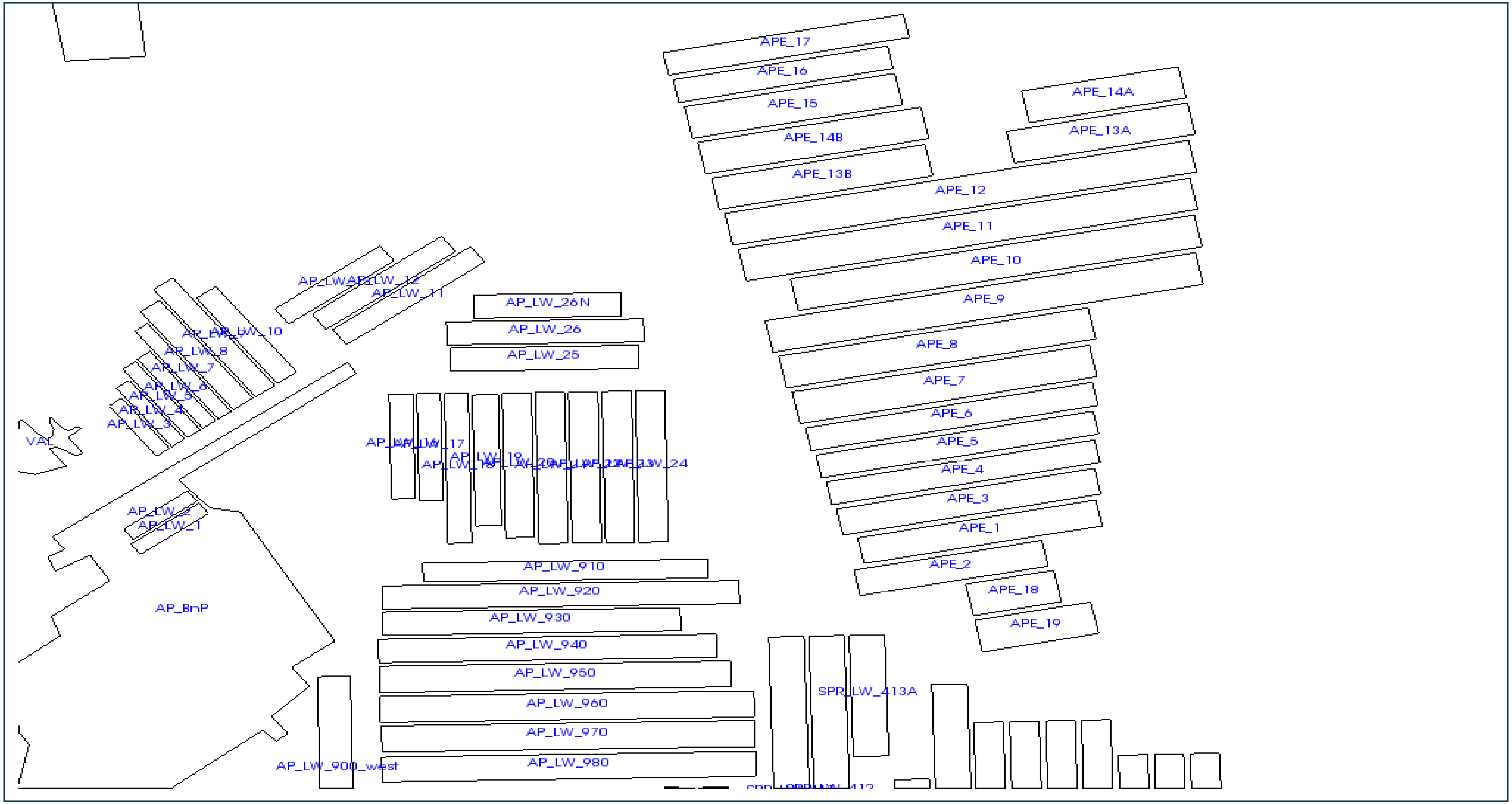

Figure G1 View of the mining regions of Angus Place mine, with labels

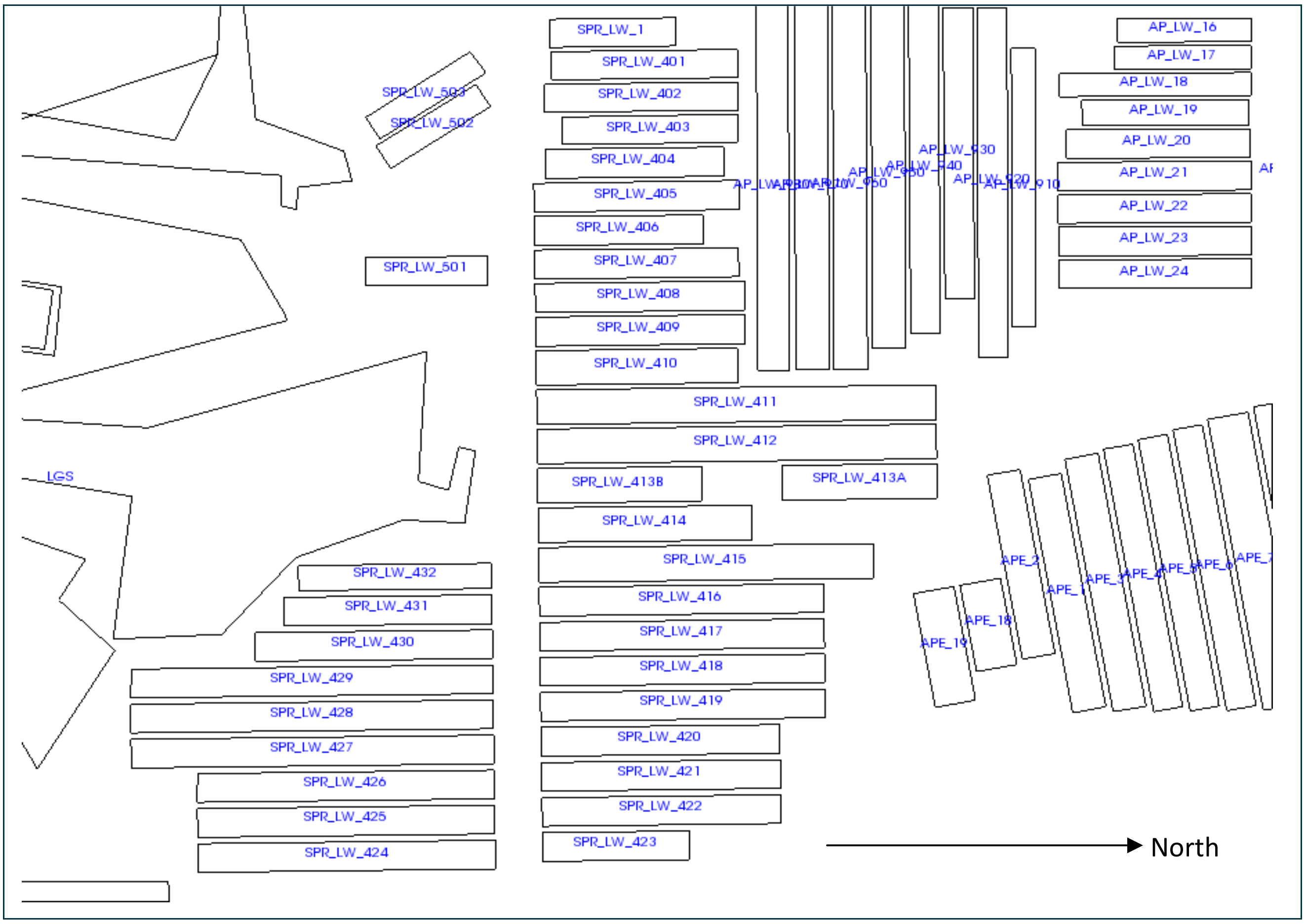

Figure G2 View of the mining regions of Springvale mine, with each region labelled. Note that the orientation is such that north is rotated

Transient calibration commences from 1950, transient validation commences from 20 December 2006 and transient prediction commences from 1 January 2012. The stress period used in the current study varies as described below. The columns in Table G1 are:

- The Name column lists the name of the panel or area to be mined.
- The Start Date and End Date columns list the relevant dates. These are approximately what are used in the model, subject to the following conditions:
    - If the start date is before 1950, the entire region is excavated in the year 1950
    - If the start date is between 1950 and 1980, the entire region is excavated at the average of the start and end, rounded to the nearest 10 years.
    - If the start date is between 1980 and 2000, the entire region is excavated at the average of the start and end, rounded to the nearest 5 years. (The first six years'-worth of Clarence_BP_2_3 is excavated in 1995.)
    - If the start date is between 2000 and 2006, the entire region is excavated at the start date.
    - If the start date is between 2006 and 2012, the region is excavated in chunks appropriate to the 3-monthly stress periods used in the transient validation part of the model. The number of chunks is indicated by the Step column of the table. (The central 6 years of Clarence_BP_2_3 are excavated in 3-monthly chunks. Only the first 6 years of Clarence_BP_4_5 are excavated in this fashion.)
    - If the start date is after 2012, the region is excavated in one step at the start date. (The last 3 years of Clarence_BP_2_3 and the last 15 years of Clarence_BP_4_5 are excavated in yearly sections.)

- The Type column indicates eithera Longwall (LW), Bord and Pillar (BP) or Opencut mine. This is important because the permeability changes induced by these mines differ.
- The Pressure column indicates the porepressure on the walls of the excavated region.
- The Direction column indicates the mining direction. This is only relevant for subdividing the region into a number of subregions corresponding to 3-monthlyi.e. for regions excavated during the 2006-2012 period (or yearly periods for Clarence_BP_2_3 and Clarence_BP_4_5).
- The Step column indicates the number of steps used to excavate the region. This is only relevant for regions excavated during the transient validation i.e. during the 2006-2012 period.

The table below shows the mining sequence for the Springvale and Angus Place longwall panels for the "SPR then APE" model. Only the information for panels where there are changes to the original schedule is shown.

Table G1 Mining sequence in the "SPR then APE" alternative model. Mining sequence and other information (see text for explanation) for the mines in the model

Name	Start_Date	End_Date	Type	Pressure (Pa)	Direction	Seam	Step
AP_LW_980	27/11/2012	11/03/2014	LW	0	EtoW	LTH	6
AP_LW_900_west	30/04/2014	24/1/2015	LW	0	StoN	LTH	4
APE_1	12/4/2024	26/9/2024	LW	0	EtoW	LTH	3
APE_2	24/10/2023	18/3/2024	LW	0	EtoW	LTH	3
APE_3	17/10/2024	31/3/2025	LW	0	EtoW	LTH	4
APE_4	21/4/2025	20/10/2025	LW	0	EtoW	LTH	3
APE_5	10/11/2025	31/5/2026	LW	0	EtoW	LTH	3
APE_6	21/6/2026	11/1/2027	LW	0	EtoW	LTH	3
APE_7	1/2/2027	18/10/2027	LW	0	EtoW	LTH	4
APE_8	8/11/2027	15/8/2028	LW	0	EtoW	LTH	4
APE_9	5/9/2028	23/6/2029	LW	0	EtoW	LTH	6
APE_10	14/7/2029	26/3/2030	LW	0	EtoW	LTH	5
APE_11	16/4/2030	23/3/2031	LW	0	EtoW	LTH	6
APE_12	13/4/2031	18/4/2032	LW	0	EtoW	LTH	6
APE_13A	9/5/2032	2/9/2032	LW	0	EtoW	LTH	3
APE_13B	23/9/2032	21/4/2033	LW	0	EtoW	LTH	3
APE_14A	12/5/2033	5/9/2033	LW	0	EtoW	LTH	3
APE_14B	26/9/2033	1/5/2034	LW	0	EtoW	LTH	3
APE_15	22/5/2034	22/11/2034	LW	0	EtoW	LTH	3
APE_16	13/12/2034	10/6/2035	LW	0	EtoW	LTH	2
APE_17	Unmined	Unmined	LW	0	EtoW	LTH	3
APE_18	Unmined	Unmined	LW	0	EtoW	LTH	2
APE_19	Unmined	Unmined	LW	0	EtoW	LTH	2
AP_LW_910	1/7/2035	10/1/2036	LW	0	EtoW	LTH	2
SPR_LW_415	15/03/2012	16/9/2013	LW	0	NtoS	LTH	6
SPR_LW_416	23/9/2013	19/8/2014	LW	0	NtoS	LTH	4
SPR_LW_417	11/10/2014	30/6/2015	LW	0	NtoS	LTH	3
SPR_LW_418	19/7/2015	20/3/2016	LW	0	NtoS	LTH	3
SPR_LW_419	20/3/2016	25/10/2016	LW	0	NtoS	LTH	2
SPR_LW_420	25/10/2016	15/5/2017	LW	0	NtoS	LTH	2

SPR_LW_421	15/5/2017	29/11/2017	LW	0	NtoS	LTH	2
SPR_LW_422	29/11/2017	3/7/2018	LW	0	NtoS	LTH	2
SPR_LW_423	Unmined	Unmined	LW	0	NtoS	LTH	1
SPR_LW_424	3/7/2018	6/2/2019	LW	0	StoN	LTH	3
SPR_LW_425	13/2/2019	16/9/2019	LW	0	StoN	LTH	3
SPR_LW_426	16/9/2019	6/5/2020	LW	0	StoN	LTH	3
SPR_LW_427	6/5/2020	27/1/2021	LW	0	StoN	LTH	3
SPR_LW_428	27/1/2021	12/10/2021	LW	0	StoN	LTH	3
SPR_LW_429	12/10/2021	5/7/2022	LW	0	StoN	LTH	3
SPR_LW_430	5/7/2022	5/1/2023	LW	0	StoN	LTH	3
SPR_LW_431	5/1/2023	19/6/2023	LW	0	StoN	LTH	2
SPR_LW_432	19/6/2023	24/10/2023	LW	0	StoN	LTH	2
SPR_LW_501	Unmined	Unmined	LW	0	StoN	LTH	2
SPR_LW_502	Unmined	Unmined	LW	0	StoN	LTH	2
SPR_LW_503	Unmined	Unmined	LW	0	StoN	LTH	2

2 Prediction and Groundwater Impact Assessment

2.1 Scenarios simulated

Sections 3.6.4 in the main report describes the depressurisation of the strata due to climatic variation and past and present mining activities in the region until 2012. The proposed Angus Place Extension (APE) and SV longwall panels will result in further depressurisation of the strata in the region. The magnitude of depressurisation will vary from place to place depending upon the relative position and distance from the mining voids, the extent of mining induced strata fracturing, and the relative position of the aquitard layers. The extraction of APE and SV panels may induce:

- loss of pressures in the strata
- potential change in baseflow to swamps and streams, and
- potential loss on pressures on private bores

Table G2 Scenarios simulated in predictive and recovery modes

Scenarios	Description
SPR then APE	This case continues from the calibration-validation model. The model was run using the actual rainfall data to October 2012 and then run with a constant rainfall recharge rate of 0.15mm/day. Panels 980 and 900West are mined and complete on 24/1/2015. Pumping of Angus Place proceeds until 10/1/2036. The Springvale mine is completed: SPR_LW_415 is mined, and so on through to SPR_LW_432, which completes on 24/10/2023. At that date, the Springvale pumps are turned off and the Springvale panels are allowed to flood with water. The Angus Place extension panels are then mined, commencing with APE_2 on 24/10/2023 and concluding with AP_LW_910 on 10/1/2036. Pumping of Angus Place and the Angus Place Extension is then turned off, and the mine voids allowed to flood with water.. The Clarence mine is also completed. The detailed mining schedule is given in Table G1. Results are extracted at years 2083, 2183 and 2383.

2.2 Predictive simulation

2.2.1 Water balance during the predictive period

The average rates of recharge and discharge throughout the predictive period from 2015 to 2018 are given in

Table G3. The average recharge to the groundwater system is 132 ML/day, comprising mainly rainfall recharge (126 ML/day) and leakage from swamps and streams into the groundwater system (6 ML/day).

The average groundwater discharge across the model is 157 ML/day. ET represents the major source of discharge (97 ML/day). Baseflow to swamps and streams is 15 ML/day.

A net loss of groundwater across the model boundary is 16 ML/day. The loss in fluid storage in the groundwater system is 24 ML/day. Mine inflow during the predictive period is 29 ML/day, which accounts for about 120% of the net loss in the fluid storage.

Table G3 Average rates of recharge and discharge 2012 to 2014

Component	Groundwater Inflow (Recharge) (ML/day)	Groundwater Outflow (Discharge) (ML/day)
Rainfall recharge	125.2	
Evapotranspiration		97.2
Swamps and rivers	5.5	14.6
Net outflow through model boundary (ML/day)	15.7 .	
Mine inflow (ML/day)		34.7
Total (ML/day)	130.7	162.2
Net Outflow (ML/day)	31.4	
Change in fluid volume contained (storage) in the model (ML/day)	-31.4	
Discrepancy	1.2x10-2 %	

Table G4 Average rates of recharge and discharge 2015 to 2018

Component	Groundwater Inflow (Recharge) (ML/day)	Groundwater Outflow (Discharge) (ML/day)
Rainfall recharge	126.5	
Evapotranspiration		97.1
Swamps and rivers	5.8	14.7
Net outflow through model boundary (ML/day)	15.5 .	
Mine inflow (ML/day)		29.3
Total (ML/day)	132.3	156.7
Net Outflow (ML/day)	24.4	
Change in fluid volume contained (storage) in the model (ML/day)	-24.4	
Discrepancy	1.0x10-3 %	

The average rates of recharge and discharge throughout the predictive period from 2019 to 2024 are given in

Table G5.

Table G5 Average rates of recharge and discharge 2019 to 2024

Component	Groundwater Inflow (Recharge) (ML/day)	Groundwater Outflow (Discharge) (ML/day)
Rainfall recharge	126.5	
Evapotranspiration		95.7
Swamps and rivers	6.25	14.9
Net outflow through model boundary (ML/day)	15.5	
Mine inflow (ML/day)		31.5
Total (ML/day)	132.7	157.7
Net Outflow (ML/day)	24.9	
Change in fluid volume contained (storage) in the model (ML/day)	-24.9	
Discrepancy	9.6x10-4 %	

The average recharge to the groundwater system is 133 ML/day, comprising mainly rainfall recharge (126 ML/day) and leakage from swamps and streams into the groundwater system (6ML/day).

The average groundwater discharge across the model is 158 ML/day. ET represents the major source of discharge (96 ML/day). Baseflow to the swamps and streams is 15 ML/day.

A net loss of groundwater across the model boundary is 16 ML/day. The loss in fluid storage in the groundwater system is 25 ML/day. Mine inflow during the predictive period is 32 ML/day, which accounts for about 127% of the net loss in the fluid storage.

Table G6 Average rates of recharge and discharge 2025 to 2032

Component	Groundwater Inflow (Recharge) (ML/day)	Groundwater Outflow (Discharge) (ML/day)
Rainfall recharge	126.5	
Evapotranspiration		94.1
Swamps and rivers	6.6	14.9
Net outflow through model boundary (ML/day)	15.4 .	
Mine inflow (ML/day)		34.0
Total (ML/day)	133.1	158.4
Net Outflow (ML/day)	25.3	
Change in fluid volume contained (storage) in the model (ML/day)	-25.3	
Discrepancy	1.1x10-3 %	

The average rates of recharge and discharge throughout the predictive period from 2025 to 2032 are given in Table G6. The average recharge to the groundwater system is 133 ML/day, comprising mainly rainfall recharge (126 ML/day) and leakage from swamps and streams into the groundwater system (7 ML/day). The average groundwater discharge across the model is 158 ML/day. ET represents the major source of discharge (94 ML/day). Baseflow to swamps and streams is 15 ML/day.

A net loss of groundwater across the model boundary is 15 ML/day. The loss in fluid storage in the groundwater system is 25 ML/day. Mine inflow during the predictive period is 34 ML/day, which accounts for about 134% of the net loss in the fluid storage.

Table G7 Average rates of recharge and discharge 2033 to 2036

Component	Groundwater Inflow (Recharge) (ML/day)	Groundwater Outflow (Discharge) (ML/day)
Rainfall recharge	126.5	
Evapotranspiration		93.4
Swamps and rivers	6.7	14.7
Net outflow through model boundary (ML/day)	15.4 .	
Mine inflow (ML/day)		35.4
Total (ML/day)	133.2	159.0
Net Outflow (ML/day)	25.8	
Change in fluid volume contained (storage) in the model (ML/day)	-25.8	
Discrepancy	9.0x10-4 %	

The average rates of recharge and discharge throughout the predictive period from 2033 to 2036 are given in Table G7. The average recharge to the groundwater system is 133 ML/day, comprising mainly rainfall recharge (126 ML/day) and leakage from swamps and streams into the groundwater system (7 ML/day). The average groundwater discharge across the model is 159 ML/day. ET represents the major source of discharge (93 ML/day). Baseflow to swamps and streams is 15 ML/day.

A net loss of groundwater across the model boundary is 15 ML/day. The loss in fluid storage in the groundwater system is 26 ML/day. Mine inflow during the predictive period is 35 ML/day, which accounts for about 135% of the net loss in the fluid storage.

Table G8 Comparison between the simulated rates of recharge and discharge during predictive period

Component	2015 to 2018		2019 to 2024		2025 to 2032		2033 to 2036	
	Groundwater Inflow (Recharge) (ML/day)	Groundwater Outflow (Discharge) (ML/day)	Groundwater Inflow (Recharge) (ML/day)	Groundwater Outflow (Discharge) (ML/day)	Groundwater Inflow (Recharge) (ML/day)	Groundwater Outflow (Discharge) (ML/day)	Groundwater Inflow (Recharge) (ML/day)	Groundwater Outflow (Discharge) (ML/day)
Rainfall recharge	126.5		126.5		126.5		126.5	
Evapotranspiration		97.1		95.7		94.1		93.4
Swamps and rivers	5.8	14.7	6.25	14.9	6.6	14.9	6.7	14.7
Net outflow through model boundary (ML/day)	15.5		15.5		15.4		15.4	
Mine inflow (ML/day)		29.3		31.5		34.0		35.4
Total (ML/day)	132.3	156.7	132.7	157.7	133.1	158.4	133.2	159.0
Net Outflow (ML/day)	24.4		24.9		25.3		35.4	
Change in fluid volume contained (storage) in the model (ML/day)	-24.4		-24.9		-25.3		-25.8	
Discrepancy	1.0x10-3 %		9.7x10-4 %		1.0x10-3 %		9.0x10-4%	

Table G8 presents a comparison between the simulated water balances at different times during the predictive period. The water balance within the groundwater system seems to remain fairly consistent throughout the validation (see Table 24 in the main report) and predictive periods except for the mine inflows which increase from about 29 ML/day (2006 to 2012) to 29 ML/day (2015 to 2018), 32 ML/day (2019-2024), 34 ML/day (2024-2032) and 35.4 ML/day (2033-2036). The groundwater recharge fluctuates around 132 to 133 ML/day and evapotranspiration fluctuates around low to mid 95 ML/day. The discharge to swamps/stream remains virtually steady at around 15 ML/day and leakage from streams/swamps averages around 6 ML/day.

2.2.2 Mine water inflow prediction

Figure G3 shows the predicted mine water inflows for the "SPR then APE" model in comparison with the Base model. Evidently the mine water inflows are substantially less than the base case. The SV panels are extracted in "SPR then APE" model from April 2015 resulting in marked reduction in predicted mine water inflow compared to the Base model. As the extraction of SV panels completes in October 2023, the Springvale pumps will be turned off and the Springvale panels will be allowed to flood with water, whereas the pumping was continued at Springvale in the Base model during the extraction of APE panels. In Figure G3 one can clearly see the effect of turning off the Springvale pumps in reducing the predicted mine water inflows significantly. The average mine water inflow is predicted to remain under 300 l/s during the extraction of SV panels, fall to around 200 l/s during 2024 to 2026, then gradually increase and peak at around 400 l/s in 2029, and then gradually fall afterwards.

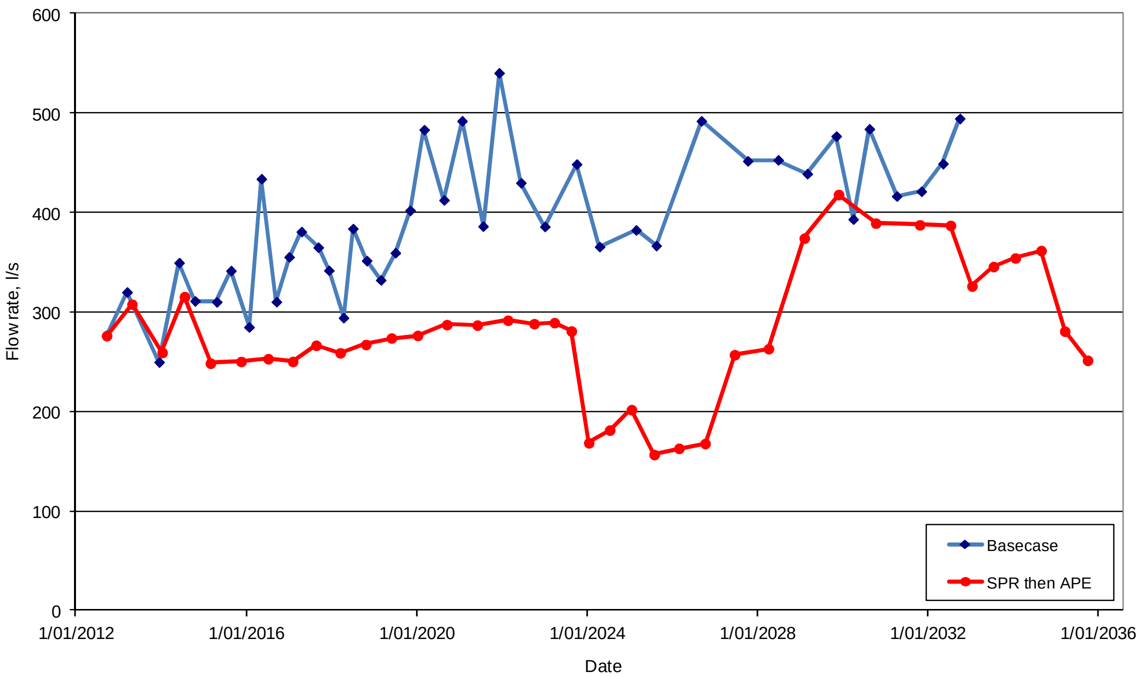

Figure G3 Mine water inflows for the "SPR then APE" model, as compared with the Base model

Figure G4 shows the predicted mine water inflows for the Springvale mine in the "SPR then APE" and Base models. The water inflows are largely unaffected by the mining-schedule changes. Figure G5 shows the mine water inflows into the Angus Place East (APE) panels. Mining of these panels commences much later in the "SPR then APE" model than in the previous mining schedule, but the overall pattern is similar: a low flow rate of around 100 l/s is predicted in the early years, which rises to around 250 l/s to 300 l/s during the later panels.

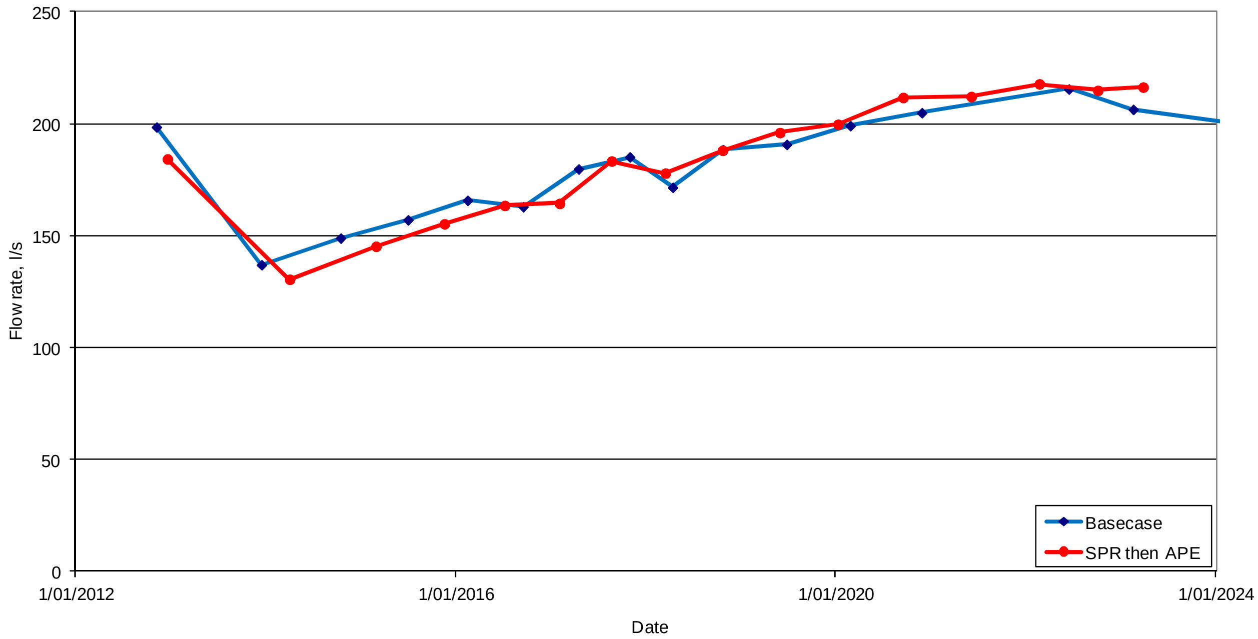

Figure G4 Mine water inflows (l/s) into the Springvale mine. Comparison of the "SPR then APE" mining schedule with the Base case scenario

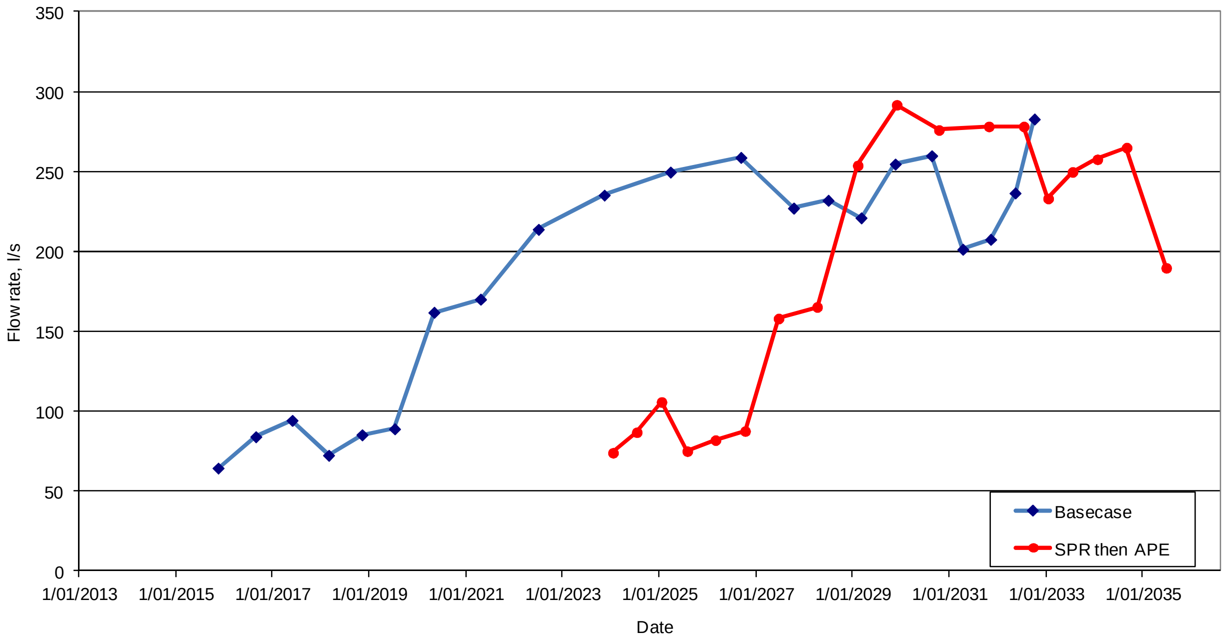

Figure G5 Mine water inflows (l/s) into the Angus Place East panels. Comparison of the "SPR then APE" mining schedule with the Base case scenario

2.2.3 Predicted changes in baseflow to swamps and streams

For the "SPR then APE" model, Appendix H provides simulated groundwater discharge plots for the twenty-one swamps and streams modelled explicitly in this study (Figures H2 to H22 in Appendix H). The swamps and streams simulated are represented by a number of finite element nodes in the model. Naturally, the number of nodes used to represent one swamp/stream will vary from the number of nodes used to represent another swamp/stream depending on the size of the swamps/streams.

It is worthwhile to note that the simulated baseflow will be sensitive to assumed ramp function representing the mining induced permeability changes at shallow depths. As described in Section 2.13.4 of the main report, in addition to the Base model further two scenarios (i.e. truncated-ramp1 and truncated-ramp2) representing the possible variations in magnitude and extent of cracking at shallow depths were simulated. The actual mining impact on baseflow is expected to lie within the bounds predicted by these three models. In the "SPR then APE" model the same ramp function as used in the earlier Base model is used.

Figure G6 and Figure G7 show the baseflow balance to Carne Creek and Wolgan River. The simulated discharge from both the Base model and the "SPR then APE" model to Carne Creek is about 6.4 ML/day at the pre-mining condition, which then drops to 5.8 ML/day in 2032. After the completion of mining the baseflow discharge to the river increases again; in 2232 the simulated discharge is 6.7 ML/day. The baseflow predicted by the "SPR then APE" model is marginally higher than that predicted by the Base model.

In both the Base model and the "SPR then APE" model the simulated discharge to Wolgan River is about 1.3 ML/day at the pre-mining condition, which then increases to 1.7 ML/day in mid 2012. The increase in baseflow discharge is mainly due to the mining induced delamination of strata lying above the mining voids resulting in increase in horizontal conductivity. The discharge is predicted to subsequently decrease to 1.4 ML/day, 1.2 ML/day and 1 ML/day in 2022, 2032 and 2064 respectively.

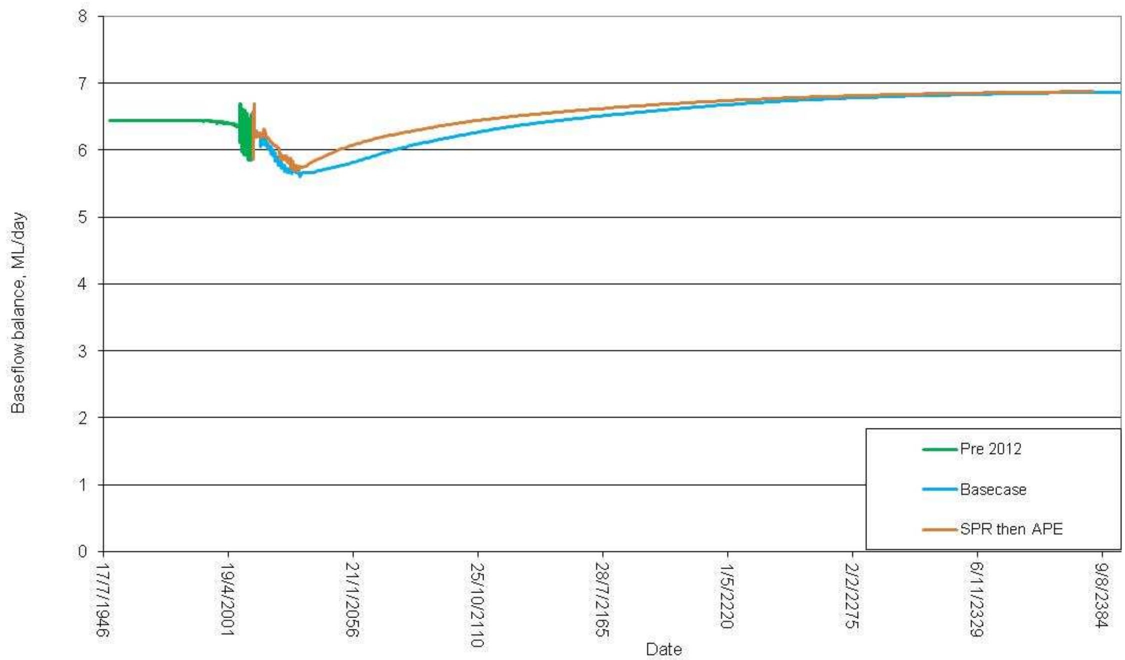

Figure G6 Simulated total baseflow balance to Carne Creek reach included in the model (CA1+CA2+CA3+CA4+CA5+CW5+CW+GGS+GGSE.See Table 5 in the main report for notation)

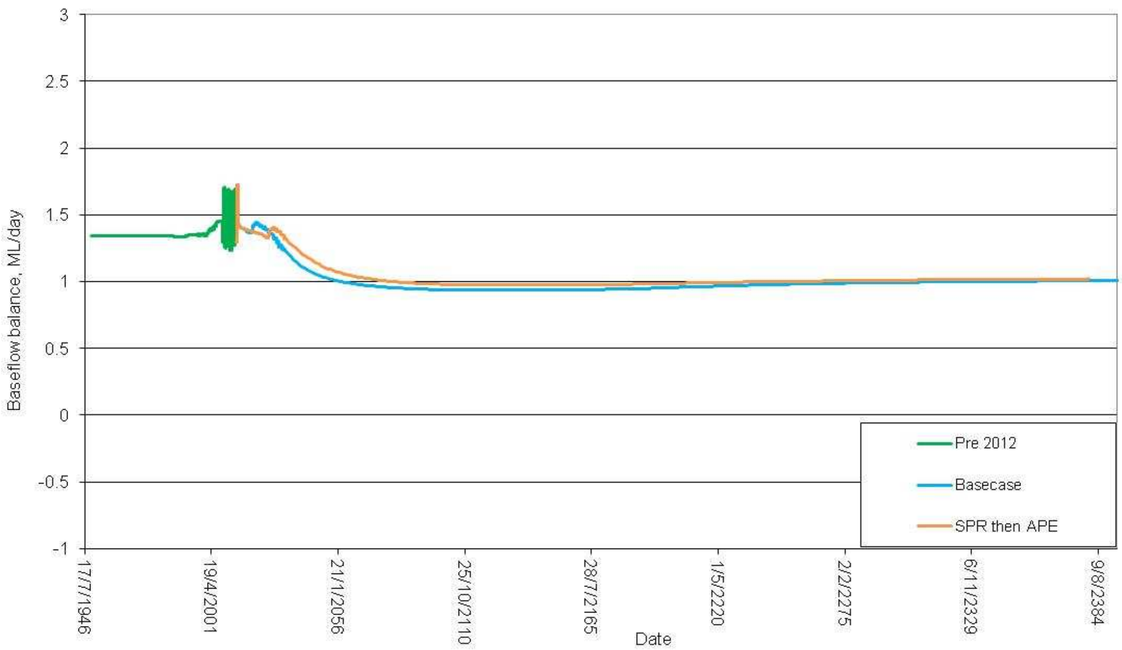

Figure G7 Simulated total baseflow balance to Wolgan River reach included in the model (WOL+TWG+TRS+SSS, see Table 5 in the main report for notation)

Similar trends of either identical or slightly higher baseflows are predicted by the "SPR then APE" model for other swamps and streams compared to the Base model (see Appendix H).

Table G9 enumerates the changes in the groundwater discharge to the swamps/streams before, during and after mining for the 'SPR then APE" models.

Table G10 enumerates the simulated maximum change (loss or gain) in baseflow with respect to baseflow at 2012.

Table G9 Predicted groundwater discharge to swamps and streams simulated in this study (SPR then APE)

Swamps and streams simulated in this study	Groundwater discharge (ML/day)						
	Pre-mining	Dec 2012	Seasonal variation	2024	2036	2064	Minimum
CA2 (includes Carne Central Swamp)	1.30	1.14	0.14	1.101	0.972	1.101	0.960
Carne West Swamp	0.02	0.02	0.01	0.052	0.045	0.041	0.019
Carne Creek Total	6.44	5.91	0.96	5.883	5.802	6.162	5.688
Gang Gang South East	-0.05	-0.06	0.02	-0.220	-0.225	-0.222	-0.226
Gang Gang Swamp South	-0.05	-0.06	0.02	-0.055	-0.072	-0.072	-0.073
Kangaroo Swamp	0.01	0.02	0.00	0.015	0.014	0.013	0.011
Kangaroo Creek (KC1)	0.30	0.00	0.24	-0.071	-0.116	-0.050	-0.138
Kangaroo Creek (KC2)	0.07	0.11	0.24	0.114	0.096	0.081	0.074
Lamb Creek	0.17	0.17	0.02	0.113	0.093	0.120	0.083
Long Swamp	-0.07	-0.07	0.01	-0.067	0.119	-0.067	-0.078
Marrangaroo Creek	0.93	0.72	0.30	0.752	0.674	0.643	0.643
Nine Mile Swamp	0.02	0.01	0.01	0.017	0.017	0.017	0.011
Paddy's Creek	0.17	0.16	0.01	0.163	0.165	0.169	0.162
Pine Swamp	0.09	0.09	0.01	0.197	0.165	0.152	0.086
Tri-Star Swamp	0.05	0.04	0.01	0.044	0.118	0.065	0.006
Twin Gully Swamp	0.08	0.07	0.01	0.073	0.091	0.065	0.044
Sunnyside Swamp	0.10	0.10	0.01	0.105	0.100	0.094	0.093
Wolgan River Total	1.34	1.29	0.55	1.330	1.268	1.034	0.974

Table G10 Maximum loss in baseflow (SPR then APE)

Swamps and streams simulated in this study	Maximum reduction in baseflow (ML/day)	%	Comments
CA2 (includes Carne Central Swamp)	0.176	15	
Carne West Swamp	Increase in baseflow		Very small volume
Carne Creek Total	0.268	4.5	Small change
Gang Gang South East	0.17	288	Leaky swamp (increase in leakage)
Gang Gang Swamp South	0.01	20	Leaky swamp (increase in leakage); very small volume
Kangaroo Swamp	0.004	24	very small volume
Kangaroo Creek (KC1)	0.145	Division by a small number	very small volume
Kangaroo Creek (KC2)	0.03	32	very small volume
Lamb Creek	0.047	36	very small volume
Long Swamp	0.000	0.000	No change
Marrangaroo Creek	0.078	11	
Nine Mile Swamp	Increase in baseflow		Very small volume
Paddy's Creek	0.001	0.5	Very small change
Pine Swamp	0.000	0.0	No change
Tri-Star Swamp	0.04	86	very small volume
Twin Gully Swamp	0.029	40	very small volume
Sunnyside Swamp	0.003	3.5	Small change
Wolgan River Total	0.33	25.5	

Figure G8 shows YS6 outcrops in the Angus Place and Springvale mining region. The YS6 layer is found to be the most important aquitard. The swamps and streams lying above the YS6 layer are much less impacted by mining than the swamps and creeks that are unsupported by the YS6 layer underneath.

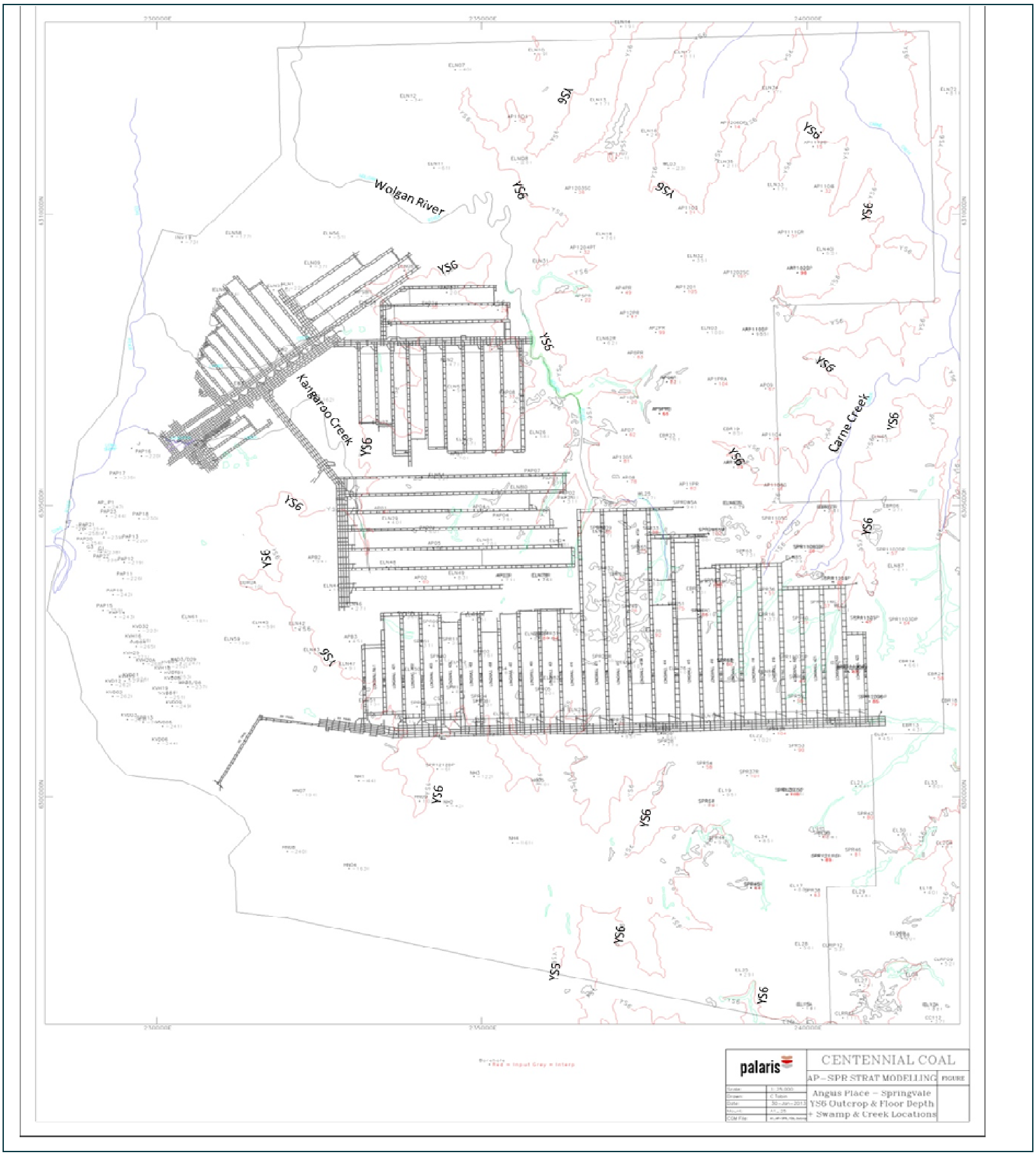

Figure G8 YS6 outcrops (brown line) in the mining region

As described earlier, a conductance of 0.085 day-1 per unit area of riverbed was assumed for all the streams and swamps. The discharge/recharge to/from streams/swamps is computed as described in Section Appendix F. Using the expression given in Appendix F, and the simulated stream/swamp area and the simulated discharge values, estimates are made for average standing water levels with respect to the ground surface and shown in Table G11. In reality, relative to the ground surface the groundwater could lie above the predicted standing groundwater level in one part of a swamp/stream and could lie below in another part.

Table G11 shows the simulated mining induced changes in the groundwater levels in the swamps/streams are of the order of centimetres; a maximum groundwater level drop of 0.34 m is estimated for the Gang Gang Southeast Swamp in 2024 for the “SPR then APE” mine schedule, which is very similar to 0.36m drop predicted for the Base model. It is worthwhile to note that the Truncated-ramp1 and Truncated-ramp2 models predict only about 5mm drop in water levels for this swamp.

As baseflow magnitude is almost linearly dependent upon the standing water level above the ground surface, the results presented here must be viewed with caution when the baseflow values are small. For example, let us say the standing groundwater level is just barely below/above the ground surface, then a change of a few millimetres in the standing water level may entirely change the groundwater and surface water interaction process within the model; a leaky swamp/stream may suddenly become a discharging swamp/stream or vice versa.

Table G12 presents the maximum predicted drop in the average standing water levels in the swamps and streams simulated using the Base model and the “SPR then APE” model. The predicted head drop by the “SPR then APE” model is either almost identical or slightly less than that predicted by the Base model.

Table G11 Predicted average change in the standing groundwater levels in swamps/streams before, during and after mining (Base case)

Swamps and streams simulated in this study	Predicted average head above the ground surface (m)					Predicted average head drop from pre-mining (m)				Predicted average head drop since 2012 (m)		
	Pre-mining	2012	2024	2036	2064	2012	2024	2036	2064	2024	2036	2064
CA2 (includes Carne Central Swamp)	0.499	0.435	0.422	0.372	0.422	0.064	0.077	0.127	0.077	0.014	0.063	0.013
Carne West Swamp	0.027	0.025	0.071	0.061	0.056	0.002	-0.043	-0.034	-0.029	-0.045	-0.036	-0.031
Carne Creek Total	0.558	0.516	0.510	0.503	0.534	0.042	0.048	0.055	0.024	0.006	0.013	-0.018
Gang Gang Swamp South East	-0.106	-0.121	-0.458	-0.469	-0.463	0.015	0.352	0.363	0.357	0.337	0.348	0.342
Gang Gang Swamp South	-0.065	-0.082	-0.074	-0.097	-0.097	0.017	0.009	0.032	0.032	-0.008	0.014	0.015
Kangaroo Swamp	0.179	0.386	0.376	0.353	0.330	-0.207	-0.197	-0.174	-0.151	0.010	0.033	0.057
Kangaroo Creek (KC1)	0.116	0.003	-0.027	-0.045	-0.019	0.113	0.143	0.161	0.135	0.030	0.047	0.022
Kangaroo Creek (KC2)	0.067	0.104	0.109	0.092	0.077	-0.037	-0.042	-0.025	-0.010	-0.005	0.013	0.027
Lamb Creek	0.102	0.078	0.068	0.056	0.072	0.024	0.034	0.046	0.030	0.010	0.022	0.006
Long Swamp	-0.101	-0.118	-0.101	0.179	-0.101	0.017	0.000	-0.280	0.000	-0.017	-0.297	-0.017
Marrangaroo Creek	0.148	0.115	0.120	0.108	0.103	0.033	0.028	0.040	0.045	-0.005	0.008	0.012
Nine Mile Swamp	0.037	0.024	0.039	0.038	0.038	0.012	-0.002	-0.001	-0.002	-0.015	-0.014	-0.014
Paddy's Creek	0.120	0.114	0.115	0.116	0.119	0.006	0.006	0.004	0.001	0.000	-0.002	-0.005
Pine Swamp	0.087	0.083	0.191	0.161	0.148	0.005	-0.104	-0.073	-0.060	-0.108	-0.078	-0.065
Tri-Star Swamp	0.097	0.087	0.086	0.232	0.128	0.010	0.010	-0.135	-0.032	0.001	-0.145	-0.042
Twin Gully Swamp	0.130	0.124	0.126	0.155	0.111	0.006	0.005	-0.025	0.020	-0.001	-0.031	0.014
Sunnyside Swamp	0.181	0.176	0.193	0.183	0.173	0.005	-0.011	-0.001	0.009	-0.017	-0.007	0.003
Wolgan River Total	0.187	0.183	0.186	0.178	0.145	0.004	0.001	0.010	0.043	-0.003	0.006	0.038

Note: Positive values indicate head drops and negative value indicate head increases.

Table G12 Predicted maximum drop in the average standing groundwater levels in swamps/streams with respect to the groundwater levels in December 2012

Swamps and streams simulated in this study	Base Model (m)	"SPR then APE" model (m)
CA2 (includes Carne Central Swamp)	0.103	0.068
Carne West Swamp	Small head increase	0.000
Carne Creek Total	0.027	0.023
Gang Gang Swamp South East	0.364	0.349
Gang Gang Swamp South	0.030	0.016
Kangaroo Swamp	0.095	0.093
Kangaroo Creek (KC1)	0.129	0.056
Kangaroo Creek (KC2)	0.035	0.034
Lamb Creek	0.047	0.028
Long Swamp	0.017	0.000
Marrangaroo Creek	0.020	0.013
Nine Mile Swamp	Small head increase	Small head increase
Paddy's Creek	0.001	0.001
Pine Swamp	0.000	0.000
Tri-Star Swamp	0.081	0.075
Twin Gully Swamp	0.051	0.050
Sunnyside Swamp	0.013	0.006
Wolgan River Total	0.050	0.047

**As discussed earlier, the actual mining impact on baseflow is expected to lie within the bounds predicted by the three models*.

2.2.4 Predicted drawdown

Appendix I provides the simulated drawdown for the Lithgow Seam, AQ1, AQ2, AQ3, AQ4, AQ5, AQ6 and the top of the model (i.e. the ground surface) at years 2020, 2025 and 2036 within the predictive simulation period.

Figures I1 to I21 in Appendix I show the simulated drawdown with respect to the pre-mining groundwater conditions and Figures I22 to I42 show the simulated drawdown with respect to groundwater levels at 2013.

Figure G9 to Figure G11 show typical drawdown plots in the Lithgow Seam during the mining period. Figure G9 to Figure G11 show the drawdown with respect to the pre-mining groundwater condition while Figure G12 shows the drawdown with respect to the groundwater level at 2013. A maximum drawdown of 160m is predicted around the SV longwalls in year 2020, and 120m around the APE longwalls in year 2036. The maximum depressurization seems to occur within the SPR_LW423 region in 2023 with respect to the groundwater level at 2013 (Figure G12) during the extraction of SV panels. The magnitude of depressurization gradually decreases away from the SPR_LW423 region; 5m drawdown contour can be seen to extend about 5km from Springvale (just outside the eastern boundary of the Clarence Colliery). As the Springvale pump is tuned off in 2023, water heads in the SV mined voids start to increase gradually. In 2036, the maximum depressurization can be seen to occur within the APE panel regions.

The depressurization of the strata can be seen to decrease the vertical distance away from the Lithgow Seam (Figures G25 to G30). However, the drawdown patterns in AQ2 and AQ3 are similar to those in AQ1.

The depressurization of AQ3 occurs in a different manner (Figures G31 to G33). In 2036, maximum drawdown in AQ3 (with respect to the groundwater levels in 2013) can be seen to concentrate over the APE panels. Depressurization in AQ4 can also be seen to concentrate more over the APE panels (Figure G36).

The average saturated head drop at the ground surface is generally of the order of centimetres (see Figure G13).

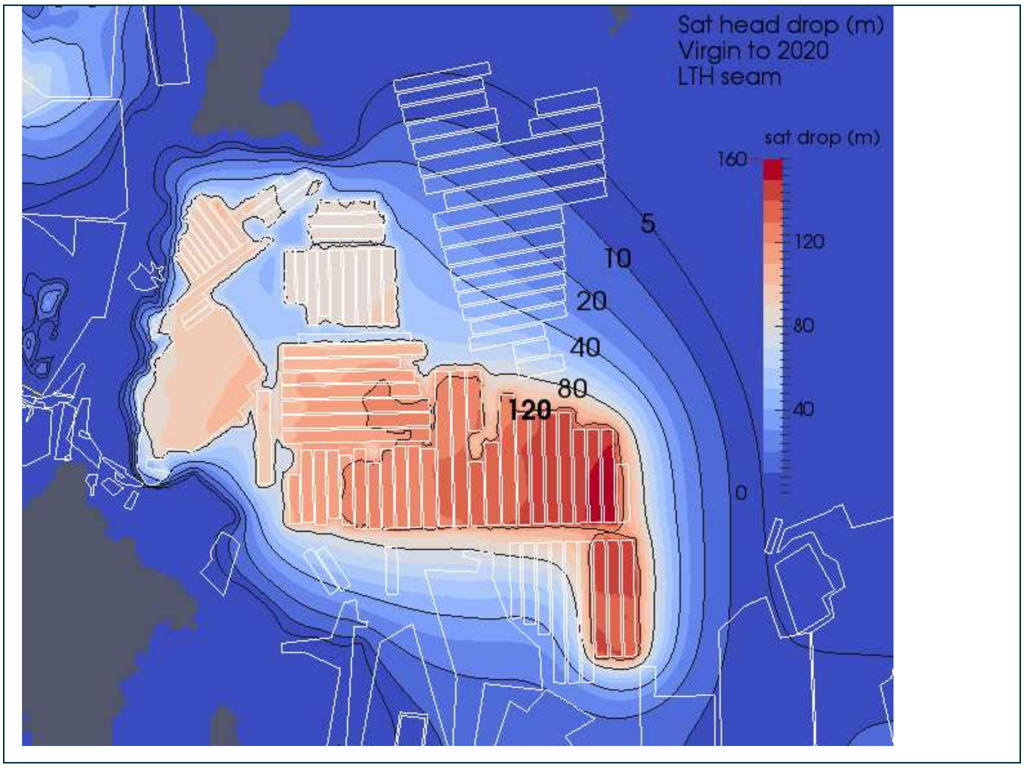

Figure G9 Distribution of drawdown in the Lithgow Seam in January 2020 with respect to pre-mining groundwater condition

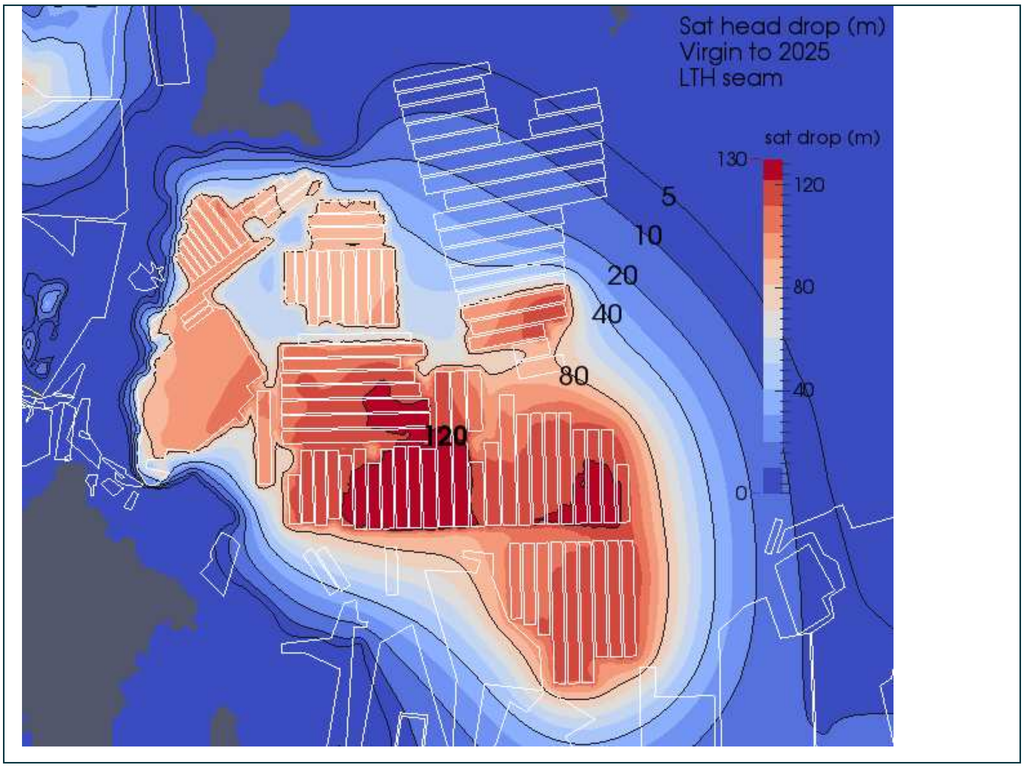

Figure G10 Distribution of drawdown in the Lithgow Seam in January 2025 with respect to pre-mining groundwater condition

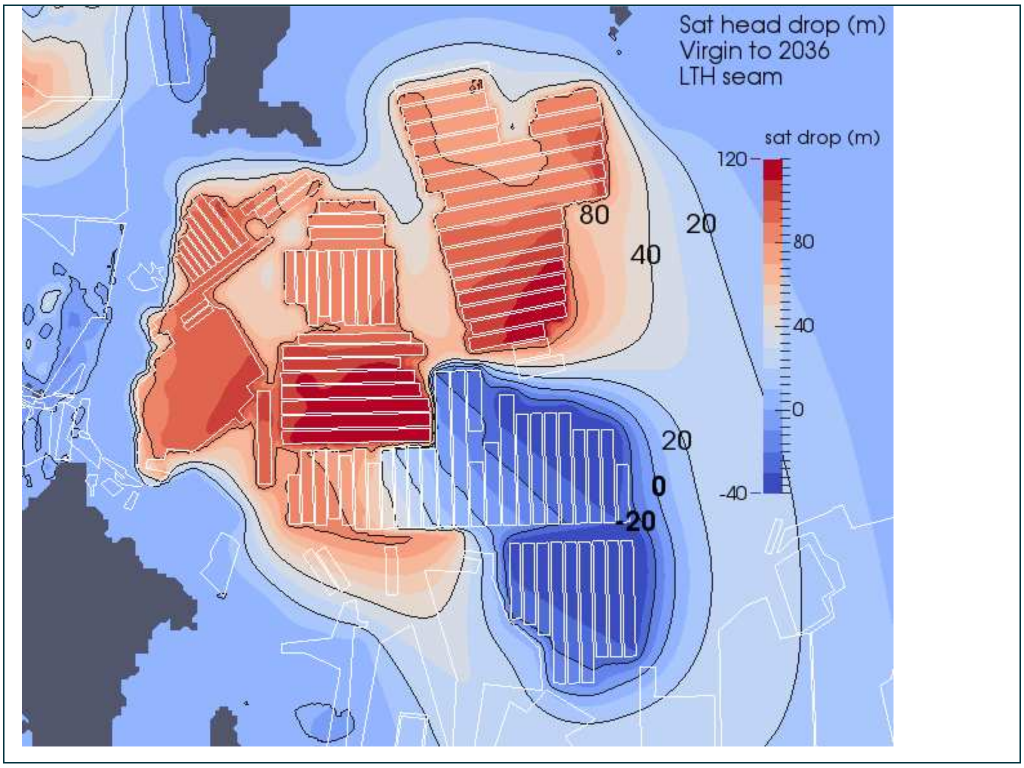

Figure G11 Distribution of drawdown in the Lithgow Seam in January 2036 with respect to pre-mining groundwater condition. At this time, pumping of Springvale has ceased, hence the negative values of head drop.

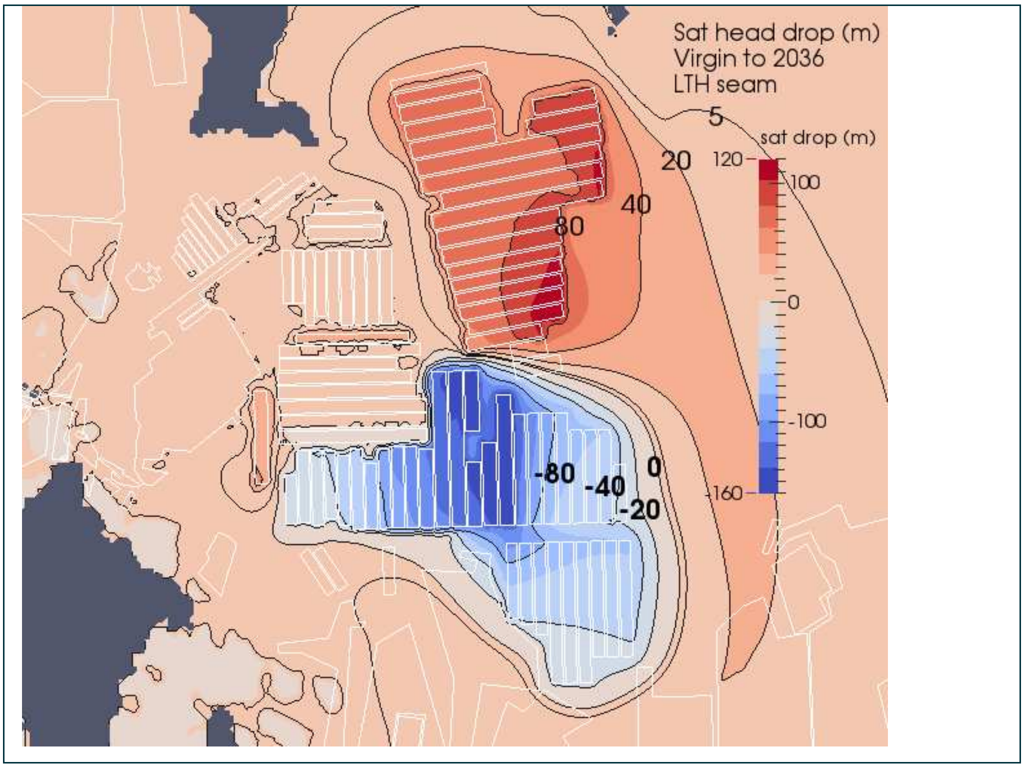

Figure G12 Distribution of drawdown in the Lithgow Seam in January 2036 with respect to groundwater levels in January 2013

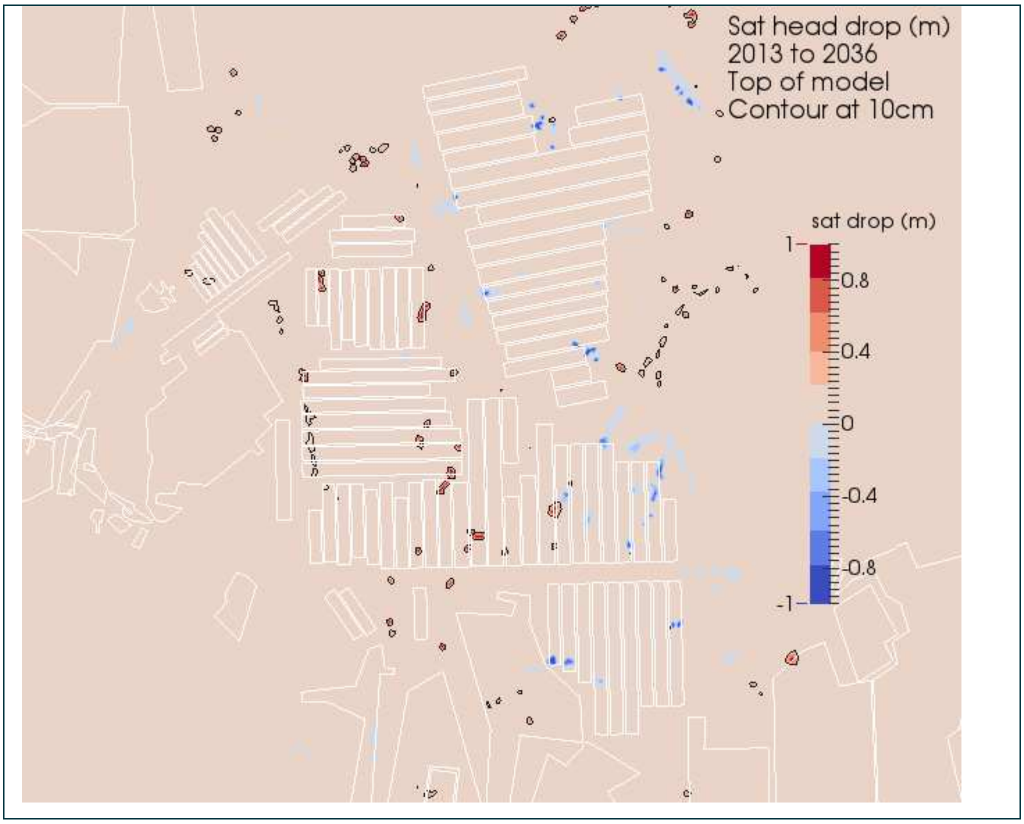

Figure G13 Distribution of head drops at the ground surface in January 2036 with respect to groundwater levels in January 2013

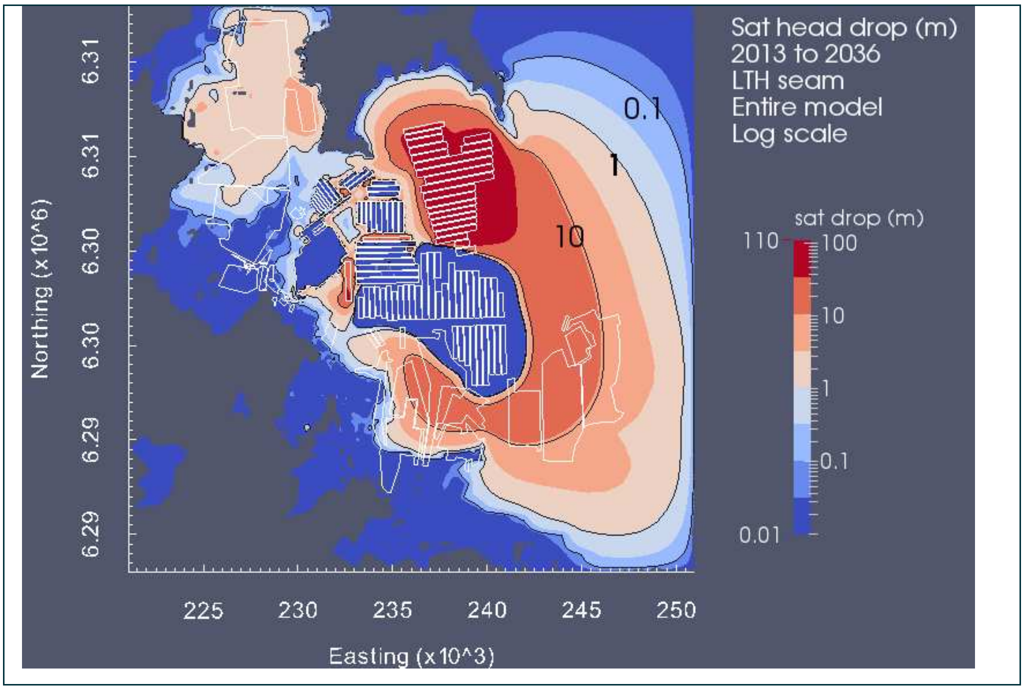

Figure G14 Drawdown in the Lithgow Seam in 2036 with respect to groundwater levels in January 2013 (entire model)

Figure G14 shows the drawdown in the Lithgow Seam in 2036 with respect to groundwater levels in January 2013 for the entire model. Water heads on the eastern side of the model boundary can be seen to drop by up to 10m at a distance of 5 to 10km from mining operations. Further away, the magnitude of head drop seems to decrease rapidly; the drop in water heads seems to decrease from 10m to 2m within a 2 to 3km distance. Boundary effects were studied in the previous base model and shown to have minimal effect in overall numerical analysis.

2.2.5 Changes in the groundwater phreatic surface

The phreatic surfaces on the vertical sections before mining (1949) are shown in Figure G15. The phreatic surfaces on the vertical sections at the end of the validation period (2012) and at the end of the predictive period (2036) after mining, as well as during recovery are shown in Figure G15 to Figure G17. Quantitatively, the only substantial difference between this “SPR then APE” scenario and the original base case scenario is that the former recovers slightly faster due to earlier cessation of pumping in Springvale.

These figures contain a lot of information and give a good qualitative understanding of water redistribution by mining. However, while the phreatic-surface lines delineate regions of full saturation from regions of partial saturation, the figures do not give any information about the porepressures within each region. Scanning downwards along a vertical line from the top of the model determines whether an area is saturated or unsaturated. For example, in Figure G15, to determine the saturated regions for the virgin configuration, the following procedure can be used. The region directly below the word “topo” is unsaturated. Moving downwards by about 5m a blue line is encountered which separates the unsaturated from the saturated region, meaning that the region below this blue line is saturated. Moving further downwards the lower part of SP4 another blue line is encountered, meaning the region below this line is unsaturated. Moving further downwards still, another blue line is encountered below YS6, meaning the region below this line is saturated. No more blue lines are encountered to the bottom of the model, so the lower part is all fully saturated.

The following observations can be made from Figure G15 to Figure G17.

- Extensive desaturation occurs in AQ1 wherever mining has occurred in the Lithgow seam,
- Though porepressures do drop in AQ2, as evidenced by the drawdown pictures in Appendix G, the aquifer remains fully saturated,
- Much of AQ3 becomes desaturated above the mining panels and beyond them to the hillsides.
- AQ4 remains almost fully saturated, only in section NS desaturation is observed. AQ4 is shielded by the MYC layer,
- A slight drop of the phreatic surface in AQ5 is evident in section WE, but mostly AQ5 appears to be shielded by MYC and YS6, and
- Underneath the topographic ridges at the top of the model, the phreatic surface drops by a few metres, while the drops near the valley regions are significantly less.

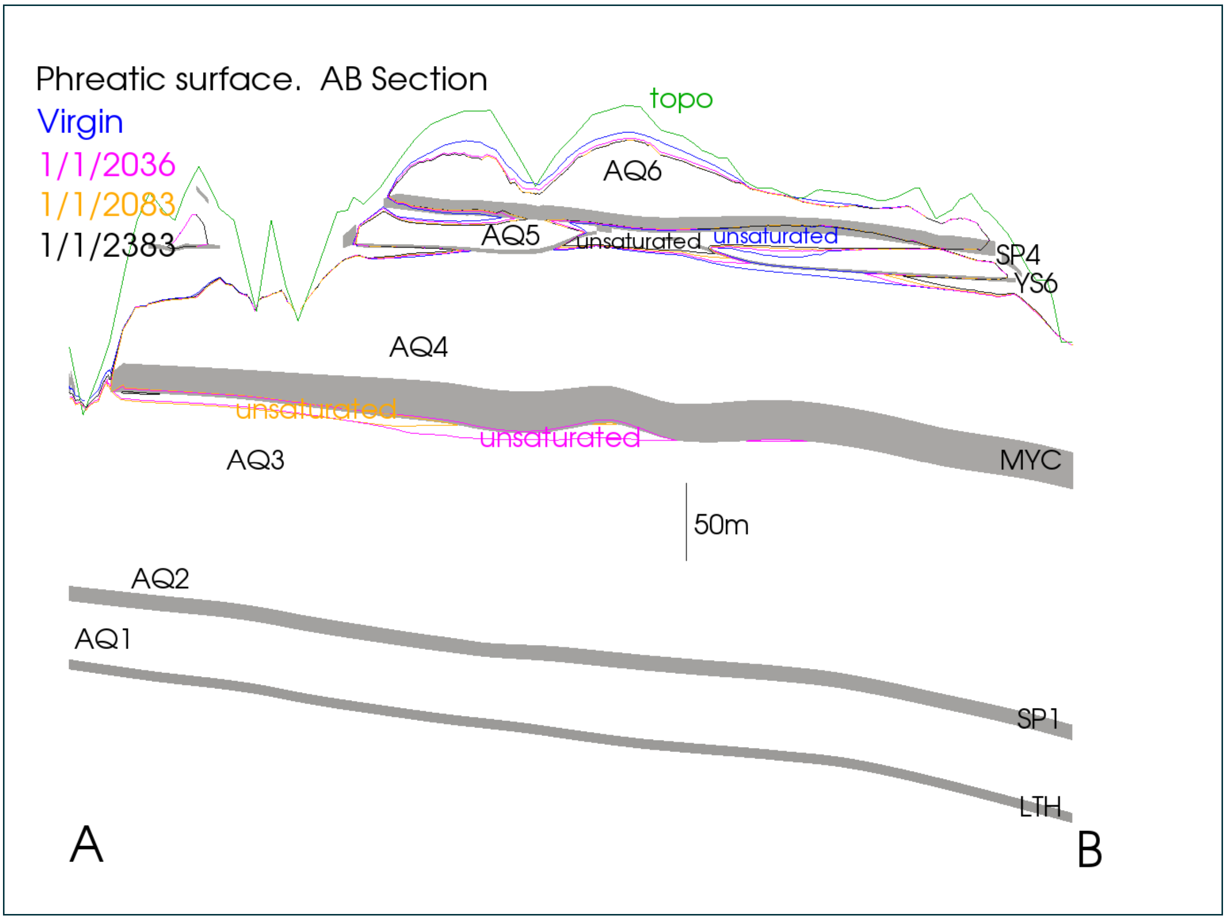

Figure G15 Phreatic surface before mining (blue lines), after mining (pink lines), year 2083 (yellow lines), and year 2383 (black lines) along A-B section

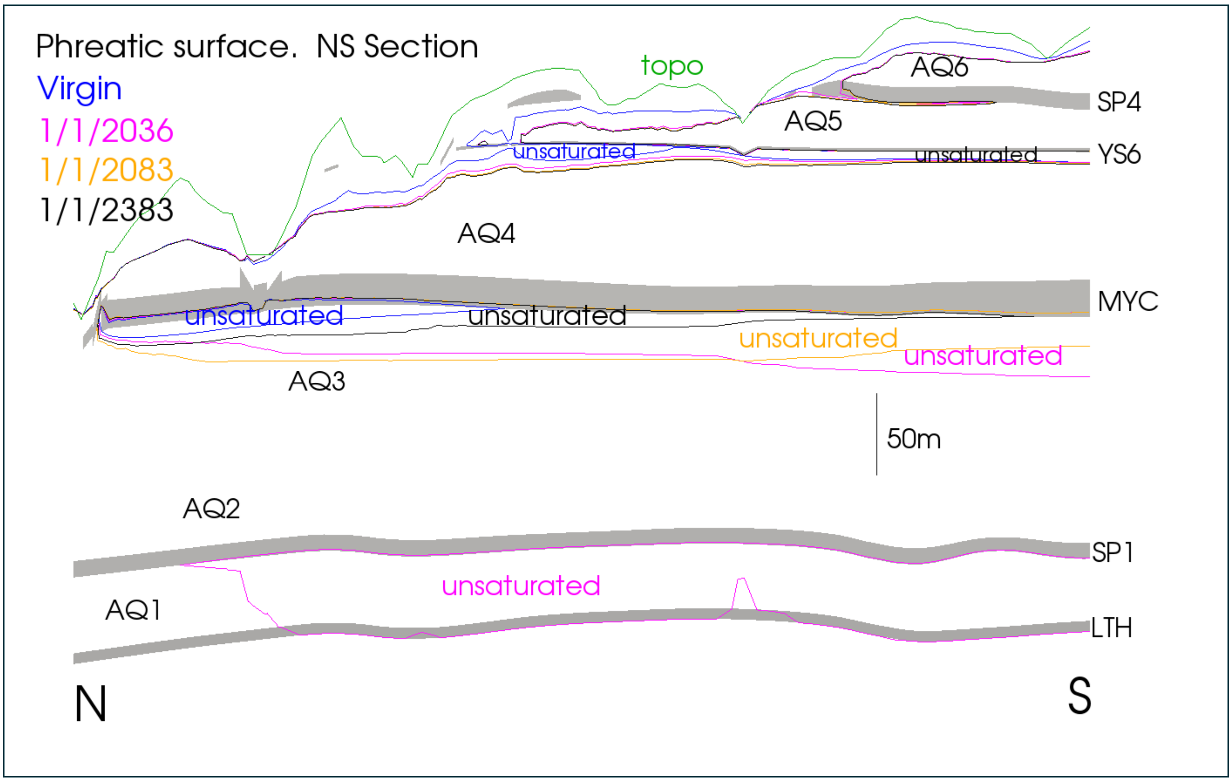

Figure G16 Phreatic surface before mining (blue lines), after mining (pink lines), year 2083 (yellow lines), and 2383 (black lines) along N-S section

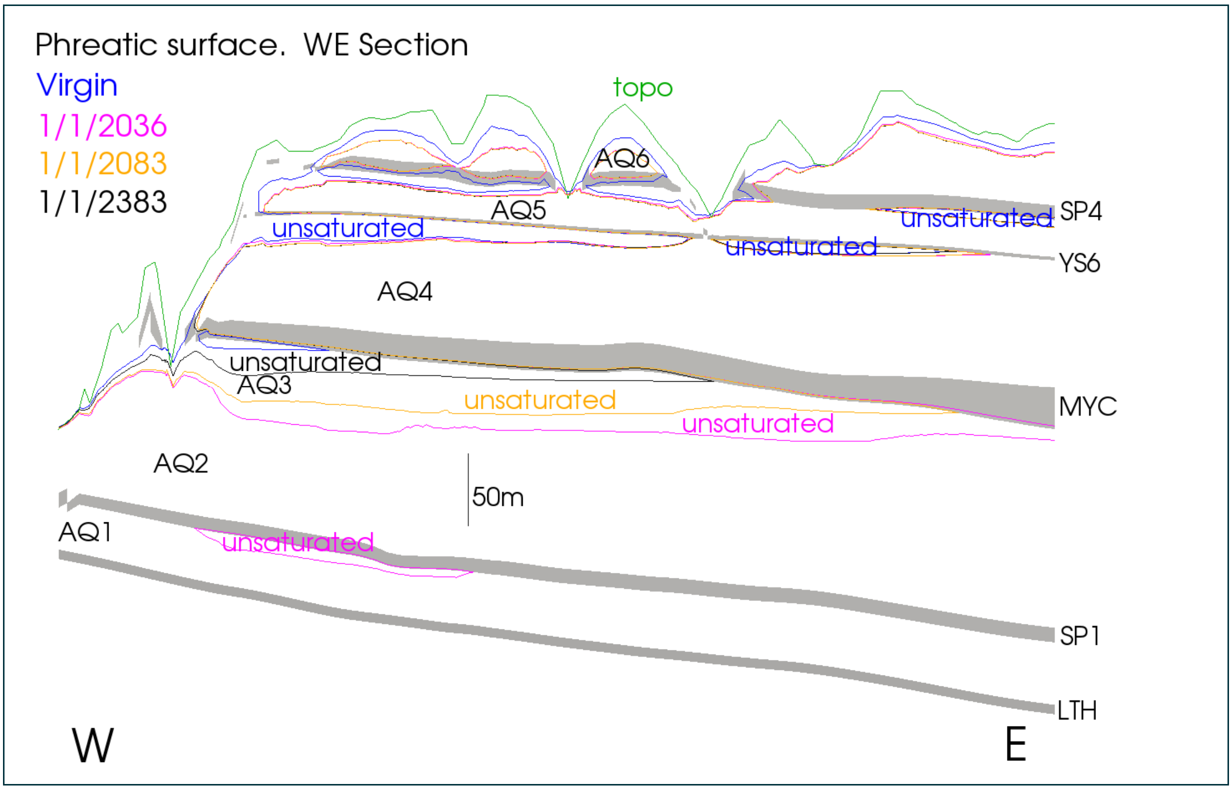

Figure G17 Phreatic surface before mining (blue lines), after mining (pink lines), in 2083 (yellow lines), and 2383 (black lines) along E-W section

2.2.6 Head drops along the Cox's River

Cox's river was not explicitly included in the model, and so the model cannot directly yield the changes in baseflow due to mining. However, two proxies for these changes have been explored:

1. The changes in baseflow for Long Swamp, which lies along Cox's river. These changes have been presented in Appendix C, and are negligible.
2. The drop in saturated heads at the surface of the model along Cox's river.

These pressure heads along Cox's river are explored further in this section.

Firstly, the model predicts that the phreatic surface generally lies below Cox's river, as shown in Figure G18. Since Cox's river was not included explicitly, the depth of the water table must be obtained using interpolation. There are two ways of doing this: interpolating the depth values, which typically yield lower water tables than the true situation; interpolating the phreatic elevation values, which typically yield higher water tables than the true situation. These interpolation schemes are described in Figure G19.

In Figure G19 COSFLOW nodes are at the black dots, where the phreatic surface is correctly simulated. The interpolation using the phreatic surface's depth is shown as a red line. Typically this yields a lower phreatic surface in valleys and a higher surface in ridges when compared with the real phreatic surface. The interpolation using the phreatic surface's elevation is shown as a black dashed line. Typically this yields a higher phreatic surface in valleys and a lower surface in ridges when compared with the real phreatic surface.

At the southern end of the river, the Elevation Interpolation suggests that the depth is negative (the water table is above the ground surface). While this may be true, this is the region where the interpolation of COSFLOW's results is less accurate due to large finite-element mesh sizes, as shown in Figure G20.

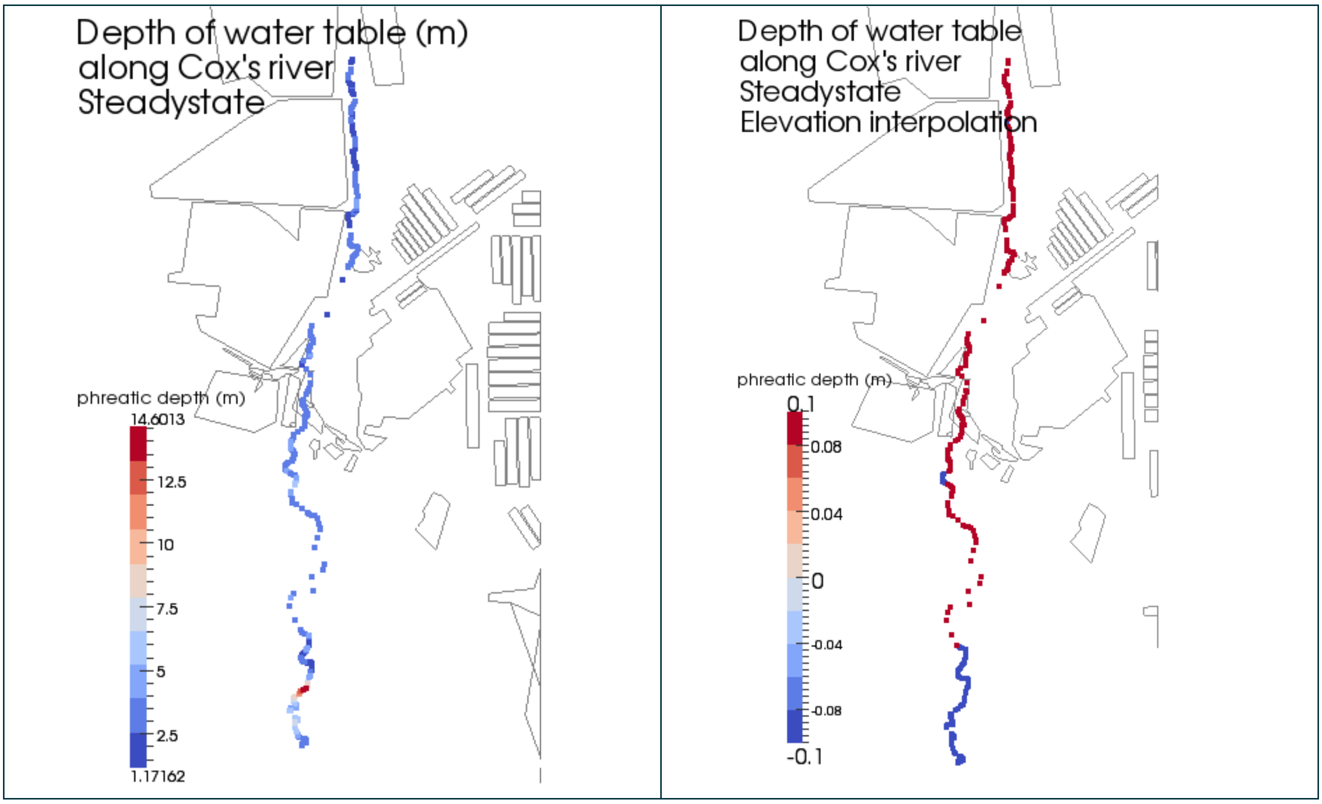

Figure G18 Depth of the watertable along Cox's river before any mining. Left picture: interpolation using the phreatic depth. Right picture: interpolation using the phreatic elevation. Notice that the depth is positive along most of Cox's river regardless of the interpolation used.

The drop in the phreatic surface along Cox's river is between steady-state, year 2013 and year 2033 is shown in Figure G21. Note that a logarithmic scale has been used and that most of the drops are of the order of centimetres. The largest effects are at the north of the modelled region, and are not due to mining Angus Place or Springvale mines, as discussed in Section 4.2.6 in the main report.

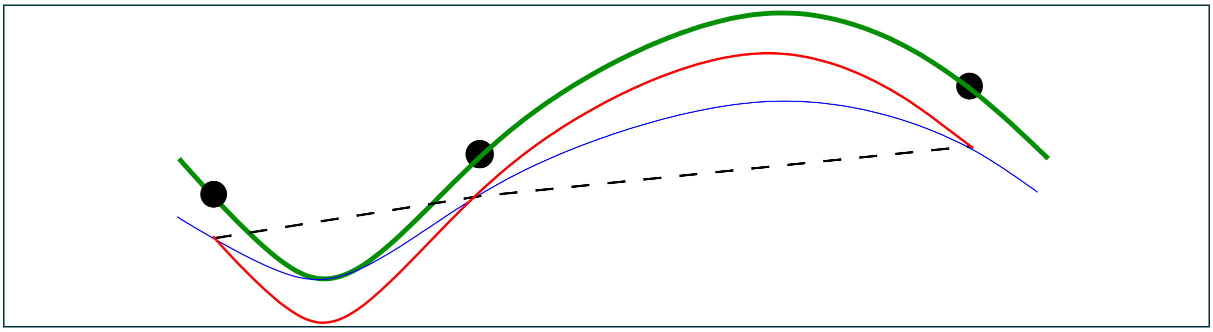

Figure G19 The phreatic surface (blue line) below the topography (green line)

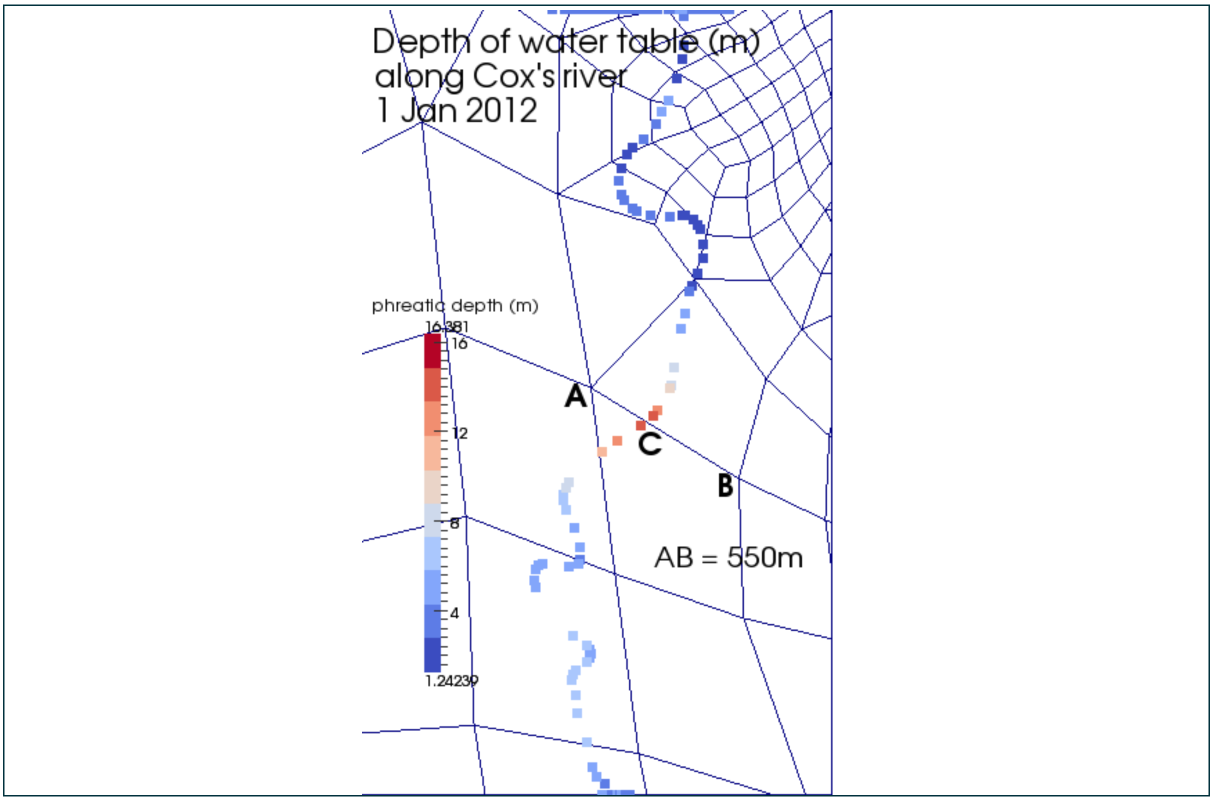

Figure G20 The finite element mesh is overlayed upon results from Figure G18. At the southern end of Cox's river, the interpolation is much less accurate since the element side-length is around 500m. By inspecting Figure 2, it is easy to imagine the interpolation from results at "A" and "B" to point "C" has significant error.

Figure G22 and Figure G20 show the drop in phreatic surface along Cox's river between year 2013 and year 2033 due to mining of the new Springvale panels (LW416 onwards) and then the Angus Place Extension. This picture was obtained by comparing the drops in the "SPR then APE" and "no new" scenarios. Again a logarithmic scale has been used, and this time the maximum drop is 1cm and most head drops are less than 1mm.

Thus the Cox's river could be categorised as a leaking river. Assuming the same riverbed conductance as the Sunnyside Swamp, this drop in the water table would account for a maximum extra leakage of 0.01 ML/day per unit width of the river.

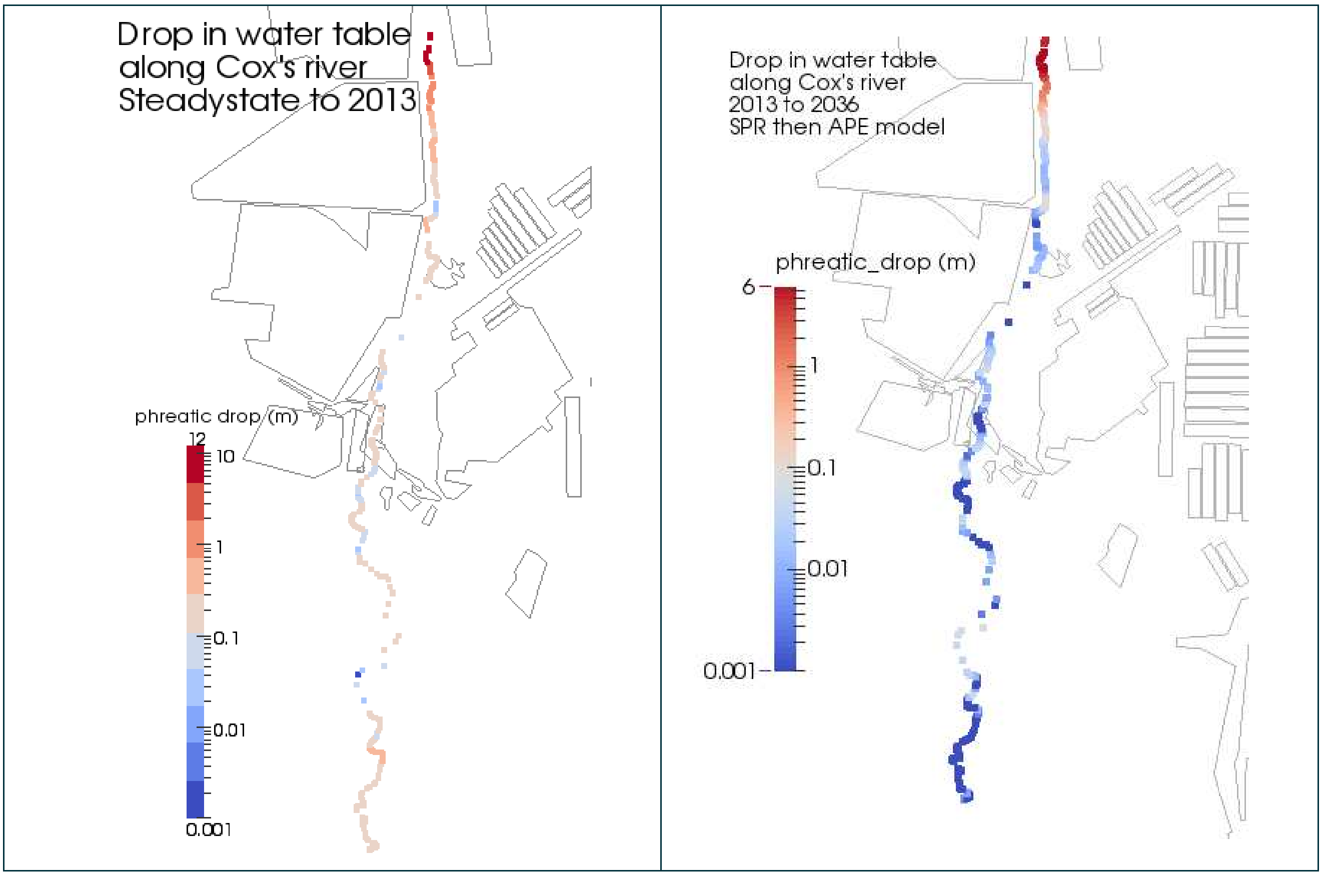

Figure G21 Drop in the phreatic surface along Cox's river between steady-state and 2013 (left), and 2013 and 2036 (right). A logarithmic scale has been used

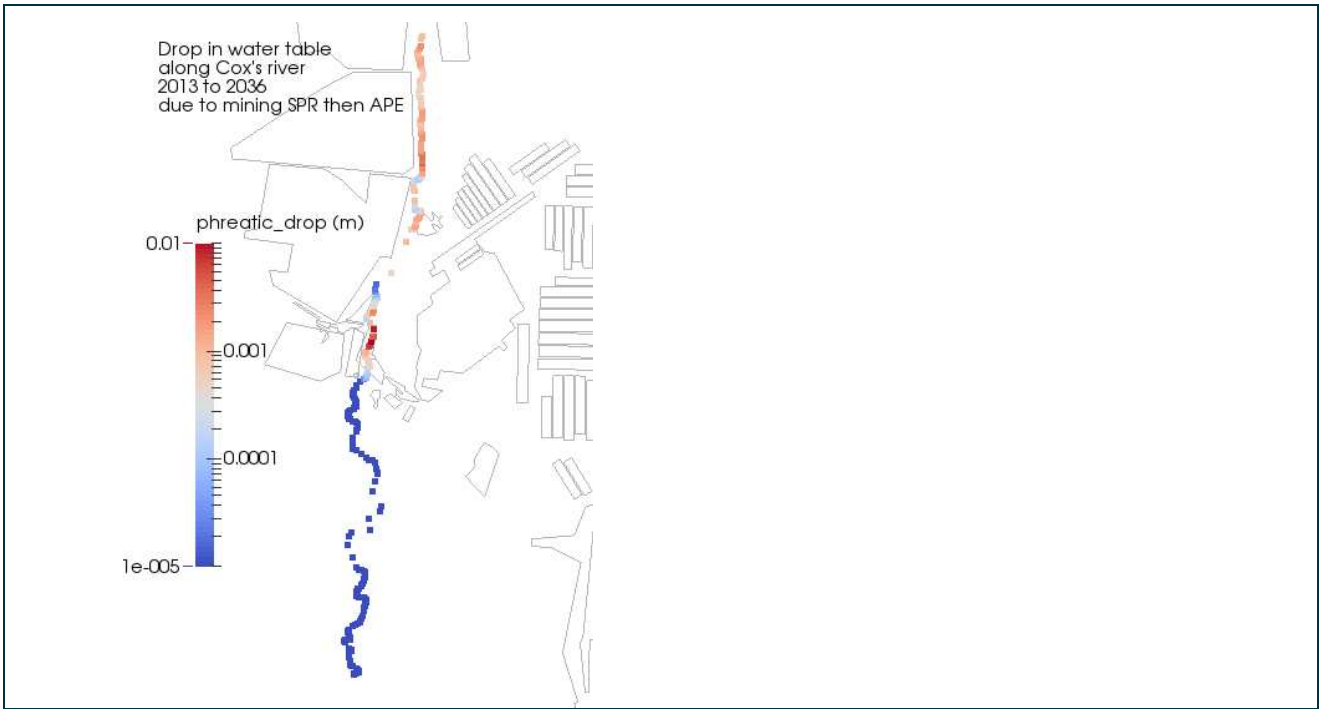

Figure G22 Drop in the phreatic surface along Cox's river between 2013 and 2036 due to mining APE and the new SV panels (SPR then APE scenario). A logarithmic scale has been used

2.2.7 Saturated head drops on private bores

Table G13 shows the positions of 108 private bores within 10km of the Springvale and Angus Place mines. The simulated head drops at the bottom of each of these private bores compared with the initial heads at year 2013 are produced. The data is tabulated for the years 2033 (Base case), 2036 ("SPR then APE"), 2083 and 2383. A negative value indicates the head has risen compared with 2013. Clearly, for most private bores of depth less than 50m, the head drops are very small and the median head drop is 0.0 in 2033. The head drops in the private bores in 2036 relative to 2013 heads are depicted graphically in Figure G23 where private bores have been categorised by their depths in order to highlight the drawdown quantities. These data were obtained by interpolation from COSFLOW results in a similar way as was done for Cox's river in Section 4.2.6.

Table G13 also contains columns indicating the result from the Base case where SPR and APE are mined concurrently. Evidently, the difference between these two cases is insubstantial (in the order of centimetres) for all but the deepest bores. The median of the differences in drawdowns between the "SPR then APE" scenario and the Base case is 2%, or around 1mm.

Table G13 Private bore data and simulated head drops at the bottom of each bore

Name	Depth (m)	Easting (m)	Northing (m)	Base case saturated drawdown 2033 (m)	SPR then APE saturated drawdown 2036 (m)	Base case saturated drawdown 2083 (m)	SPR then APE saturated drawdown 2083 (m)	Base case saturated drawdown 2383 (m)	SPR then APE saturated drawdown 2383 (m)
GW110707	1.4	242590	6295589	0.00	0.00	0.00	0.00	0.00	0.00
GW110704	1.55	241550	6296992	0.00	0.00	0.00	0.00	0.00	0.00
GW110705	1.7	241839	6297076	0.00	0.00	0.00	0.00	0.00	0.00
GW101299	3.75	233678.9	6294345	-0.08	-0.08	-0.19	-0.19	-0.19	-0.20
GW100625	4.1	236219	6297109	0.00	0.00	0.00	0.00	0.00	0.00
GW101294	4.25	233679.1	6294345	-0.08	-0.08	-0.19	-0.19	-0.19	-0.20
GW067397	4.5	237222.3	6292575	0.00	0.00	0.00	0.00	0.00	0.00
GW067395	5	237152.6	6292819	-0.06	-0.06	-0.14	-0.14	-0.15	-0.15
GW011892	5.4	232547.3	6296341	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
GW067398	5.5	237283.3	6292515	-0.06	-0.06	-0.11	-0.12	-0.12	-0.13
GW101293	5.9	233679.1	6294345	-0.08	-0.08	-0.19	-0.19	-0.19	-0.20
GW109263	6	230188	6302354	0.46	0.49	-3.67	-3.68	-3.82	-3.84
GW101297	6	233678.9	6294345	-0.08	-0.08	-0.19	-0.19	-0.19	-0.19
GW100627	6	236218.6	6297109	0.00	0.00	0.00	0.00	0.00	0.00
GW100629	6	236218.6	6297109	0.00	0.00	0.00	0.00	0.00	0.00
GW100628	6	236218.6	6297108	0.00	0.00	0.00	0.00	0.00	0.00
GW100638	6	236218.8	6297109	0.00	0.00	0.00	0.00	0.00	0.00
GW067396	6	237158.2	6292750	-0.06	-0.07	-0.14	-0.14	-0.15	-0.15
GW101301	6.8	233678.9	6294345	-0.08	-0.08	-0.19	-0.19	-0.19	-0.20
GW067399	7	237310	6292626	-0.06	-0.06	-0.13	-0.13	-0.14	-0.15
GW101292	7.2	233678.9	6294345	-0.08	-0.08	-0.19	-0.19	-0.20	-0.20
GW103224	7.6	238274.8	6293738	0.00	0.00	-0.30	-0.32	-0.44	-0.46
GW109260	9	231949	6301451	0.00	0.00	0.00	0.00	0.00	0.00
GW101302	9	233679.1	6294345	-0.08	-0.08	-0.19	-0.19	-0.20	-0.20
GW100632	9	236218.8	6297109	0.00	0.00	0.00	0.00	0.00	0.00
GW100633	9	236218.8	6297109	0.00	0.00	0.00	0.00	0.00	0.00

GW100639	10.5	236218.6	6297109	0.00	0.00	0.00	0.00	0.00	0.00
GW100631	10.5	236218.8	6297109	0.00	0.00	0.00	0.00	0.00	0.00
GW103223	10.5	238308.9	6293688	0.00	0.00	-0.26	-0.27	-0.37	-0.39
GW101303	11	233678.9	6294345	-0.08	-0.08	-0.19	-0.19	-0.20	-0.20
GW100636	11	236218.8	6297109	0.00	0.00	0.00	0.00	0.00	0.00
GW101300	11.8	233678.9	6294345	-0.08	-0.08	-0.19	-0.19	-0.19	-0.20
GW110162	12	228445	6304250	0.02	0.02	0.01	0.01	0.01	0.01
GW101295	12	233679.1	6294345	-0.08	-0.08	-0.19	-0.19	-0.20	-0.20
GW100626	12	236218.4	6297109	0.00	0.00	0.00	0.00	0.00	0.00
GW100637	12	236218.6	6297109	0.00	0.00	0.00	0.00	0.00	0.00
GW110480	13	229530.1	6301968	0.03	0.03	0.02	0.02	0.02	0.02
GW100634	13.8	236218.8	6297109	0.00	0.00	0.00	0.00	0.00	0.00
GW109264	14.3	229631	6302170	0.07	0.08	-0.07	-0.07	-0.07	-0.07
GW109265	14.9	229380	6301983	0.00	0.00	0.00	0.00	0.00	0.00
GW060428	15	231161.9	6296889	-0.02	-0.03	-0.03	-0.03	-0.03	-0.03
GW055053	15.2	232063.2	6295156	0.01	0.01	0.01	0.01	0.01	0.01
GW100718	15.2	236218.8	6297108	0.00	0.00	0.00	0.00	0.00	0.00
GW110481	15.8	229166	6301605	-0.13	-0.13	-0.13	-0.13	-0.13	-0.13
GW105295	16	230238.8	6307853	0.10	0.10	0.03	0.03	-0.01	-0.01
GW105294	16	230336.5	6307811	0.14	0.14	0.01	0.01	-0.05	-0.05
GW100635	16	236218.8	6297109	0.00	0.00	0.00	0.00	0.00	0.00
GW104218	17.3	234133.6	6292824	-0.43	-0.44	-0.98	-0.98	-0.99	-0.99
GW109262	17.45	230234	6301697	0.03	0.03	0.02	0.02	0.02	0.02
GW101304	18	233679.3	6294345	-0.08	-0.08	-0.19	-0.19	-0.19	-0.20
GW109261	18.03	229804	6301348	-0.10	-0.10	-0.10	-0.10	-0.11	-0.11
GW057399	18.3	231849.8	6296322	0.06	0.06	0.06	0.06	0.06	0.06
GW054416	18.3	237937.4	6293005	0.00	0.00	-0.01	-0.01	-0.01	-0.01
GW053081	18.6	232055.5	6295434	0.06	0.06	0.06	0.06	0.06	0.06
GW110483	21	229149	6303041	0.08	0.09	-0.13	-0.13	-0.13	-0.13
GW100630	21	236218.6	6297109	0.00	0.00	0.00	0.00	0.00	0.00
GW055055	21.3	232064.2	6296050	0.05	0.05	0.05	0.05	0.05	0.05
GW104220	21.3	234172.6	6292798	-0.47	-0.48	-1.05	-1.05	-1.06	-1.07
GW072713	21.336	228517.1	6302704	0.05	0.05	0.05	0.05	0.05	0.04
GW047900	21.9	236485.8	6292225	-0.01	-0.01	-0.02	-0.02	-0.02	-0.02
GW101296	23.2	233678.9	6294345	-0.08	-0.08	-0.19	-0.19	-0.20	-0.20
GW110161	27.5	228450	6304254	0.04	0.04	0.04	0.04	0.04	0.04
GW101985	30	242016.9	6296554	-0.07	-0.07	-0.09	-0.08	-0.10	-0.10
GW106646	30	243458	6294098	-0.05	-0.04	-0.20	-0.17	-0.45	-0.45
GW058108	30.5	232569.7	6296465	0.01	0.01	0.01	0.01	0.01	0.01
GW057365	30.5	232726.4	6296408	0.03	0.03	0.03	0.03	0.03	0.03
GW060112	31.4	232057.9	6294416	-0.03	-0.04	-0.04	-0.04	-0.04	-0.04
GW110482	33	229153.1	6303045	0.08	0.09	-0.13	-0.13	-0.14	-0.14
GW058554	33.5	232464.7	6296524	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04
GW102428	38.1	232195.6	6294111	-0.05	-0.05	-0.06	-0.06	-0.06	-0.06

GW054781	38.1	232468.1	6296401	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06
GW104221	38.6	234132.6	6292824	-0.44	-0.45	-1.00	-1.00	-1.01	-1.01
GW072919	40	238297.7	6293735	0.03	0.02	-0.47	-0.49	-0.60	-0.62
GW109845	42	243780	6293856	-0.02	-0.02	-0.27	-0.23	-0.44	-0.44
GW101461	45	228708	6301415	0.04	0.04	0.04	0.04	0.04	0.04
GW050996	45.7	230231.9	6299638	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04
GW107329	48	230020	6307333	0.22	0.23	-2.68	-2.62	-3.54	-3.54
GW068505	48.8	237289.6	6292088	-0.05	-0.05	-0.08	-0.08	-0.08	-0.08
GW100967	50	232630.9	6294136	-0.04	-0.04	-0.05	-0.05	-0.05	-0.05
GW109307	55	237496.3	6292948	-0.03	-0.03	0.28	0.28	0.28	0.27
GW062815	56.7	228909.6	6302101	-0.10	-0.10	-0.11	-0.11	-0.11	-0.11
GW053046	58.5	229845.5	6306997	0.20	0.20	-1.50	-1.46	-1.91	-1.92
GW110484	59	229722	6302884	1.06	1.14	-13.10	-13.09	-13.28	-13.28
GW109844	60	243657	6293783	-0.05	-0.05	-0.36	-0.32	-0.58	-0.59
GW110485	66.6	229732	6301994	0.05	0.05	-0.30	-0.30	-0.31	-0.31
GW103238	68.45	231462.8	6299286	0.19	0.19	0.19	0.18	0.18	0.18
GW102427	68.45	231520.6	6299797	0.01	0.00	0.01	-0.03	-0.15	-0.17
GW102426	70	231545.6	6299829	0.02	0.01	0.01	-0.04	-0.18	-0.21
GW039443	70	231951.6	6297312	0.17	0.17	0.17	0.17	0.17	0.17
GW105433	72	238302.6	6293824	0.04	0.04	-3.13	-3.17	-3.35	-3.38
GW105435	72	238312.6	6293760	0.04	0.04	-2.54	-2.58	-2.72	-2.75
GW105434	72	238318.6	6293795	0.04	0.04	-2.73	-2.76	-2.93	-2.96
GW109842	72	243605	6293745	-0.06	-0.06	-0.41	-0.36	-0.65	-0.66
GW109843	72	243684	6293872	-0.03	-0.02	-0.36	-0.31	-0.59	-0.60
GW109022	78	241744	6293080	0.24	0.25	-1.13	-0.99	-1.64	-1.66
GW058348	99.3	236477.3	6292534	0.25	0.25	0.30	0.30	0.29	0.30
GW105064	104	230353.6	6307750	0.36	0.37	-10.00	-9.84	-12.76	-12.78
GW105734	120	244008.7	6294415	3.61	4.41	-21.30	-17.38	-28.47	-28.62
GW030862	146	232011.3	6305423	0.69	0.34	-1.22	-2.82	-9.46	-10.19
GW102728	156.5	244489.4	6294414	3.10	3.67	-24.84	-21.94	-30.71	-30.82
GW108187	197	245529.1	6295851	3.76	4.25	-33.27	-31.24	-37.01	-37.10
GW109766	258	246343	6299273	15.50	15.51	-1.55	-1.74	-2.31	-2.38
GW109783	271.9	242072.3	6293481	3.93	4.50	-7.22	-8.47	-14.48	-14.71
GW109767	273.6	242638	6296368	13.11	15.88	-20.27	-16.63	-29.53	-30.01
GW108185	295	246570.1	6301610	6.94	7.77	-1.92	-7.83	-24.25	-24.56
GW109336	319.5	237341.9	6296562	22.56	15.86	-17.63	-20.50	-27.56	-28.08
GW109337	400	237489	6300778	24.61	-42.05	-101.53	-107.62	-124.42	-126.72

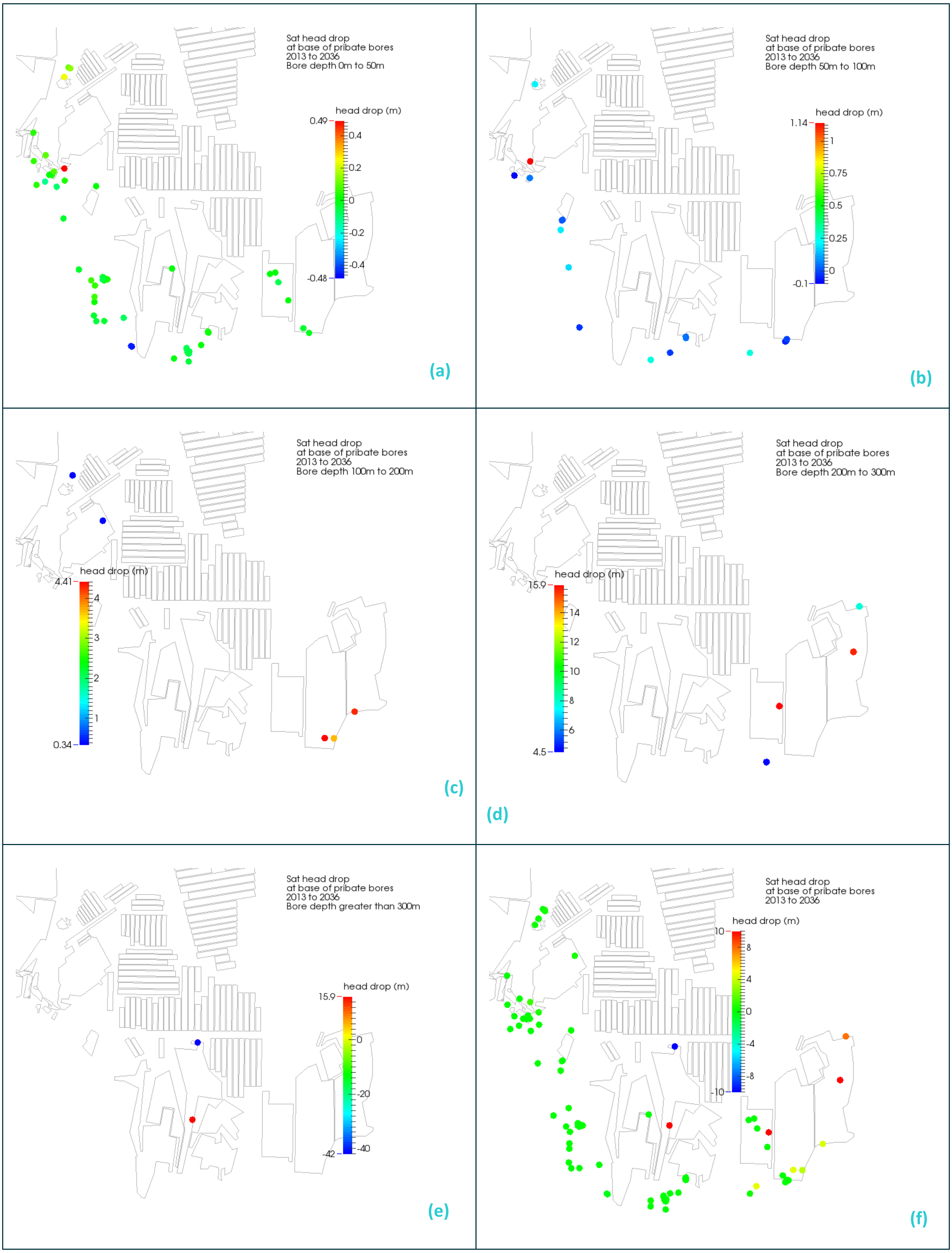

Figure G23 Head drops in private bores due to mining of the proposed APE and SV longwalls in the "SPR then APE" scenario

2.2.8 Comparison of "SPR then APE" scenario with the Base case.

The differences between the "SPR then APE" and the Base case are discussed here. By almost all measures, the "SPR then APE" has less impact than the Base case, and this is primarily because in the "SPR then APE" case the new SV panels and the APE panels are mined sequentially and the Springvale mine is allowed to flood after completion of LW432 in October 2023. This means that compared with the Base case, approximately 10 years less of groundwater pumping occurs in Springvale.

Impact on Cox's River – in Section 2.2.6 the drawdown in Cox's River was discussed. It was shown that mining APE and SV LW416 onwards induce a net drawdown at Cox's River of less than 1cm, and most drawdown quantities are much less than 1mm. The drawdowns due to mining "SPR then APE" are very small and very similar to those in the Base case.

Impact on Private bores - in Section 4.2.6 the drawdown at the bottom of private bores was discussed. The net effect of the APE and the new SV LW416 onwards on private bores was tabulated. In 2033, the median effect of these mines on private bores of depth less than 50m was 1.1cm, however some deeper bores suffer substantial drawdown. The median of the differences in drawdowns between the "SPR then APE" scenario and the Base case is 2%, or around 1mm.

Impact of baseflow to swamps and streams - The "SPR then APE" schedule has an identical or slightly less impact on the baseflows and leakages to and from streams and swamps compared with the Base case model (Appendix H). Thus the predicted impact for the "SPR then APE" scenario is less than that for the Base case for every swamp and stream.

Impacts on near-surface groundwater – The differences between the two scenarios are minor, and are shown in Figure G24. The porepressure at a few points above the Springvale panels is marginally higher in year 2036 for the "SPR then APE" scenario than the Base case, due to the pumping ceasing in Springvale in 2023. Similarly, it is marginally lower over the APE panels, due to them being extracted longer in the "SPR then APE" scenario. Over the entire top surface, the mean of the absolute magnitude of the porepressure differences between these two scenarios is only 165Pa (≈0.016m). Over the region above the Springvale and Angus-Place mines, this mean is only 460Pa[1].

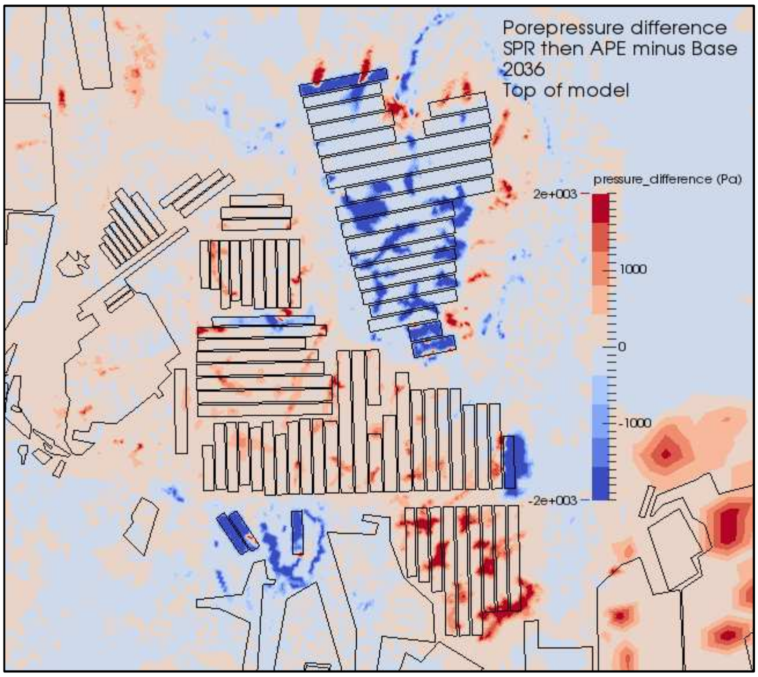

Figure G24 Difference between the SPR then APE and Base case scenarios

[1] If the topography were saturated, this would correspond to a head difference of 4.6cm. Since it is unsaturated, the head difference is less than 4.6cm.

3 Recovery Simulation

Once the APE extraction was completed in January 2036, all of Angus Place was assumed to be flooded and groundwater recovery was simulated in transient mode to 2383.

3.1.1 Water balance during the recovery period

The average rates of recharge and discharge throughout the recovery period from 2036 to 2083 are given in Table G14. The average recharge to the groundwater system is 133 ML/day, comprising mainly rainfall recharge (126.5 ML/day) and leakage from swamps and streams into the groundwater system (7 ML/day).

The average groundwater discharge across the model is 128 ML/day. ET represents the major source of discharge (97 ML/day). Baseflow to swamps and streams is 15 ML/day.

A net loss of groundwater across the model boundary is 16 ML/day. The gain in fluid storage in the groundwater system is 6 ML/day.

Table G14 Average rates of recharge and discharge 2036 to 2083

Component	Groundwater Inflow (Recharge) (ML/day)	Groundwater Outflow (Discharge) (ML/day)
Rainfall recharge	126.5	
Evapotranspiration		97.0
Swamps and rivers	6.7	15.0
Net outflow through model boundary (ML/day)	15.7 .	
Mine inflow (ML/day)		0
Total (ML/day)	133.2	127.6
Net Outflow (ML/day)	-5.6	
Change in fluid volume contained (storage) in the model (ML/day)	+5.6	
Discrepancy	3.7x10-4 %	

The average rates of recharge and discharge throughout the recovery period from 2083 to 2183 are given in Table G15.

The average recharge to the groundwater system is 133 ML/day, comprising mainly rainfall recharge (126 ML/day) and leakage from swamps and streams into the groundwater system (7 ML/day).

The average groundwater discharge across the model is 131 ML/day. ET represents the major source of discharge (99 ML/day). Baseflow to swamps and streams is 15 ML/day.

A net loss of groundwater across the model boundary is 16 ML/day. The gain in fluid storage in the groundwater system is 2 ML/day.

Table G15 Average rates of recharge and discharge 2083 to 2183

Component	Groundwater Inflow (Recharge) (ML/day)	Groundwater Outflow (Discharge) (ML/day)
Rainfall recharge	126.4	
Evapotranspiration		99.4
Swamps and rivers	6.6	15.4
Net outflow through model boundary (ML/day)	15.9 .	
Mine inflow (ML/day)		0
Total (ML/day)	133.1	130.7
Net Outflow (ML/day)	-2.32	
Change in fluid volume contained (storage) in the model (ML/day)	+2.32	
Discrepancy	3.3x10-4 %	

The average rates of recharge and discharge throughout the recovery period from 2183 to 2383 are given in Table G16. The average recharge to the groundwater system is 133 ML/day, comprising mainly rainfall recharge (126 ML/day) and leakage from swamps and streams into the groundwater system (6.5 ML/day).

The average groundwater discharge across the model is 132 ML/day. ET represents the major source of discharge (101 ML/day). Baseflow to swamps and streams is 16 ML/day.

A net loss of groundwater across the model boundary is 16 ML/day. The gain in fluid storage in the groundwater system is less than 1 ML/day.

Table G16 Average rates of recharge and discharge 2183 to 2383

Component	Groundwater Inflow (Recharge) (ML/day)	Groundwater Outflow (Discharge) (ML/day)
Rainfall recharge	126.4	
Evapotranspiration		100.5
Swamps and rivers	6.5	15.8
Net outflow through model boundary (ML/day)	16.0 .	
Mine inflow (ML/day)		0
Total (ML/day)	132.9	132.3
Net Outflow (ML/day)	-0.62	
Change in fluid volume contained (storage) in the model (ML/day)	+0.62	
Discrepancy	4.3x10-5 %	

Table G17 Average rates of recharge and discharge 2036 to 2383

Component	Recovery from 2033 to 2083		Recovery from 2083 to 2183		Recovery from 2183 to 2383	
	Groundwater Inflow (Recharge) (ML/day)	Groundwater Outflow (Discharge) (ML/day)	Groundwater Inflow (Recharge) (ML/day)	Groundwater Outflow (Discharge) (ML/day)	Groundwater Inflow (Recharge) (ML/day)	Groundwater Outflow (Discharge) (ML/day)
Rainfall recharge	126.5		126.5		126.4	
Evapotranspiration		97.0		99.4		100.5
Swamps and rivers	6.8	15.0	6.6	15.4	6.5	15.8
Net outflow through model boundary (ML/day)	15.7		15.9		16.0	
Mine inflow (ML/day)	0		0		0	
Total (ML/day)	133.2	127.0	133.1	130.7	132.9	132.3
Net Outflow (ML/day)	-5.6		-2.32		-0.62	
Change in fluid volume contained (storage) in the model (ML/day)	+5.6		+2.32		+0.62	
Discrepancy	3.7x10-4 %		3.3x10-4 %		4.3x10-5 %	

From Table G17, it can be seen that the model is close to a steady-state after 350 years; the changes in the groundwater balance between 2183 and 2383 is very small. The rate of change in groundwater storage account for only around 0.5% of the total recharge in this period.

3.1.2 Water content within the model

Figure G25 and Figure G26 depict the water content changes in each layer throughout mining and recovery. In absolute terms, AQ3 loses most water and it takes around 350 years to achieve effective steady-state. The topmost layers, Weath and AQ6, also lose 3% and 8% of their water content respectively, but take only around 50 years to achieve steady-state. As discussed earlier, the loss of water in the upper strata during the period from 2006 to 2012 may also be attributed to the climatic variation.

AQ1 loses around 3% of its water content and also takes around 50 years to achieve steady-state. Because the model has a 30km x 30km extent, only approximately 25% of AQ3 is undermined. This is the region that loses water. The figures below pertain to the whole model, so that a loss of 4% from AQ3 over the whole model means the part of AQ3 directly over mining panels loses approximately 16% of its water (4/25%). Similarly, many years after mine completion, the whole of AQ3 has 1% less water than initially, and the parts over mining panels contain approximately 4% less than the pre-mining state. This is illustrated qualitatively in the phreatic-surface cross sections.

In all layers, the “SPR then APE” model causes similar water losses as in the Base case, and in most layers the loss is slightly smaller.

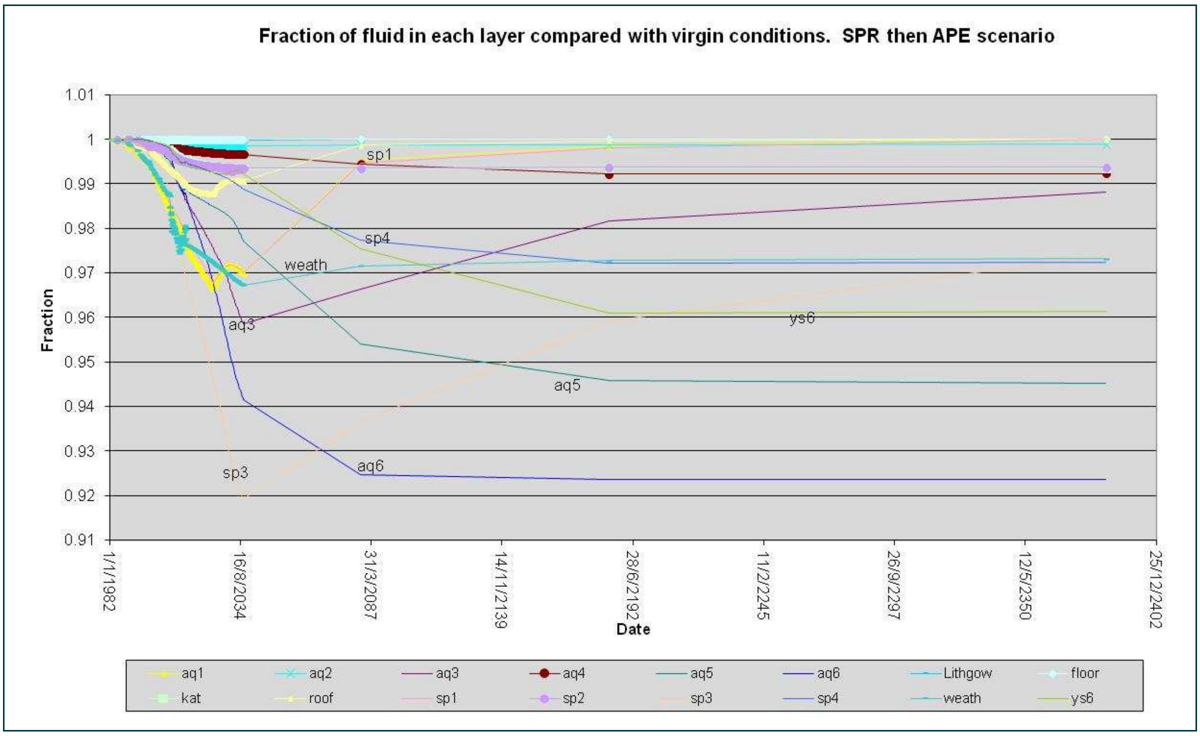

Figure G25 Fraction of fluid in each layer compared with virgin conditions during recovery

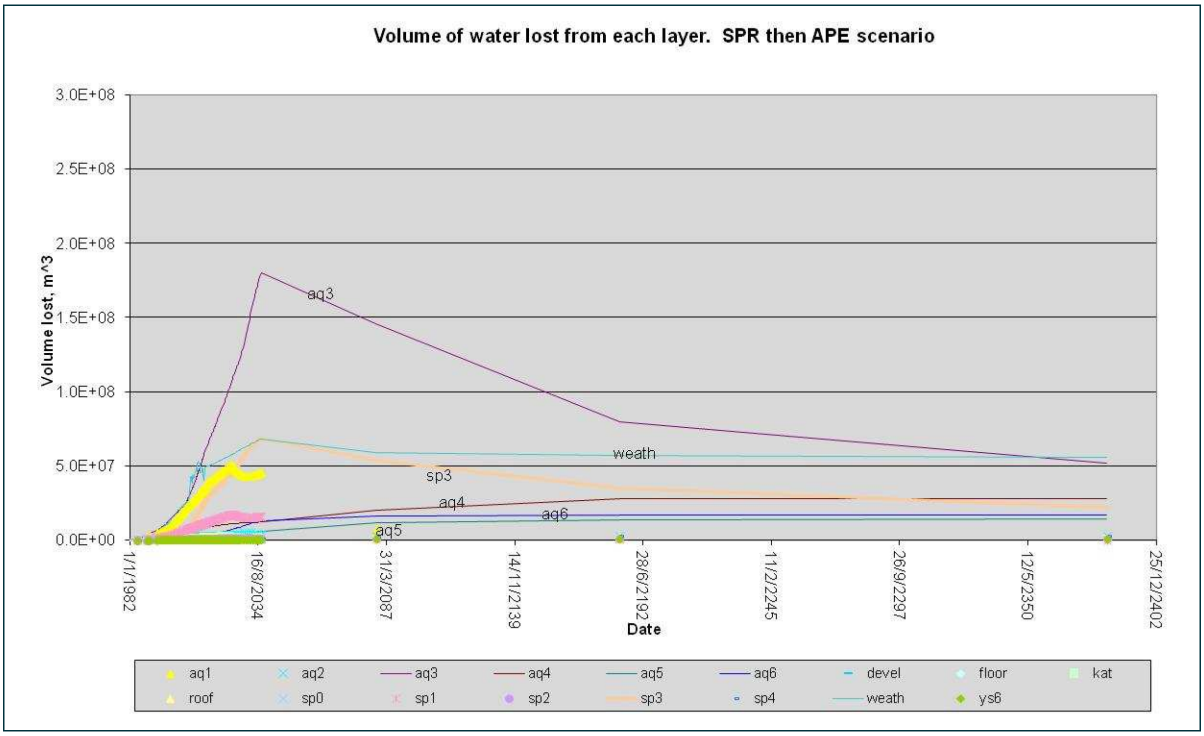

Figure G26 Volume of water lost from each layer between virgin conditions and year 2683

3.1.3 Recovery of water levels

Appendix I provides the simulated recovery of water levels in the Lithgow Seam, AQ1, AQ2, AQ3, AQ4, AQ5, AQ6 and the top of the model (i.e. the ground surface) following 46 and 96 years of recovery after completion of mining.

Figures I43 to I56 in Appendix I show the simulated recovery of water levels with respect to the pre-mining groundwater conditions and Figures G57 to G70 show the simulated recovery of water levels with respect to groundwater levels at the end of the validation period (1 Jan 2012).

Figure G27 and Figure G28 show two typical recovery plots (recovery-negative and drawdown-positive) with respect to the pre-mining groundwater condition in the Lithgow Seam following 46 years and146 years of completion of mining respectively. Figure G27 shows the recovery 46 years following completion of mining while Figure G28 shows the recovery 146 years following completion of mining. The groundwater levels in the Lithgow seam have increased by up to 100m above the pre-mining groundwater levels. The groundwater recharge zone seems to develop first in the APE_12 and APE_13A mine voids - the deepest point within the Lithgow Seam - and then gradually expand laterally in the south westerly direction filling up more mining voids. The area with 40m drawdown (west of the AP and SV mines, Figure G27) can be seen to be gradually being recharged from 2083 to 2183 (Figure G28). The drawdown quantities are typically negative, indicating an increase in porepressure compared with pre-mining conditions. This is due to mining-induced permeability enhancements allowing water to enter lower strata at a faster rate than before mining.

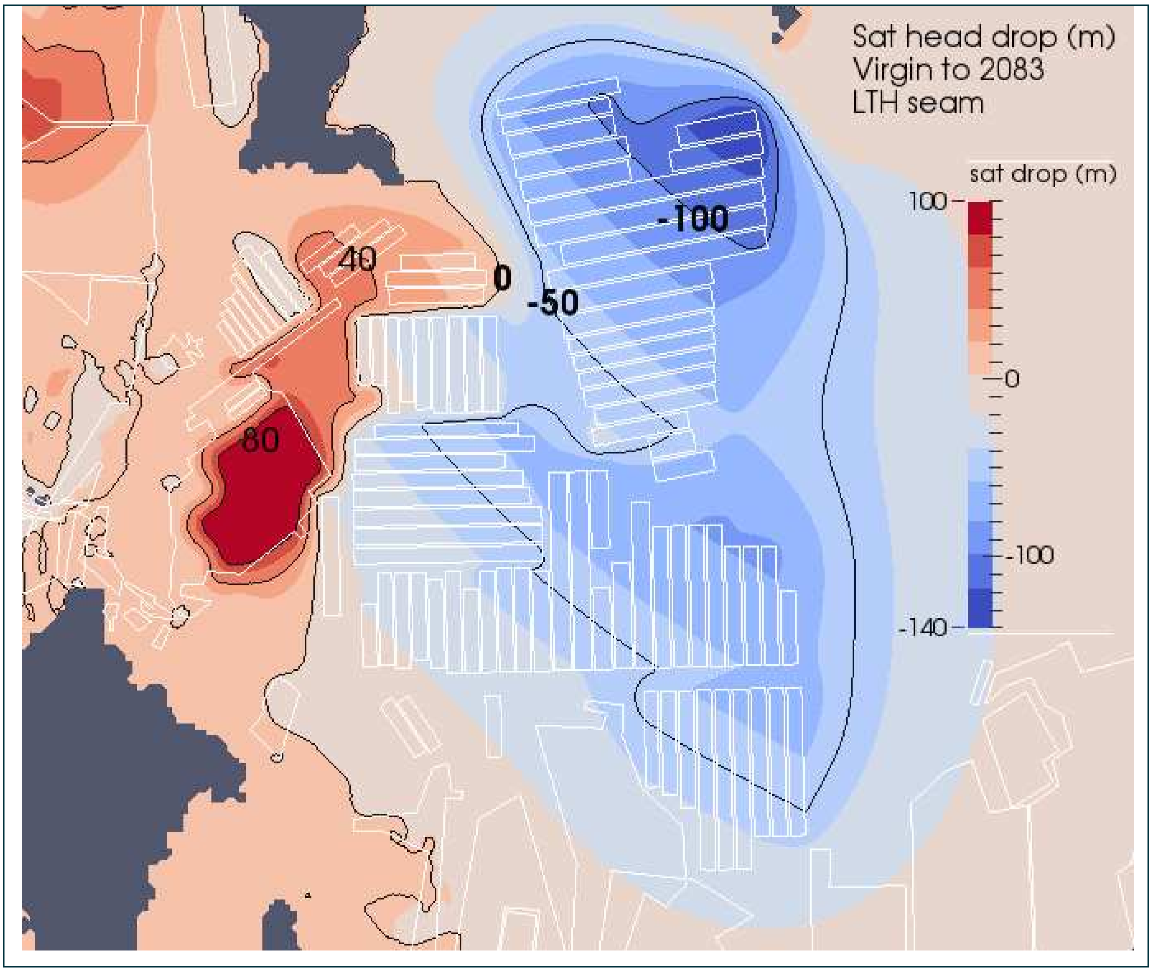

Figure G27 Distribution of head drops in the Lithgow Seam at 2083 with respect to pre-mining groundwater conditions

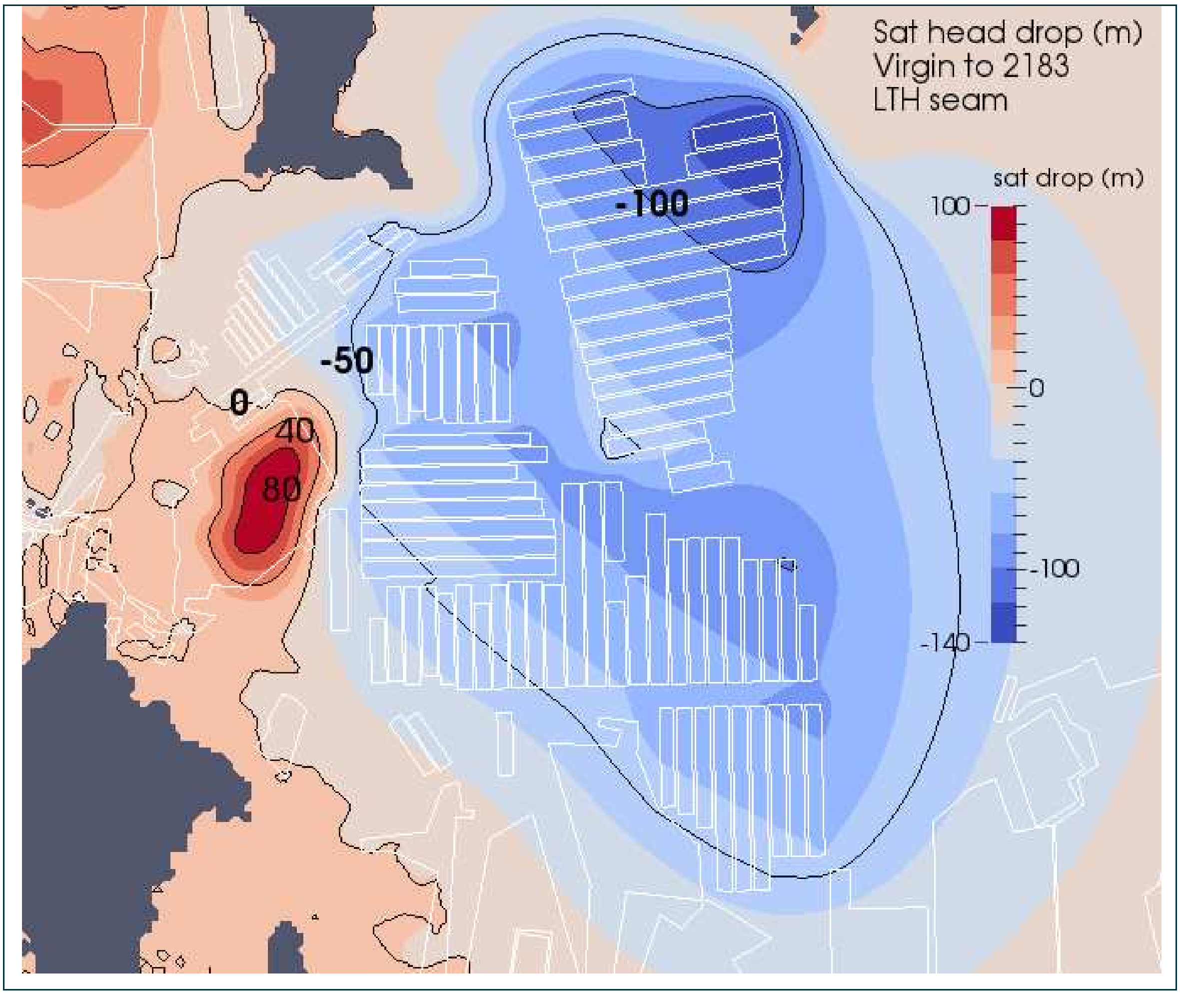

Figure G28 Distribution of head drops in the Lithgow Seam at 2183 with respect to pre-mining groundwater conditions

Recovery of water levels within AQ1, AQ2 and AQ3 can be seen in Figures I45 to I50 (Appendix I). The groundwater recharge zone again seems to develop first in the APE_12 and APE_13A regions and then gradually expand laterally in the south westerly direction filling up more strata.

Figure G29 and Figure G30 show the head drops at the ground surface of the model compared with the virgin conditions at 2083 and 2183. Head drops are similar in magnitude over the new APE and Springvale panels to those over the already-mined regions (compare with Figure 60 in the main report for instance). Figure G29 and Figure G30 are quite similar, demonstrating that for the model's topmost layer, steady-state is effectively achieved by 2083, which is also supported by graphs in Section 3.1.2.

The following observations can be made.

- The extensive desaturation occurring in AQ1 above the mining panels completely disappears within 50 years.
- The unsaturated zones in AQ3 below MYC slowly fill over the 100 years after mining, but in most cases there remains a small unsaturated zone even after the model has been run to steady-state.
- The strata above MYC effectively reach steady-state within 50 years after mining ceases.
- Some regions in AQ4 below YS6 which were initially saturated remain unsaturated after mining, while some regions which were initially unsaturated become saturated after mining.
- The regions above SP4 experience a phreatic-surface drop of a few metres below the topographic ridges, and significantly less than this in the valleys, and the phreatic surface in this region typically falls very slightly during the 50 years after mining ceases before reaching steady-state.

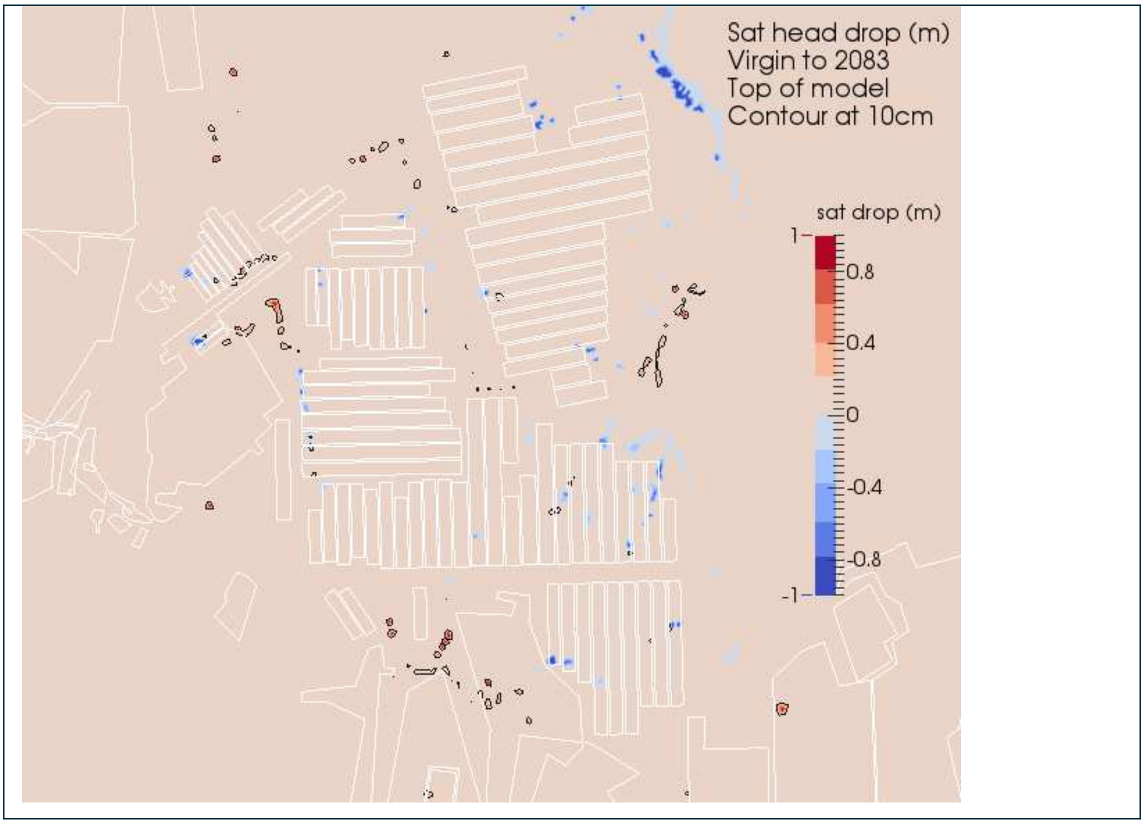

Figure G29 Distribution of saturated head drops at the ground surface in 2083 with respect to pre-mining groundwater condition (-ve values indicate head recovery)

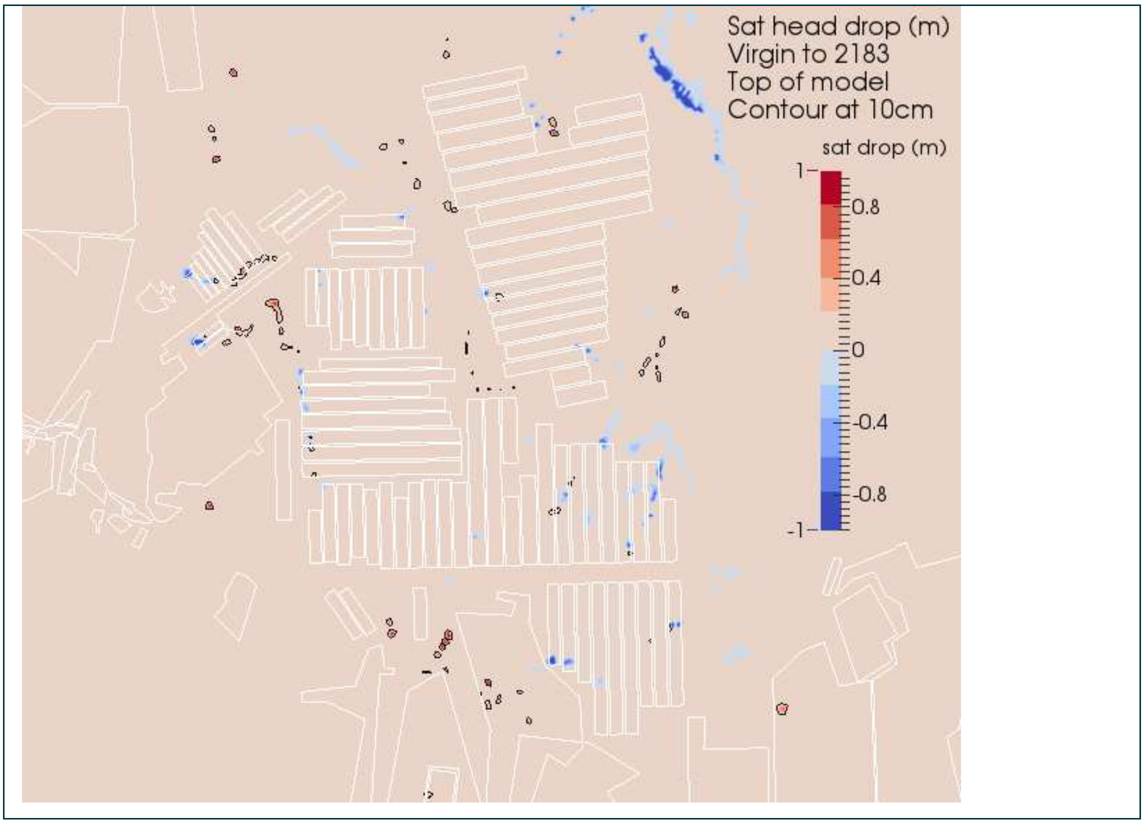

Figure G30 Distribution of saturated head drops at the ground surface in 2183 with respect to pre-mining groundwater condition (-ve values indicate head recovery)

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Appendix H

Baseflow to Swamps and Streams (Alternative Mine Schedule)

Angus Place and Springvale Colliery Operations

Groundwater Assessment

D P Adhikary and A Wilkins
Report No EP15346
January 2015

Springvale Colliery and Angus Place Colliery

Citation

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Baseflow Balance

As described in Section 2.2.3 of Appendix G, baseflow to swamps and streams and leakage from swamps and streams to the groundwater system were computed during calibration and validation period for the alternative mine schedule. Figure H2 to Figure H22 show baseflow balance in ML/day from twenty-one different swamps and streams explicitly simulated in the model (see Figure H1 and Table H1).

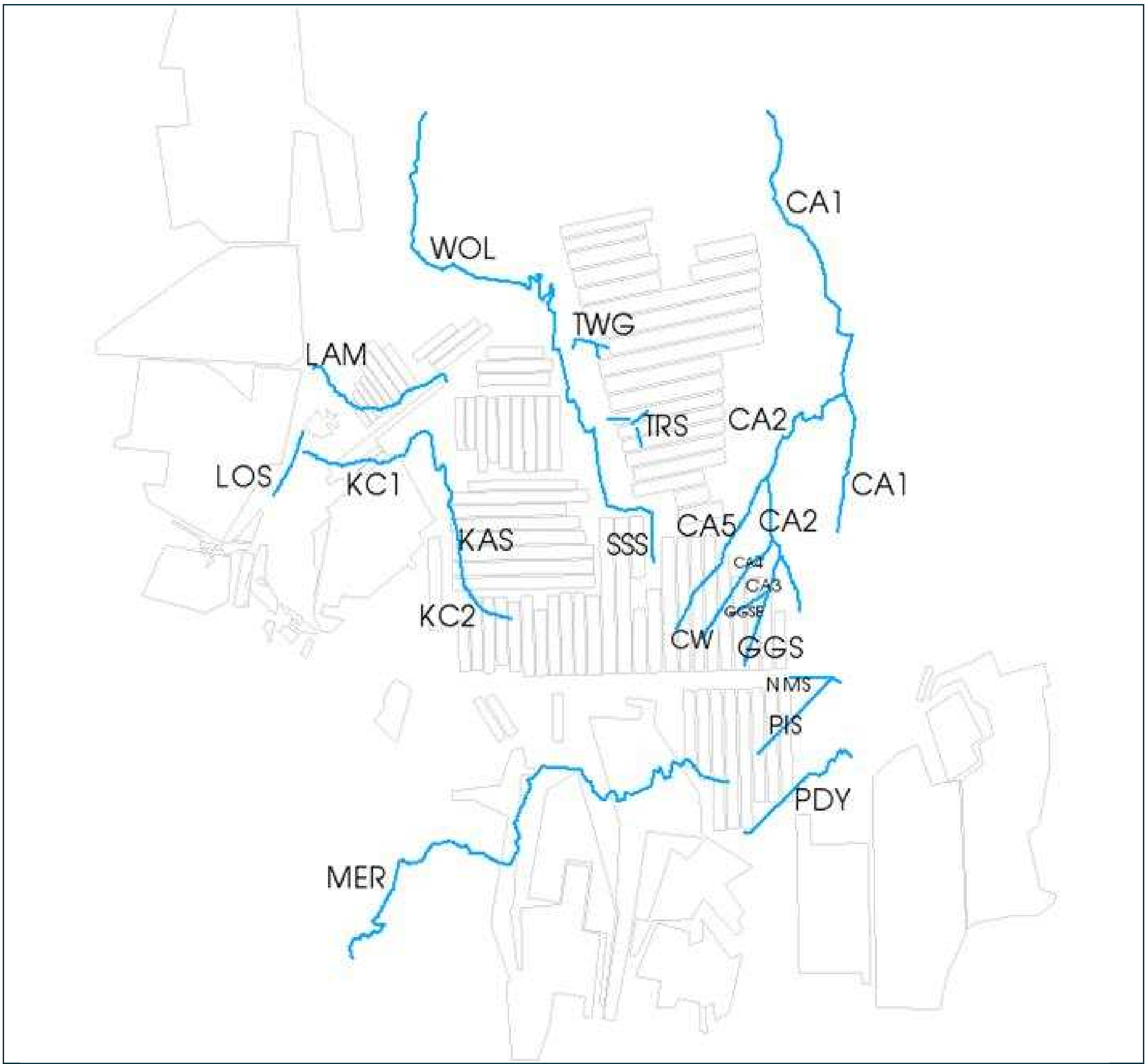

Figure H1 River reach and swamps of interest in the model

Table H1 Swamps and streams considered in the model

Notation	Rivers and swamps	Boundary conditions		Notation	Rivers and swamps	Boundary conditions
CA1	Carne Creek, main branch which flows north	Perennial		LAM	Lamb Creek	Ephemeral
CA2	Carne Creek, central branch which flows from east of LW431 and into CA1	Perennial		LOS	Long Swamp	Perennial
CA3	Carne Creek, branch which flows from GGSE and GGS to CA2	Perennial		MER	Marrangaroo Creek	Perennial
CA4	Carne Creek, branch flows from CW to CA2	Perennial		NMS	Nine-Mile Swamp	Perennial
CA5	Carne Creek, western branch which flows from above LW415 to CA2	Perennial		PDY	Paddy's Creek	Ephemeral
CW	Carne West Swamp, which flows to CA4	Ephemeral		PIS	Pine Swamp	Ephemeral
GGSE	Gang-Gang Swamp east which flows to CA3	Perennial		TRS	Tri-Star Swamp	Ephemeral
GGS	Gang-Gang Swamp south, which flows to CA3	Perennial		TWG	Twin-Gully Swamp	Ephemeral
KC1	Kangaroo Creek, downstream of KAS	Perennial		SSS	Sunnyside Swamp, which flows into WOL	Perennial
KC2	Kangaroo Creek, upstream of KAS	Ephemeral		WOL	Wolgan River	Perennial
KAS	Kangaroo Swamp	Ephemeral				

Depending upon whether a swamp/stream is permanently water logged or not, the swamp/stream node is assigned with either a constant staging height (perennial condition) or drain (ephemeral condition) as shown in Table H1. Perennial nodes will allow exchange of water in either direction between the stream and aquifer, whereas ephemeral nodes will record discharge when the groundwater pressure at the node is positive, but will allow groundwater level to drop below the node elevation without inducing leakage.

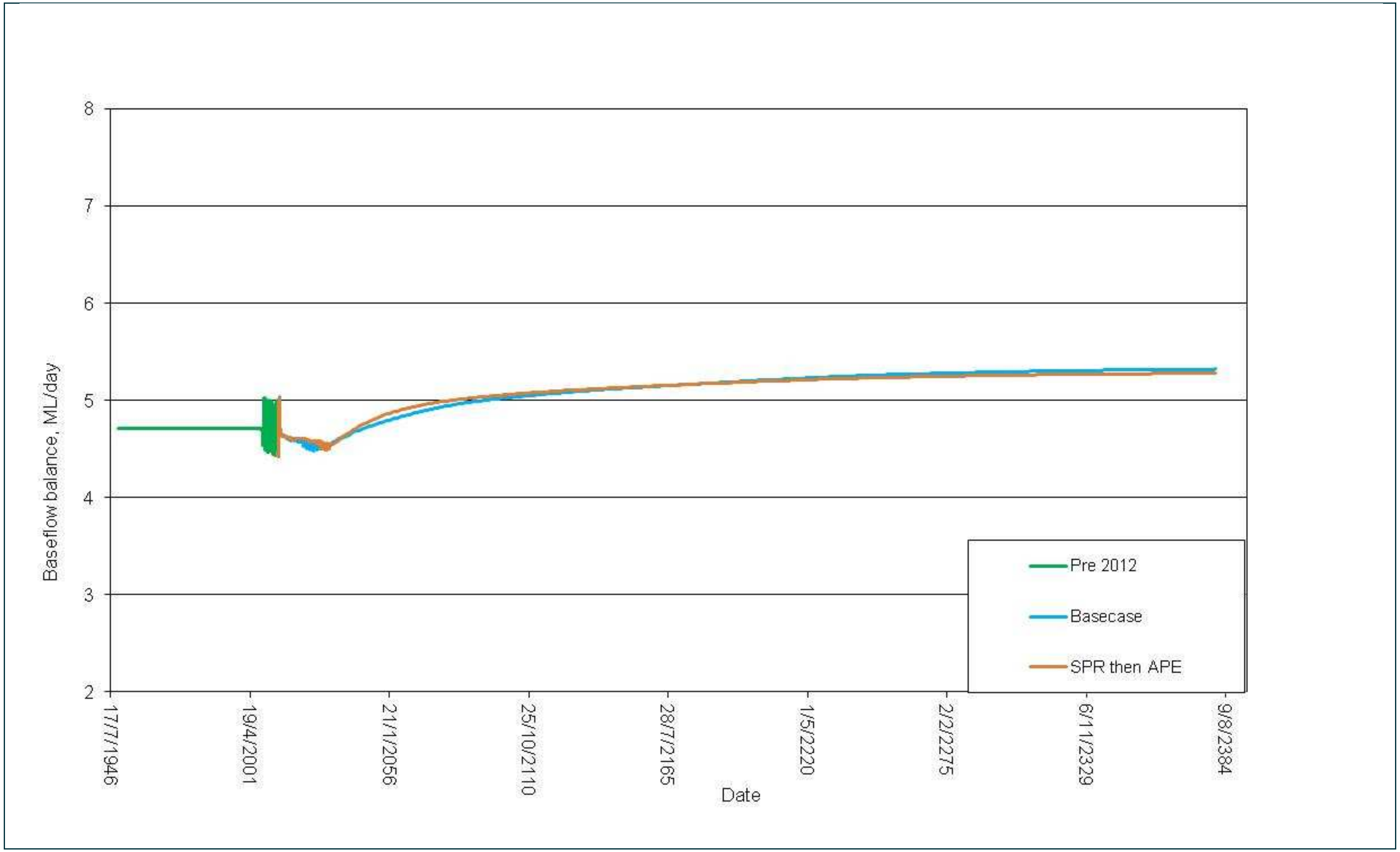

Figure H2 Estimates of baseflow balance (Carne_1)

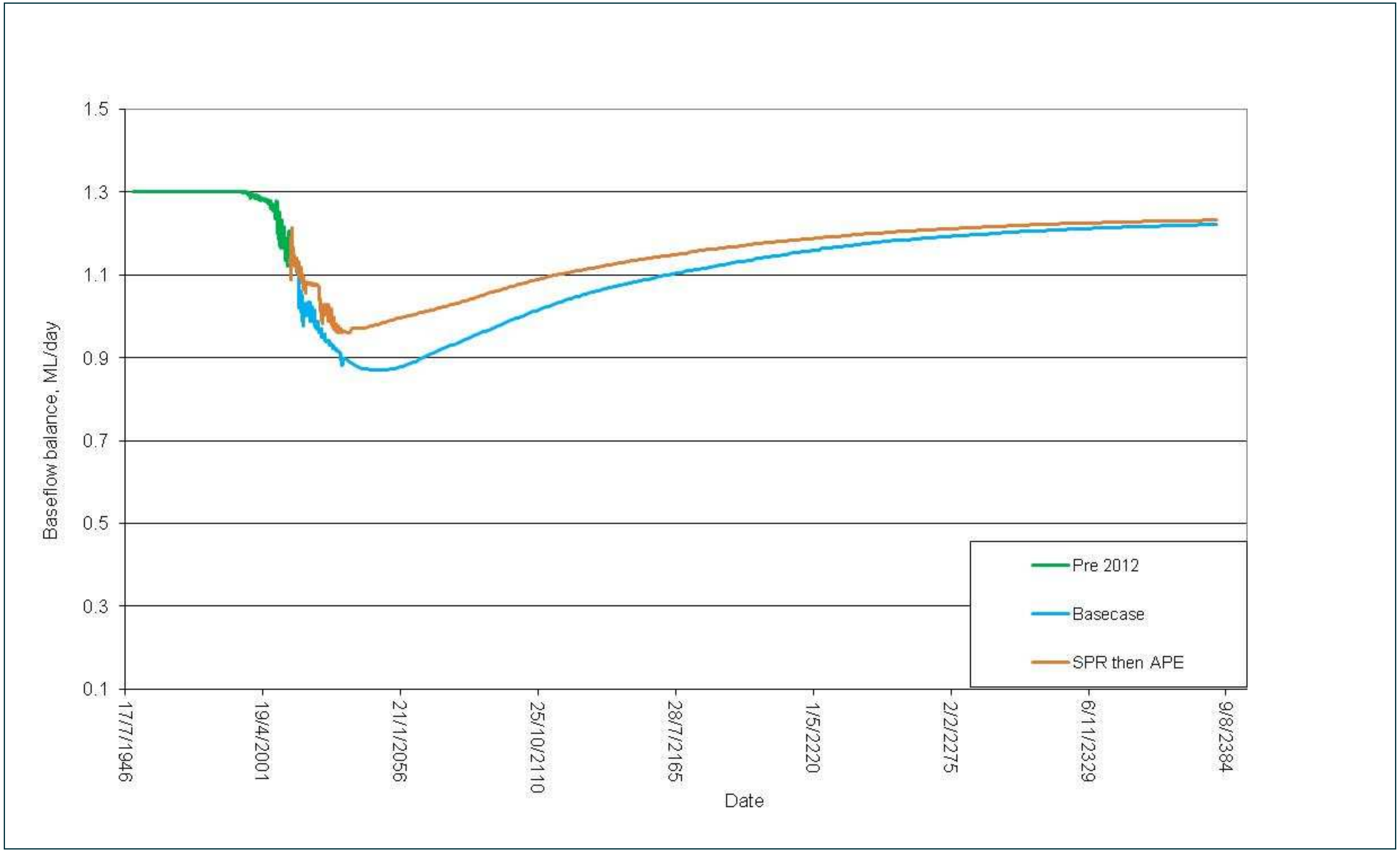

Figure H3 Estimates of baseflow balance (Carne_2)

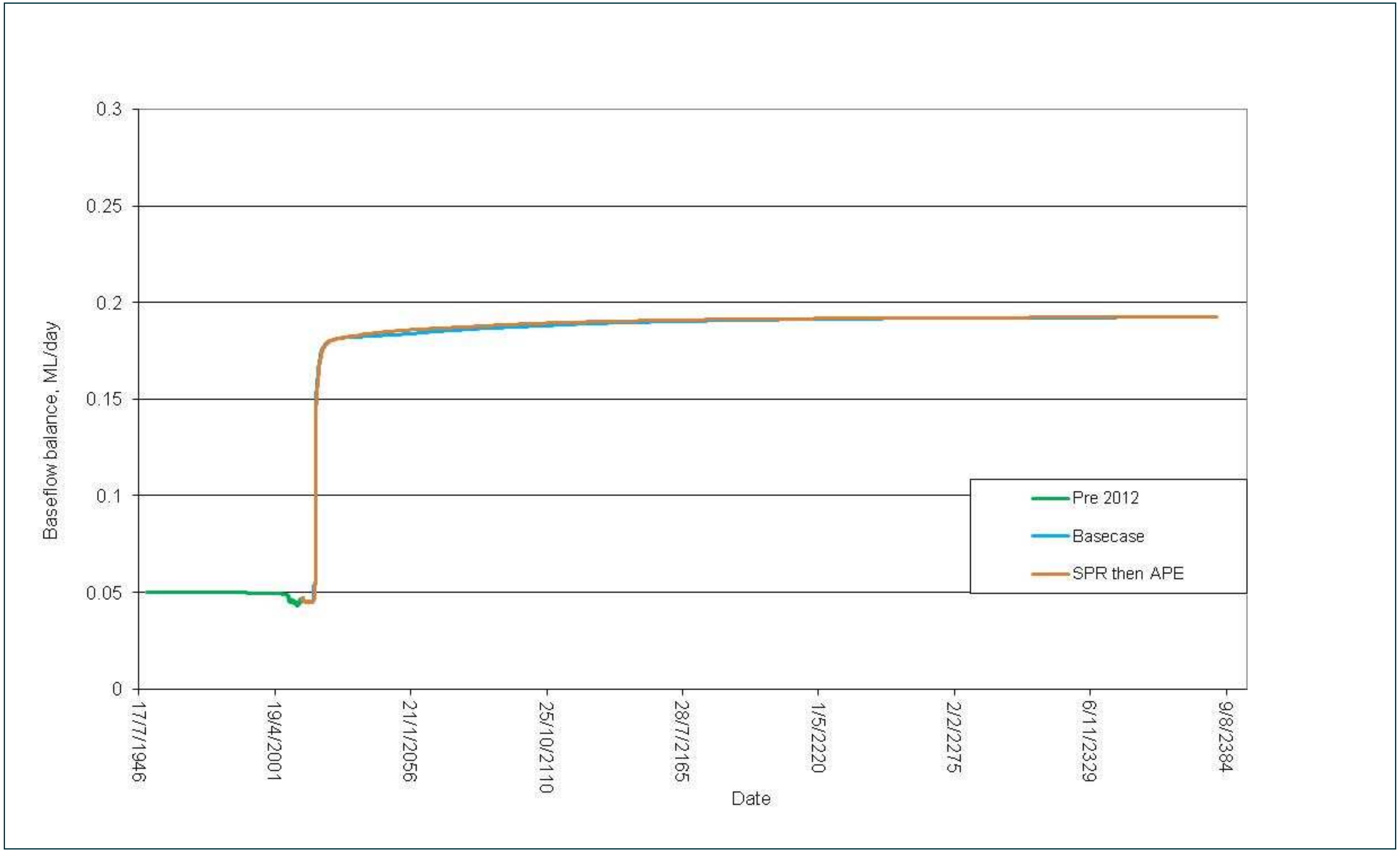

Figure H4 Estimates of baseflow balance (Carne_3)

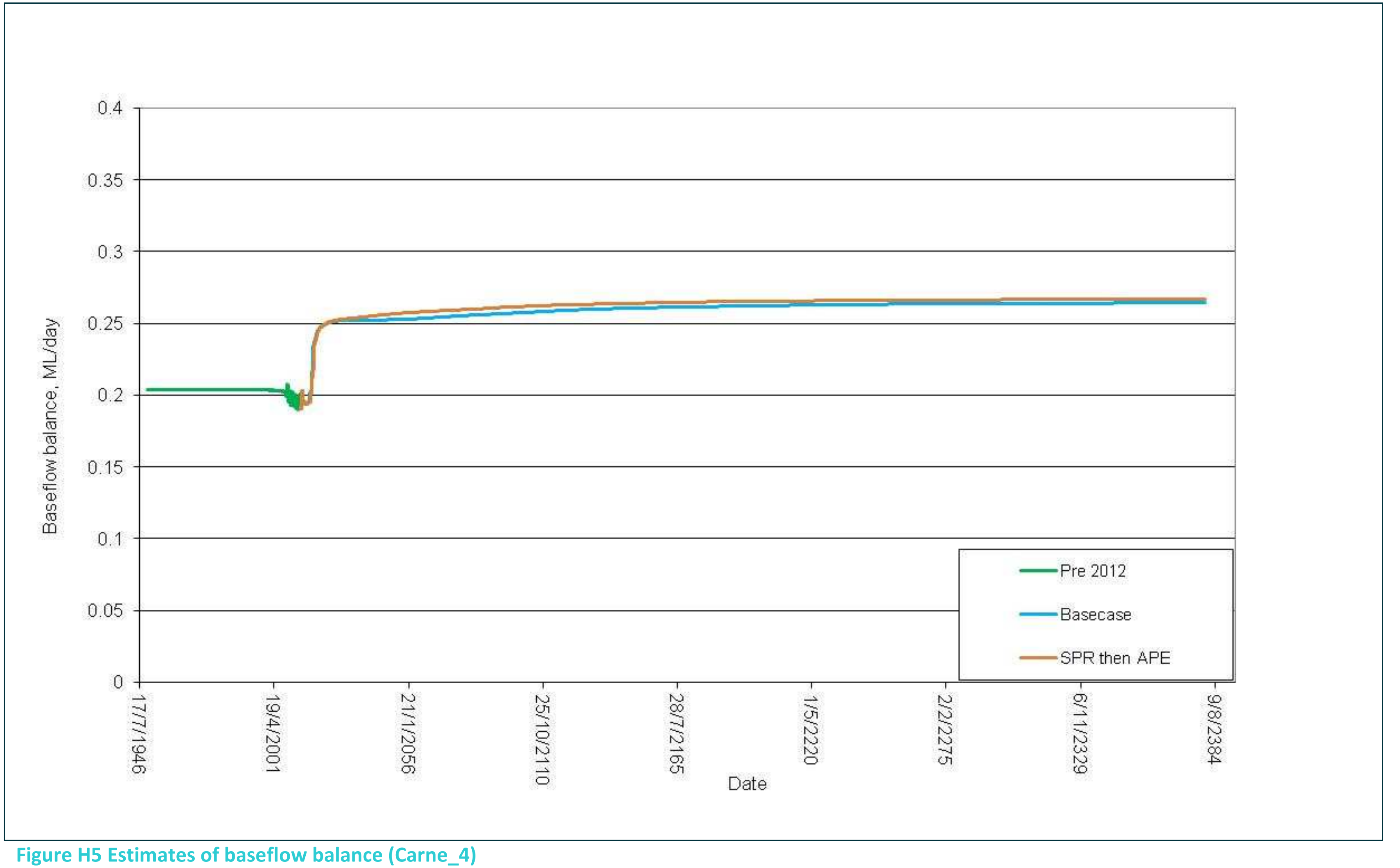

Figure H5 Estimates of baseflow balance (Carne_4)

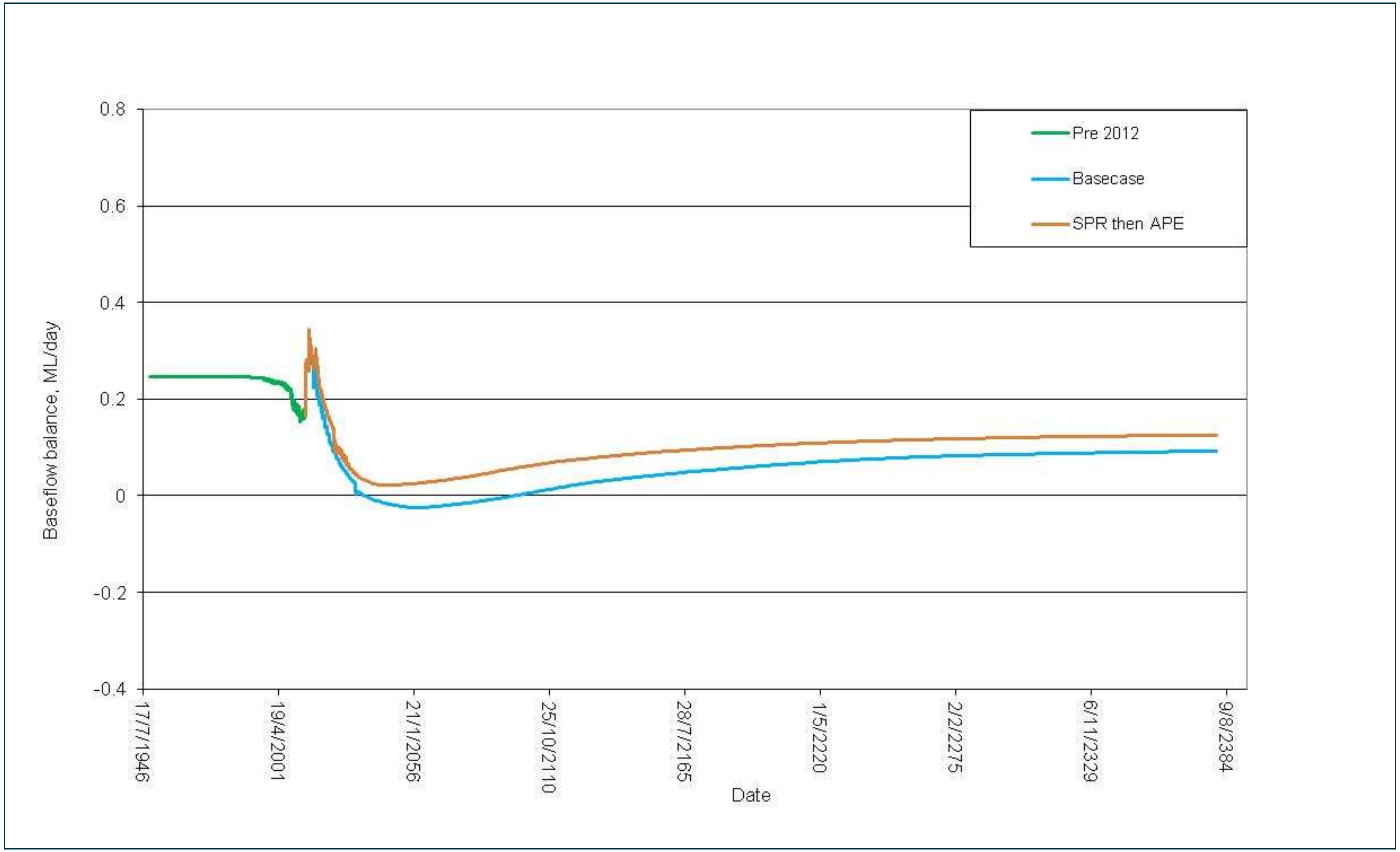

Figure H6 Estimates of baseflow balance (Carne_5)

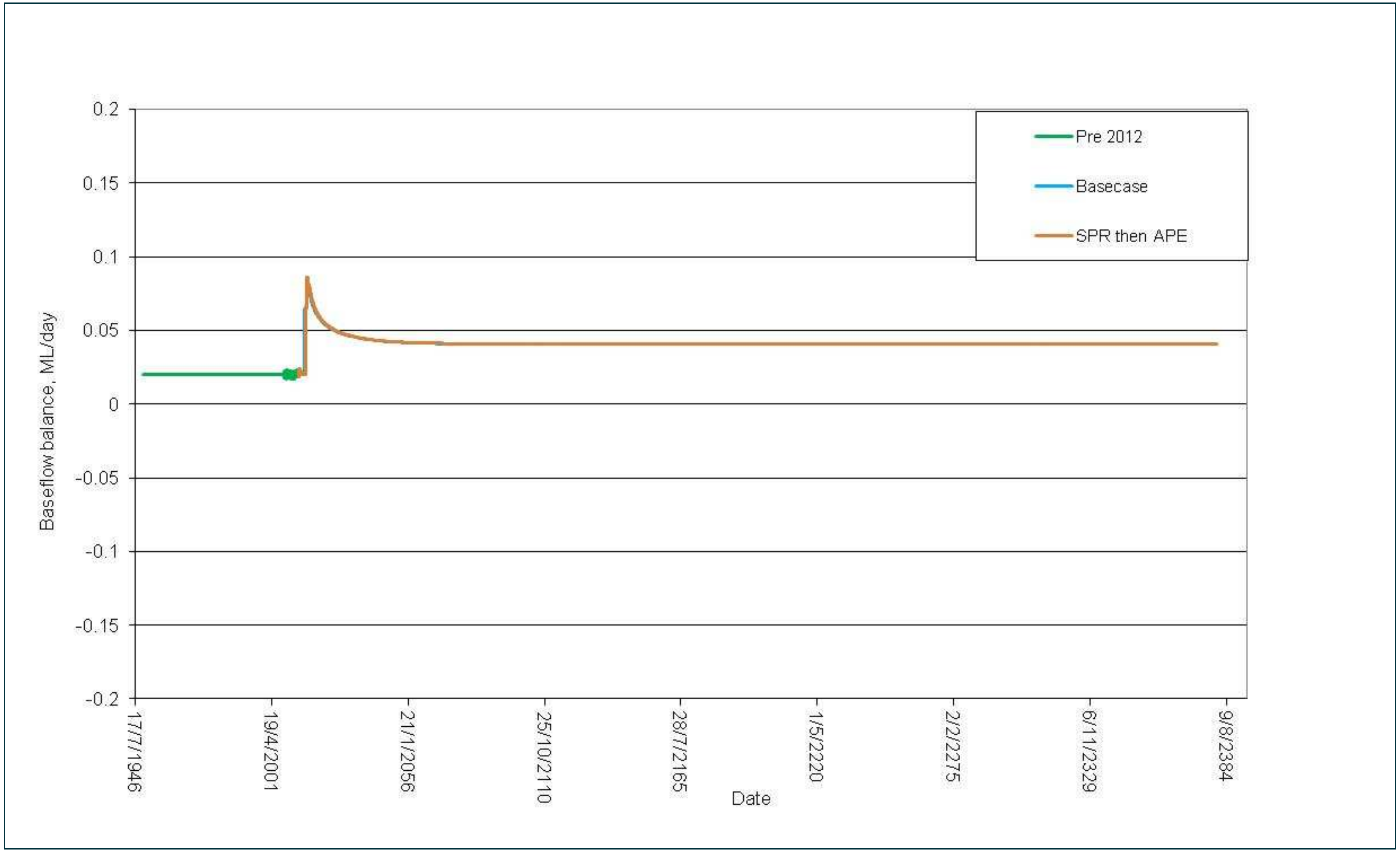

Figure H7 Estimates of baseflow balance (Carne-West Swamp)

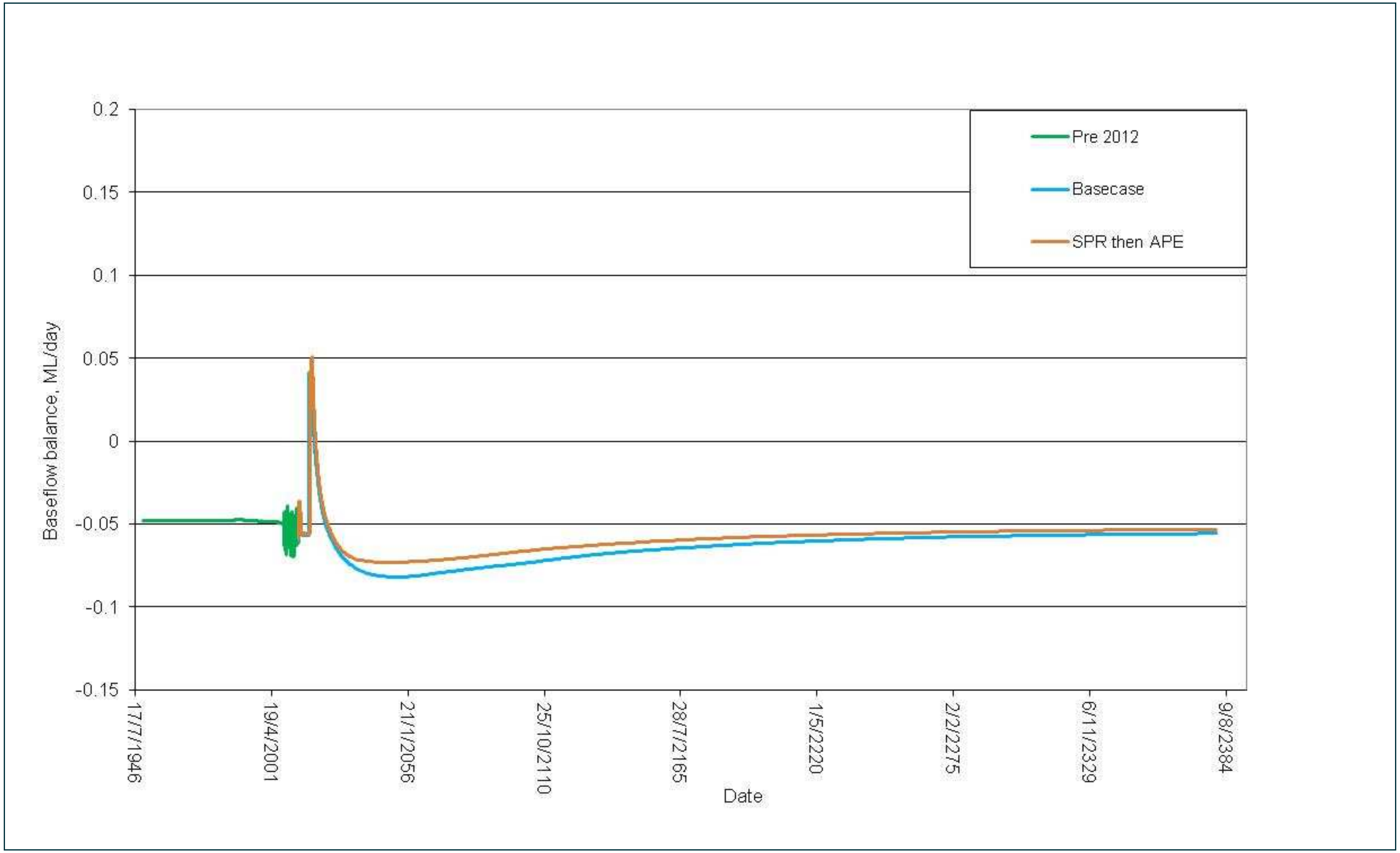

Figure H8 Estimates of baseflow balance (Gang-Gang Swamp South)

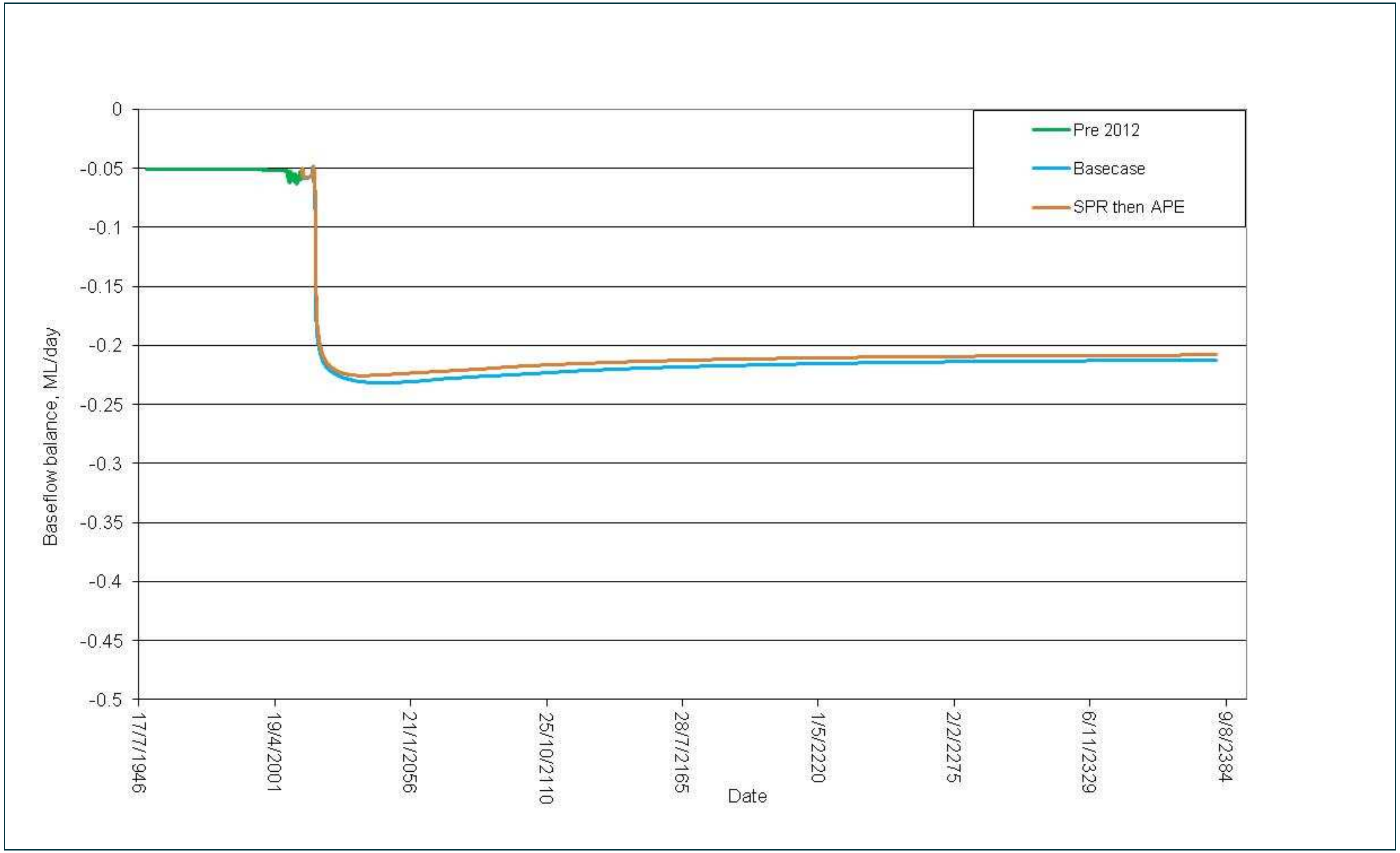

Figure H9 Estimates of baseflow balance (Gang-Gang Swamp South East)

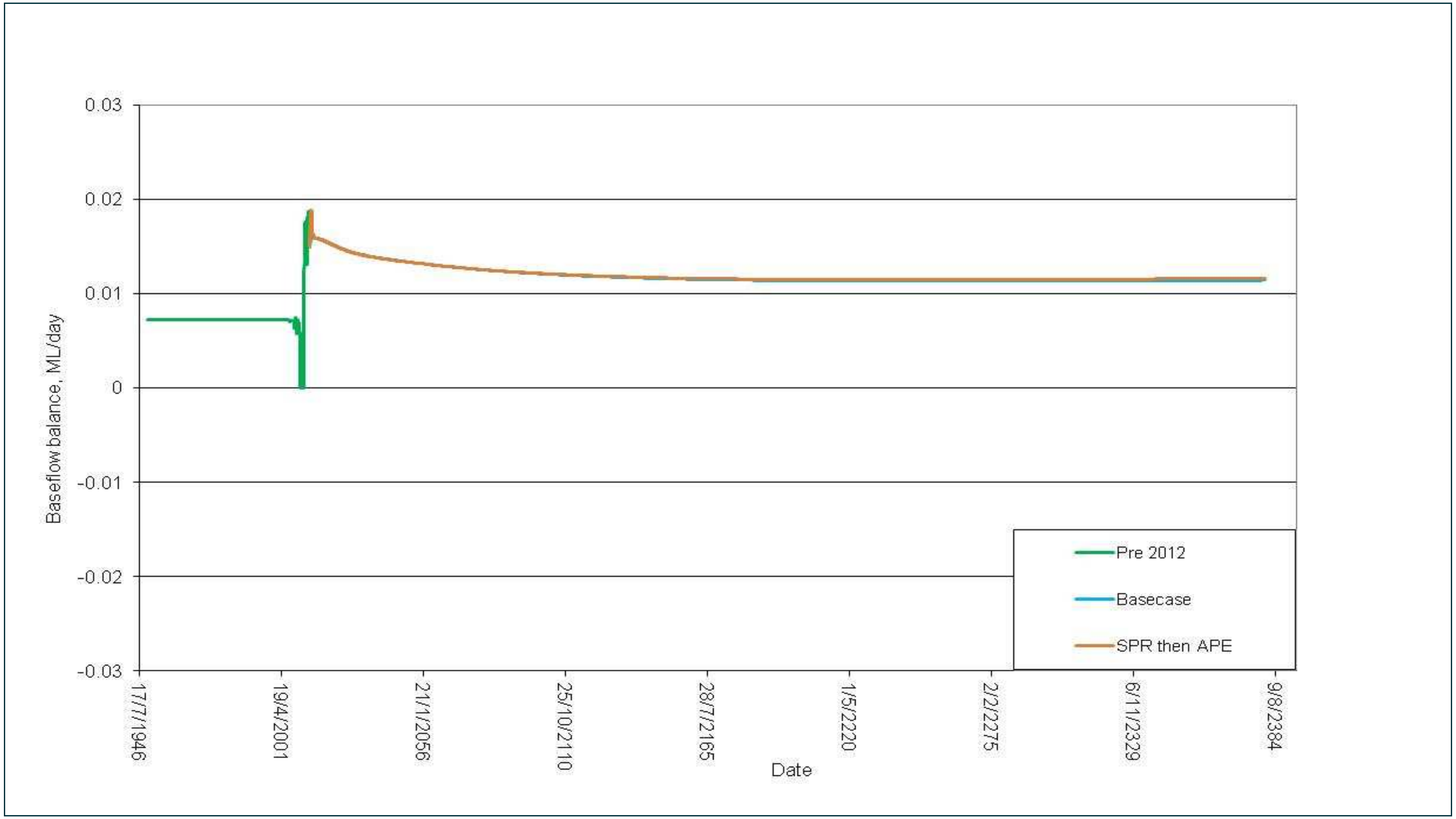

Figure H10 Estimates of baseflow balance (Kangaroo Creek Swamp). The baseflow balance reduces to zero as Angus Place LW940 passes underneath it in 2008. This agrees with piezometer data from the swamp, as described in Appendix A, Section5. As Angus Place LW950 passes underneath the swamp and upstream parts of Kangaroo Creek, the baseflow balance is restored. This is due to mining-induced permeability enhancement. The level of the waterhole near the swamp displays similar complicated behaviour, as described in Appendix A, Section 5.

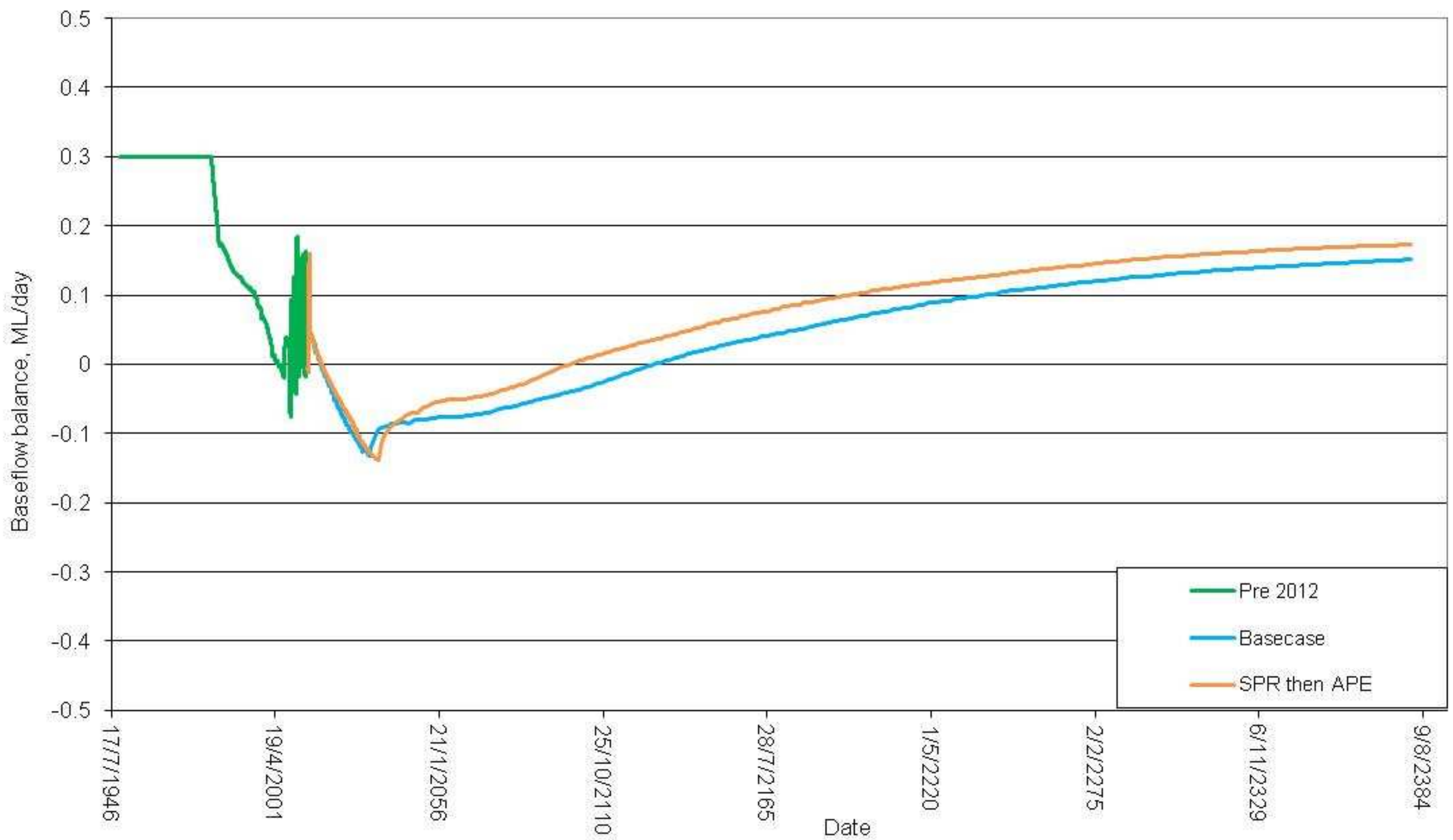

Figure H11 Estimates of baseflow balance (Kangaroo Creek_1)

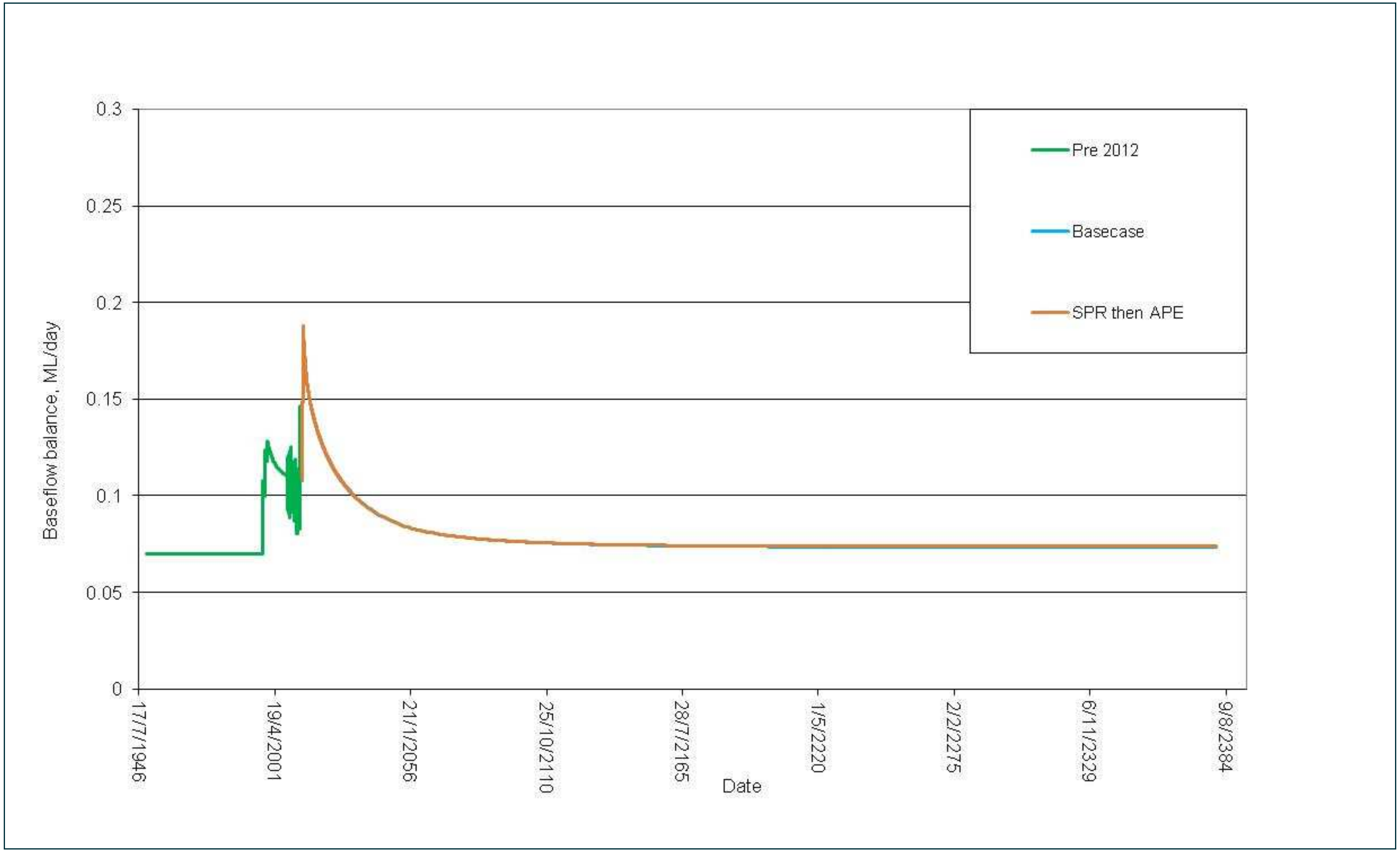

Figure H12 Estimates of baseflow balance (Kangaroo Creek_2)

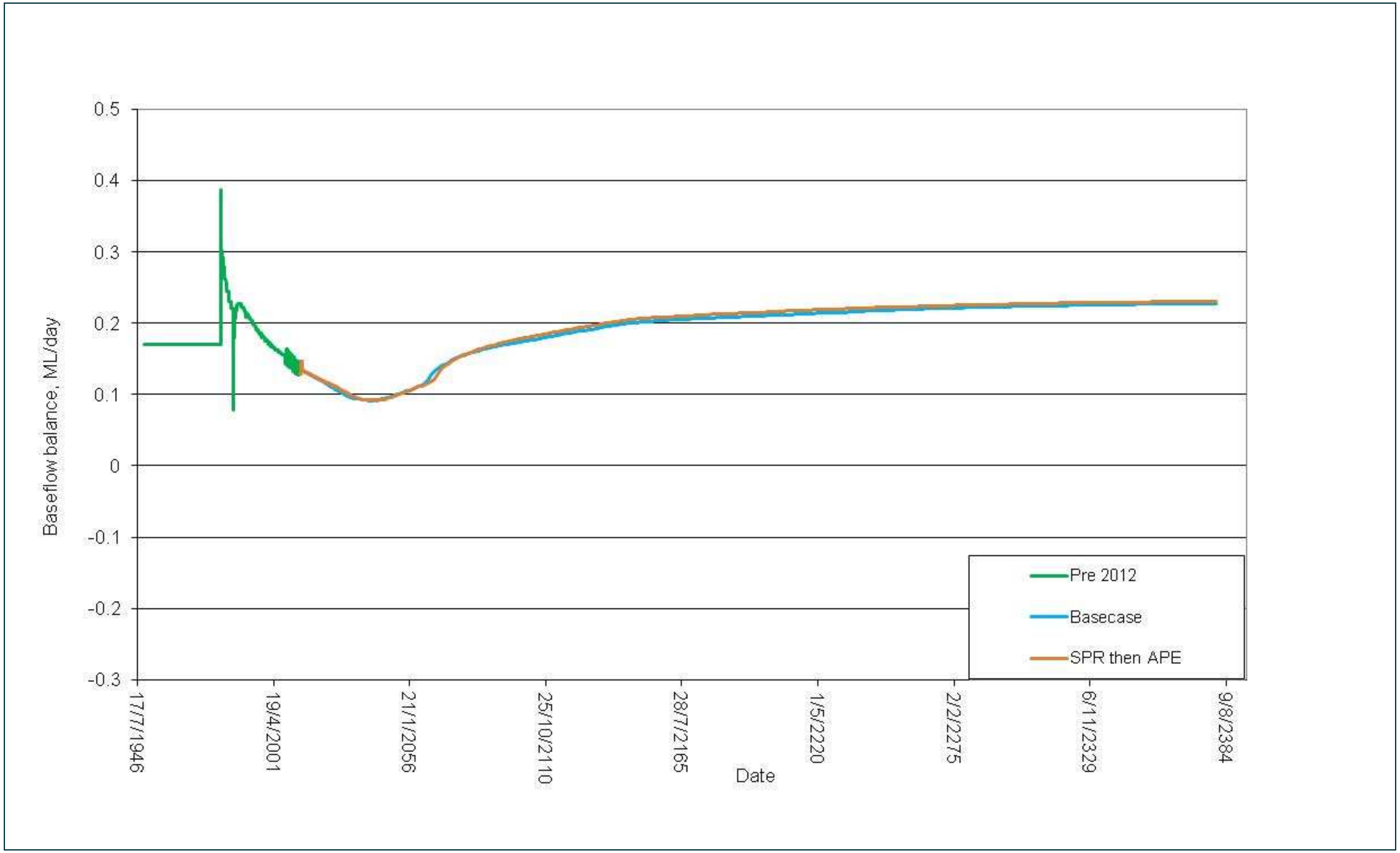

Figure H13 Estimates of baseflow balance (Lamb Creek)

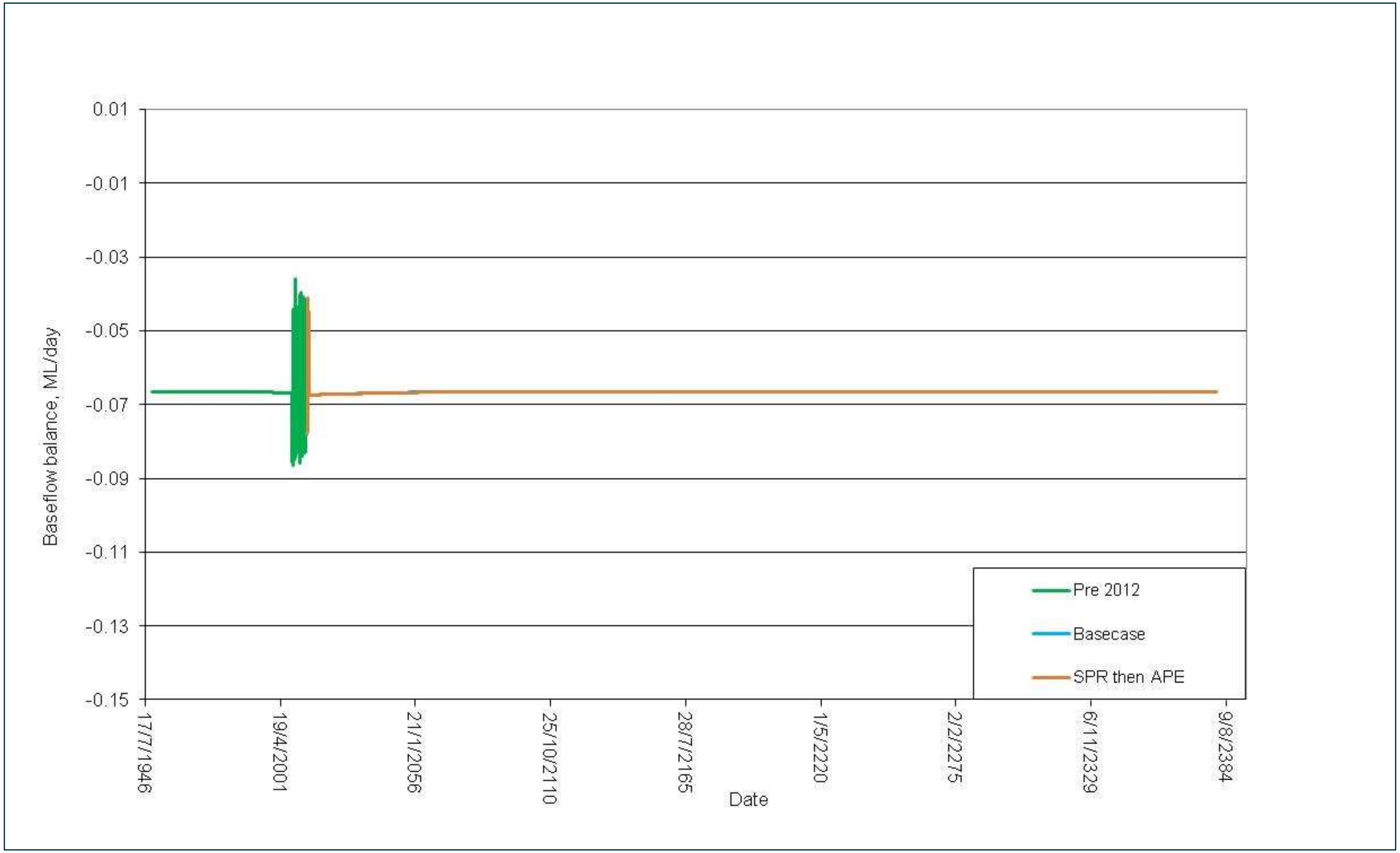

Figure H14 Estimates of baseflow balance (Long Swamp)

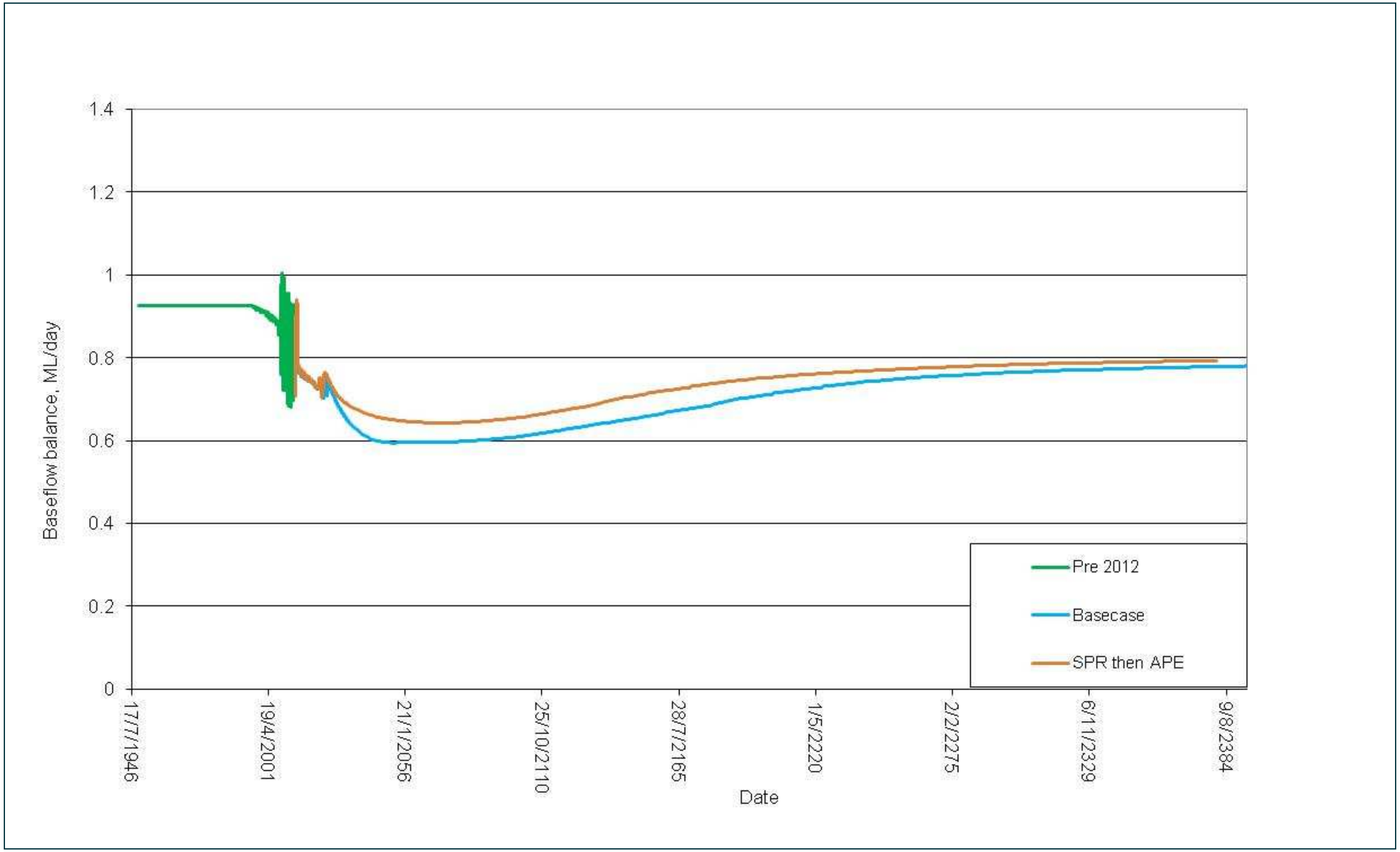

Figure H15 Estimates of baseflow balance (Marangaroo Creek)

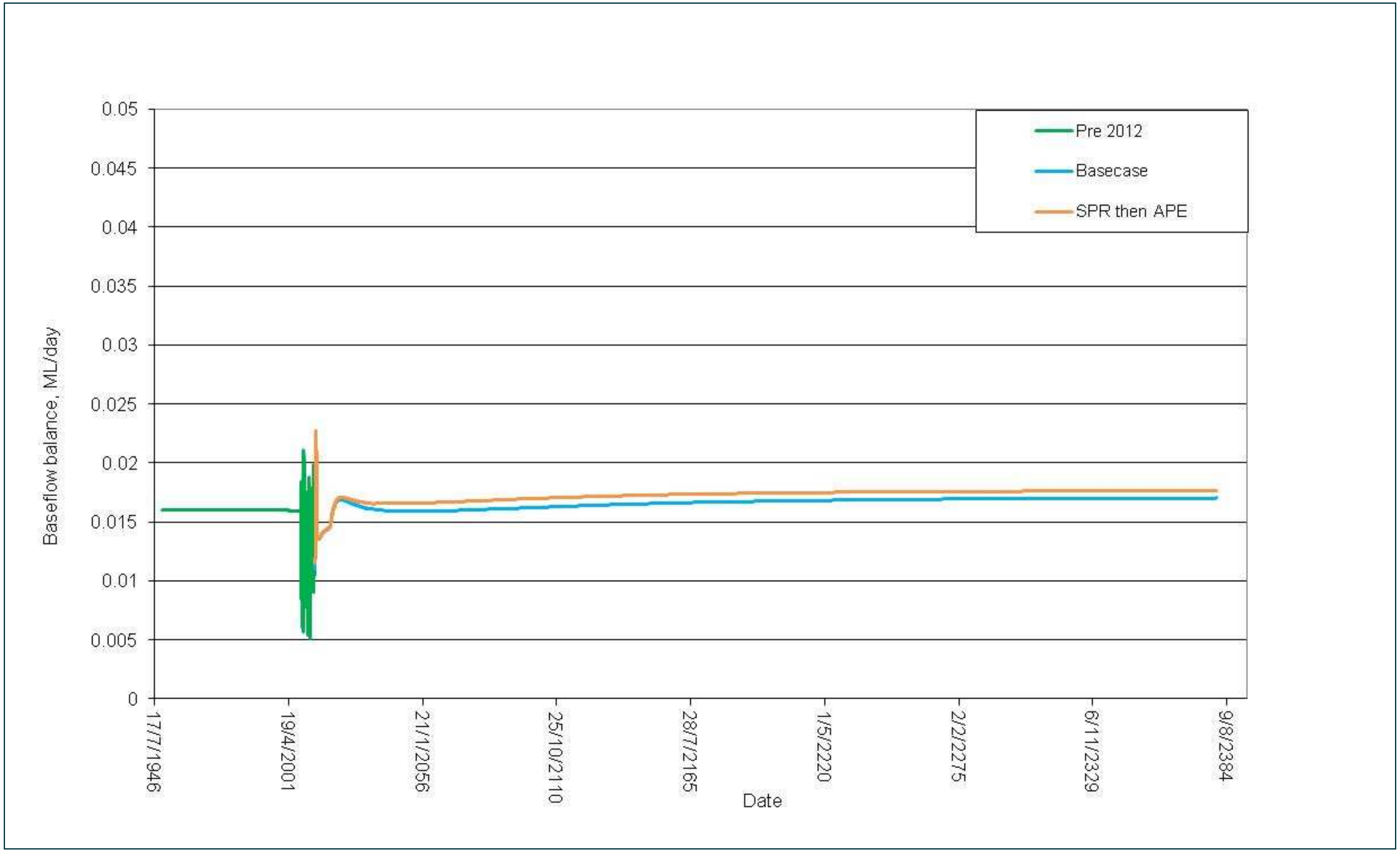

Figure H16 Estimates of baseflow balance (Nine-Mile Swamp)

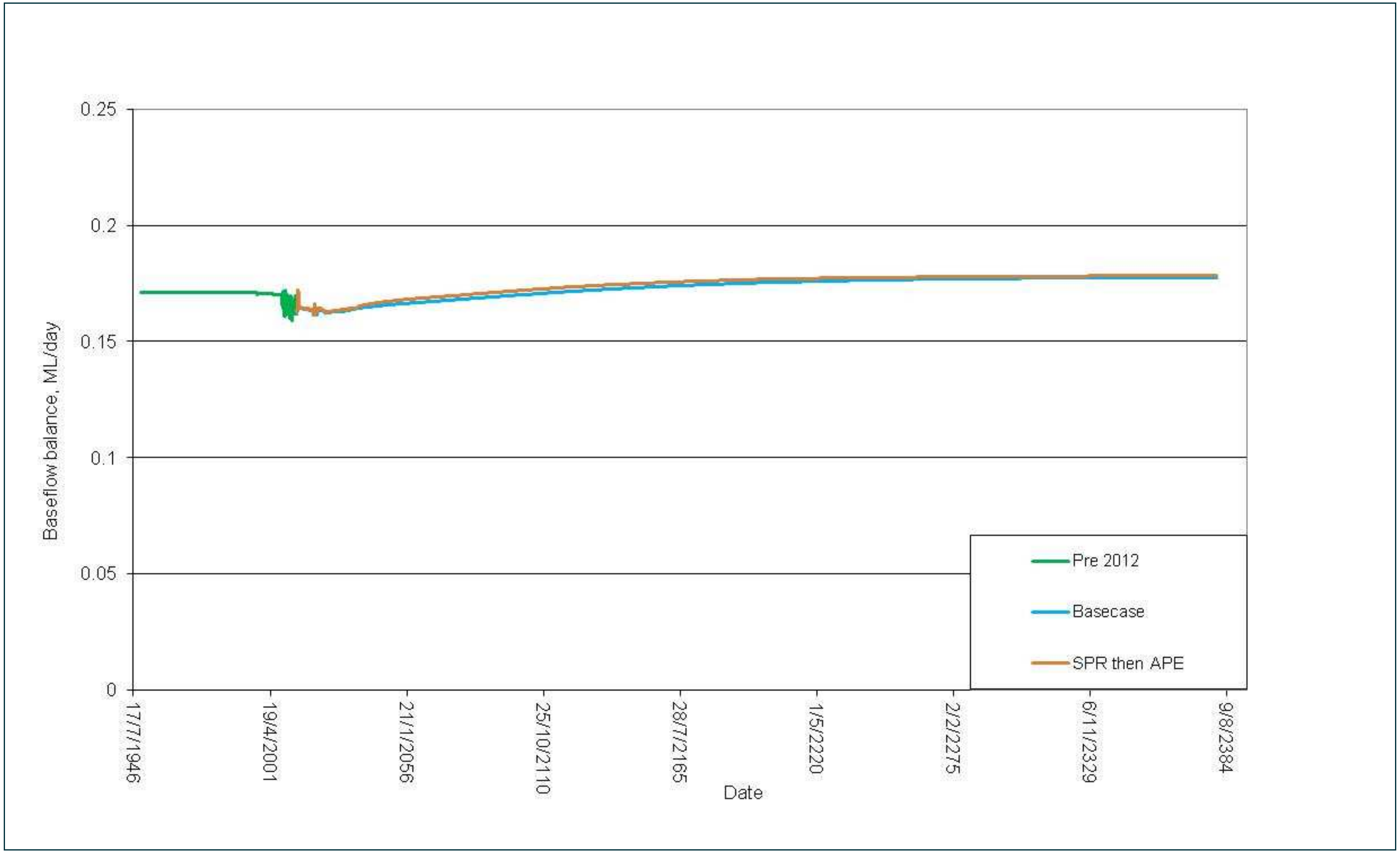

Figure H17 Estimates of baseflow balance (Paddy's Creek)

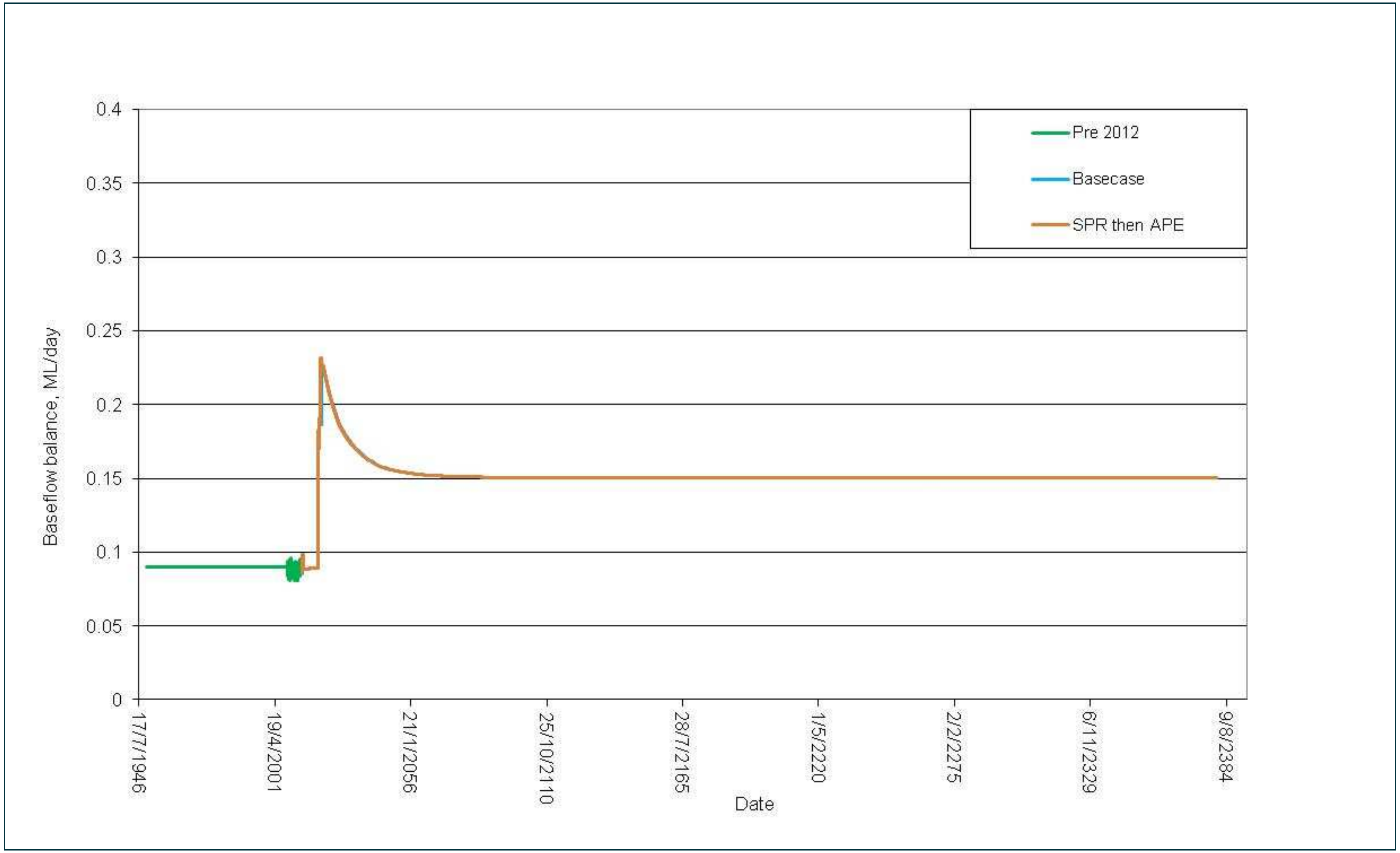

Figure H18 Estimates of baseflow balance (Pine Swamp)

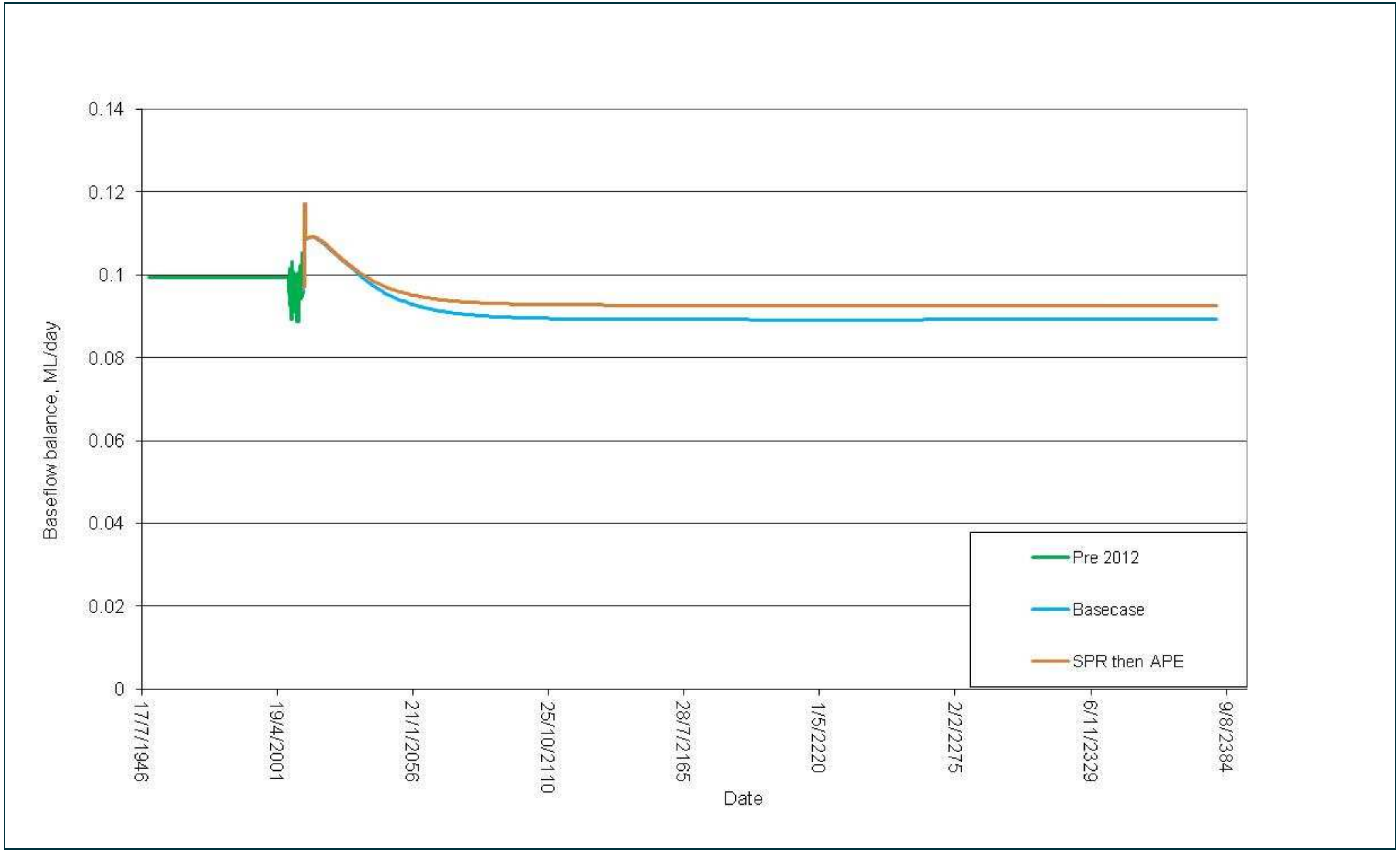

Figure H19 Estimates of baseflow balance (Sunnyside Swamp)

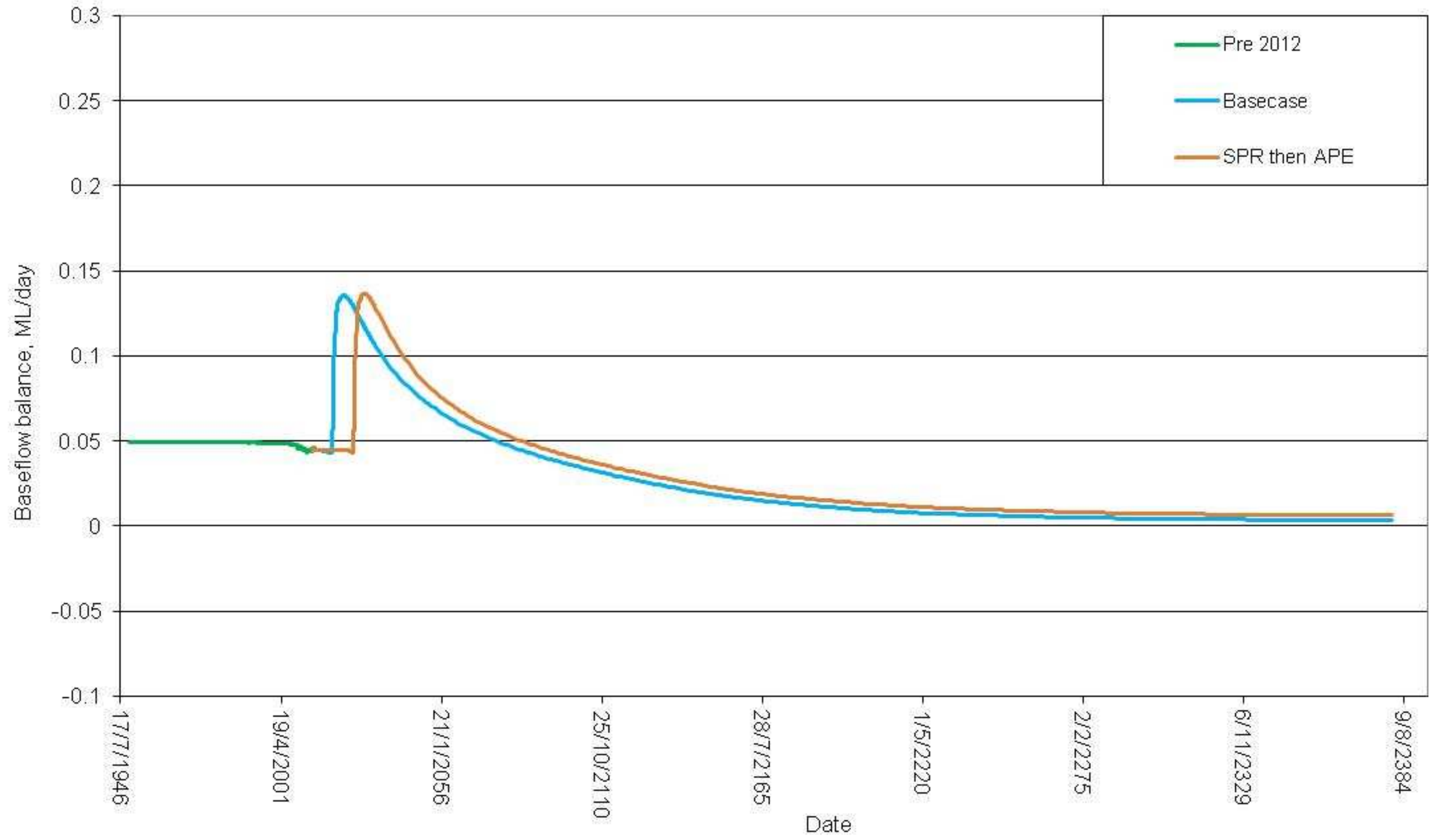

Figure H20 Estimates of baseflow balance (Tri-star Swamp)

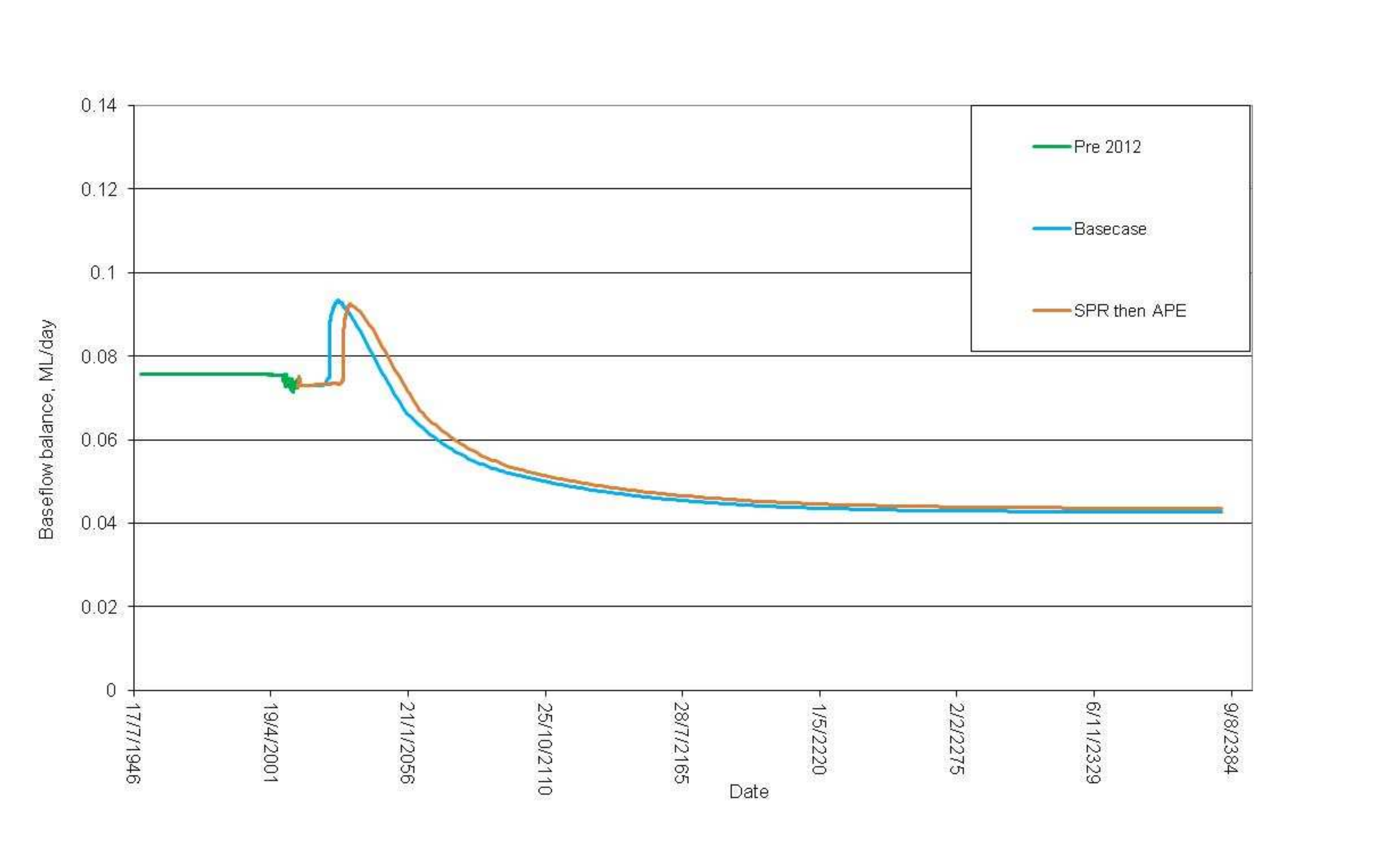

Figure H21 Estimates of baseflow balance (Twin-Gully Swamp)

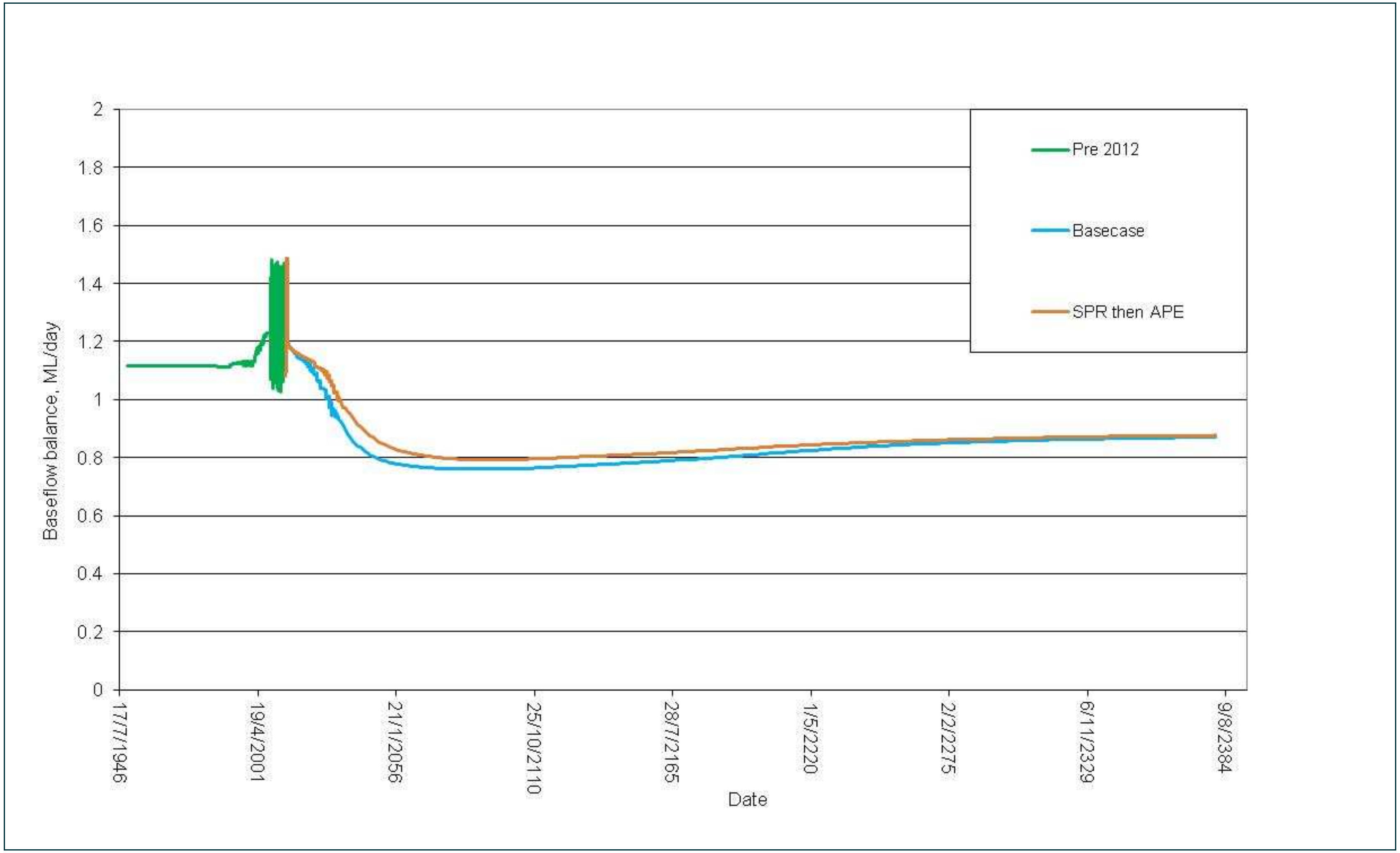

Figure H22 Estimates of baseflow balance (Wolgan River)

Appendix I

Drawdowns - Prediction and Recovery Periods (Alternative Mine Schedule)

Angus Place and Springvale Colliery Operations

Groundwater Assessment

D P Adhikary and A Wilkins
Report EP15346
January 2015

Springvale Colliery and Angus Place Colliery

Citation

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Simulated Drawdowns

The simulated drawdowns for the Lithgow Seam, AQ1, AQ2, AQ3, AQ4, AQ5, AQ6 and the top of the model (i.e. the ground surface) following 5, 10 and 21 years of mining within the predictive simulation period and the recovery period at 46 and 96 years after mining are provided in this appendix.

Figure I1 to Figure I21 show the simulated drawdowns with respect to the pre-mining groundwater conditions and Figure I22 to Figure I42 show the simulated drawdowns with respect to groundwater levels at 1 January 2013.

Figure I43 to Figure I56 show the simulated drawdowns with respect to the pre-mining groundwater conditions at 46 and 96 years after mining and Figure I57 to Figure I70 show the simulated drawdowns with respect to groundwater levels at 1 January 2013.

Predictive Period with respect to Pre-mining Groundwater Condition

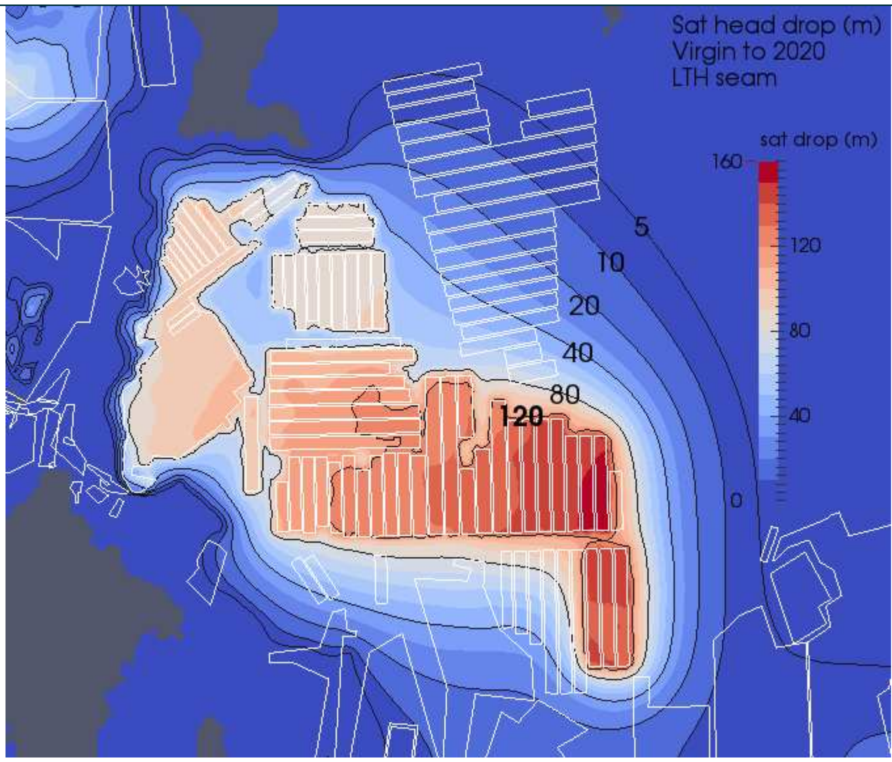


Figure I1 Distribution of drawdowns in the Lithgow Seam in 2020 with respect to pre-mining groundwater condition

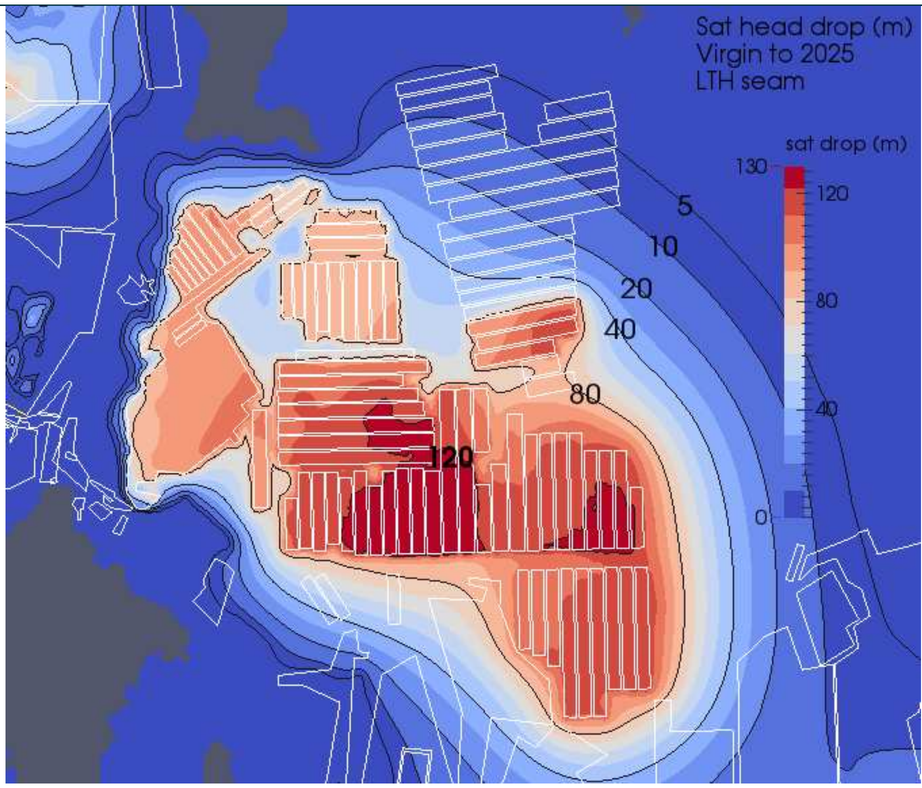


Figure I2 Distribution of drawdowns (m) in the Lithgow Seam in 2025 with respect to pre-mining groundwater condition

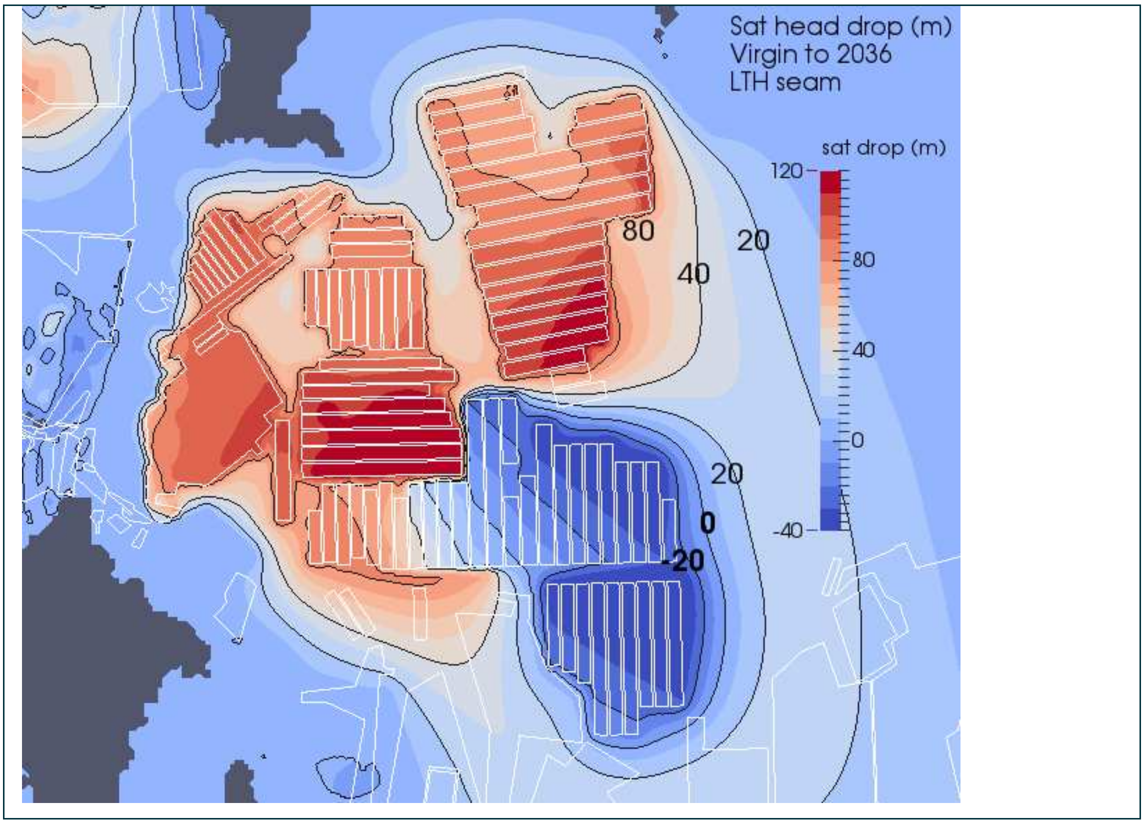


Figure I3 Distribution of drawdowns in the Lithgow Seam in 2036 with respect to pre-mining groundwater condition

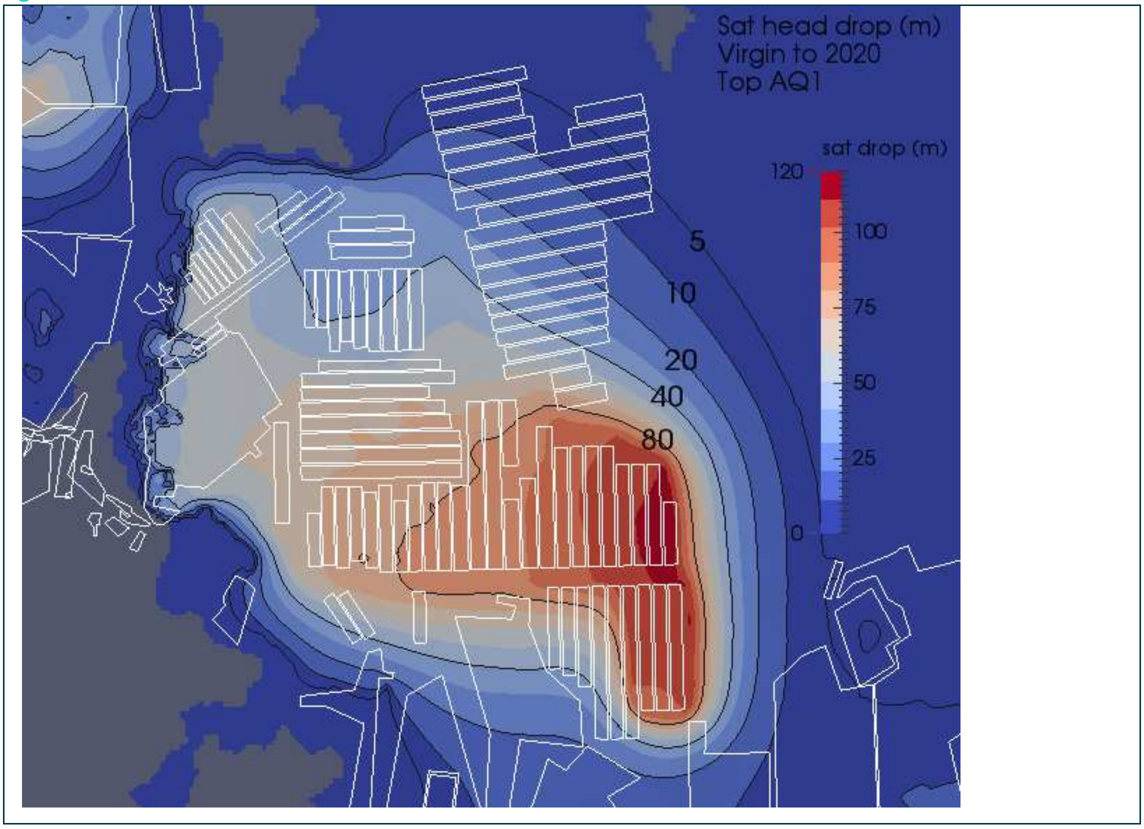


Figure I4 Distribution of drawdowns in AQ1 in 2020 with respect to pre-mining groundwater condition

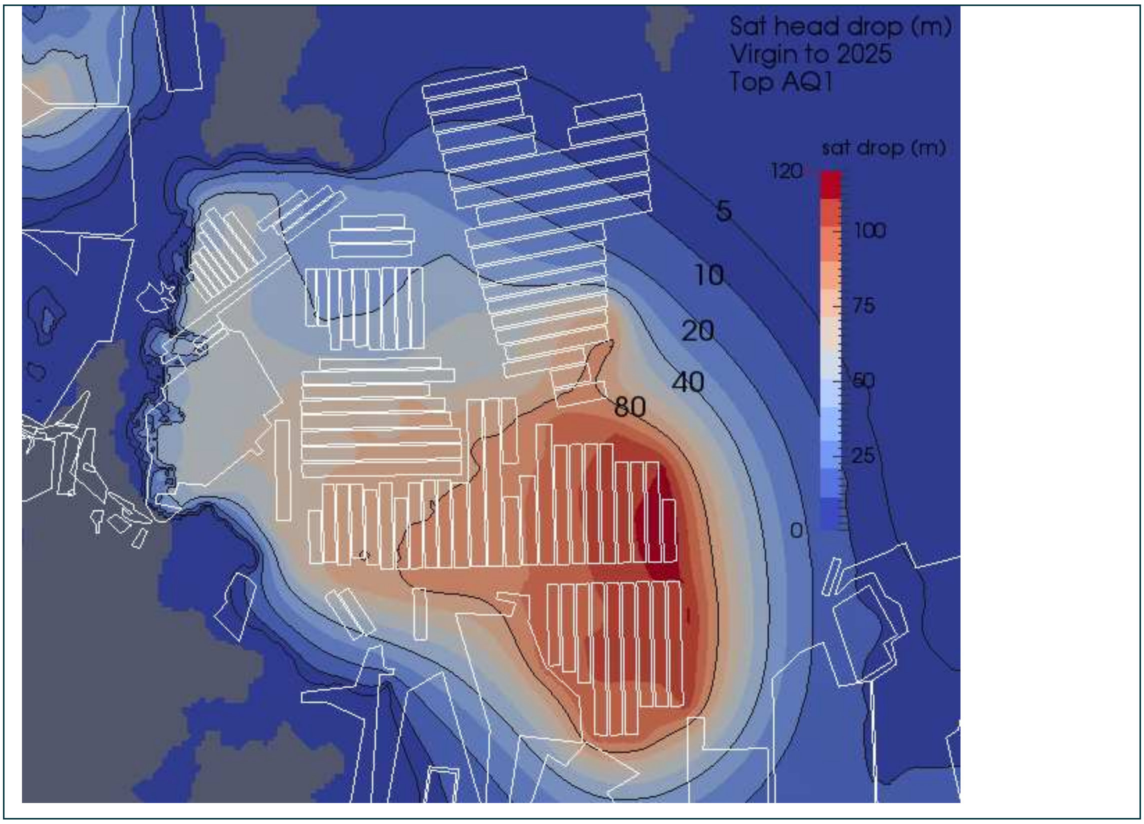


Figure I5 Distribution of drawdowns in AQ1 in 2025 with respect to pre-mining groundwater condition

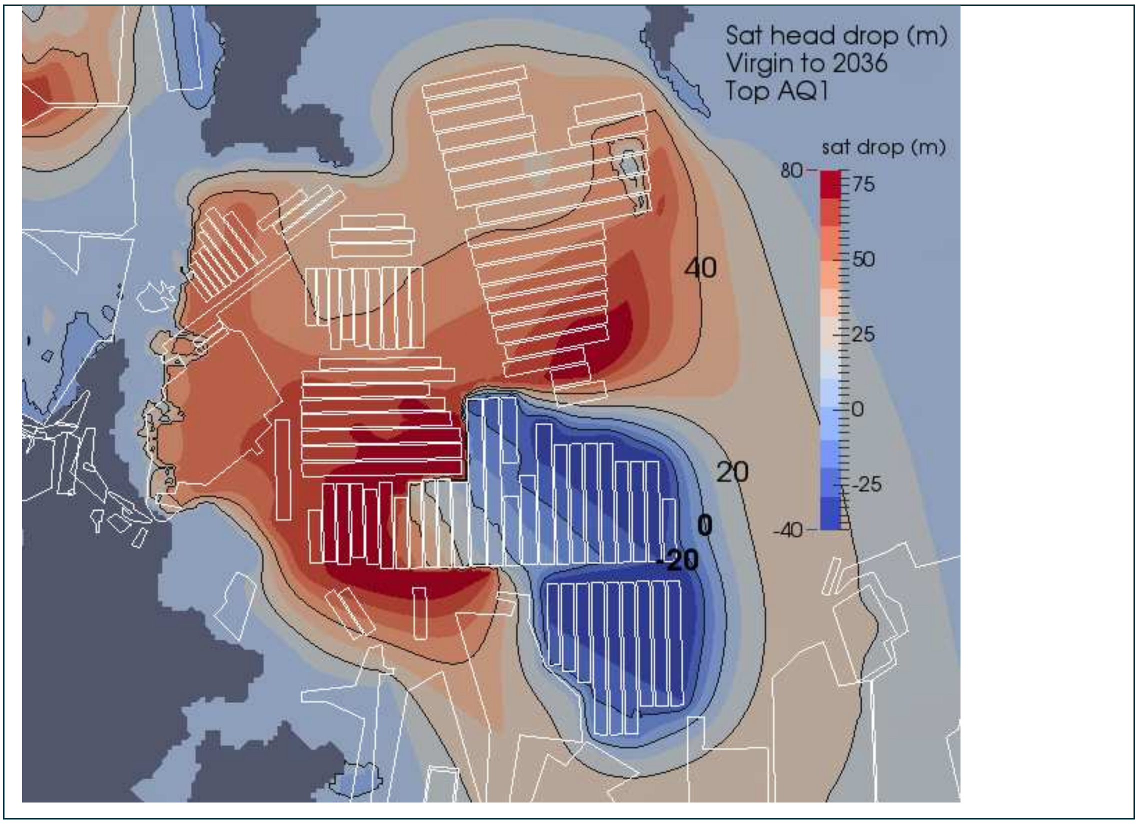


Figure I6 Distribution of drawdowns in AQ1 in 2036 with respect to pre-mining groundwater condition

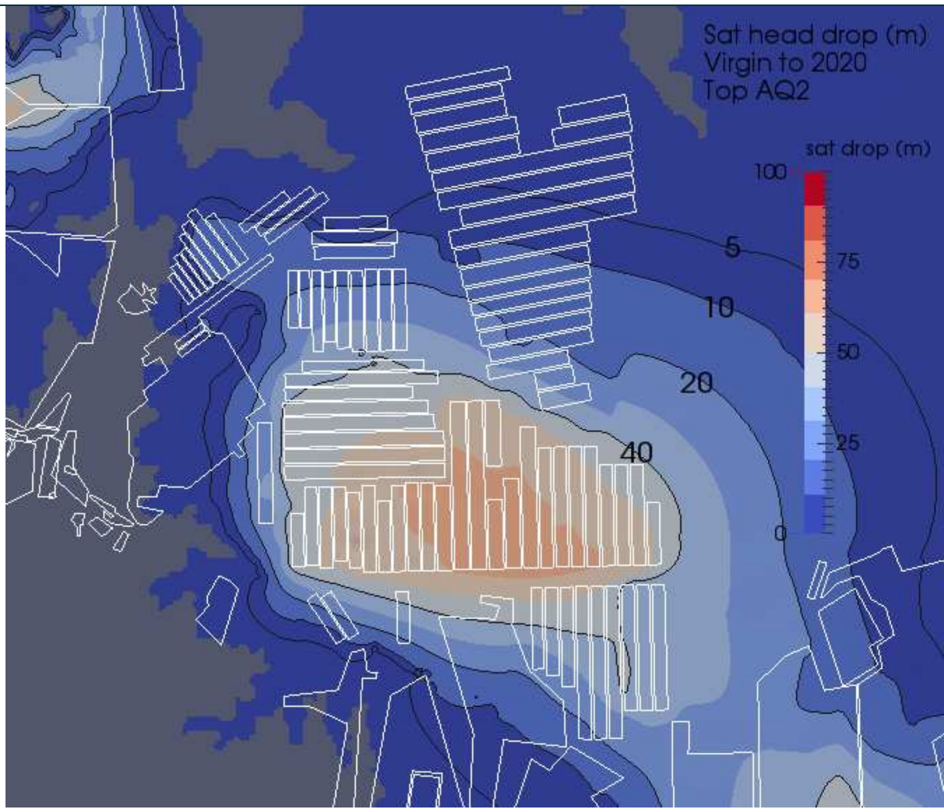


Figure I7 Distribution of drawdowns in AQ2 in 2020 with respect to pre-mining groundwater condition

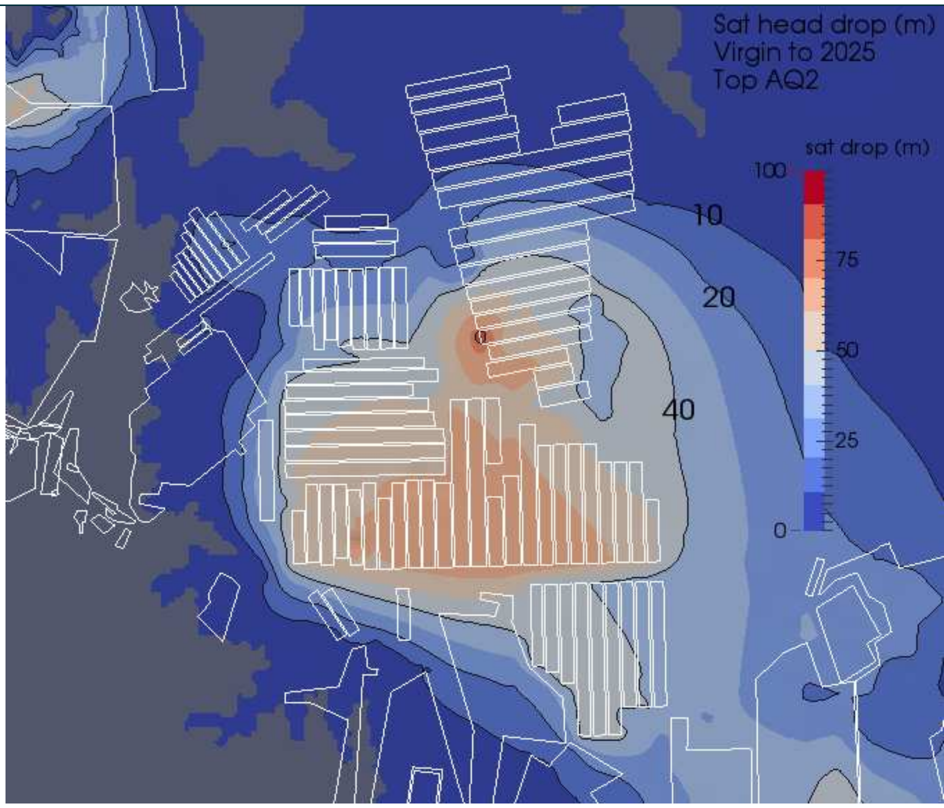


Figure I8 Distribution of drawdowns in AQ2 in 2025 with respect to pre-mining groundwater condition

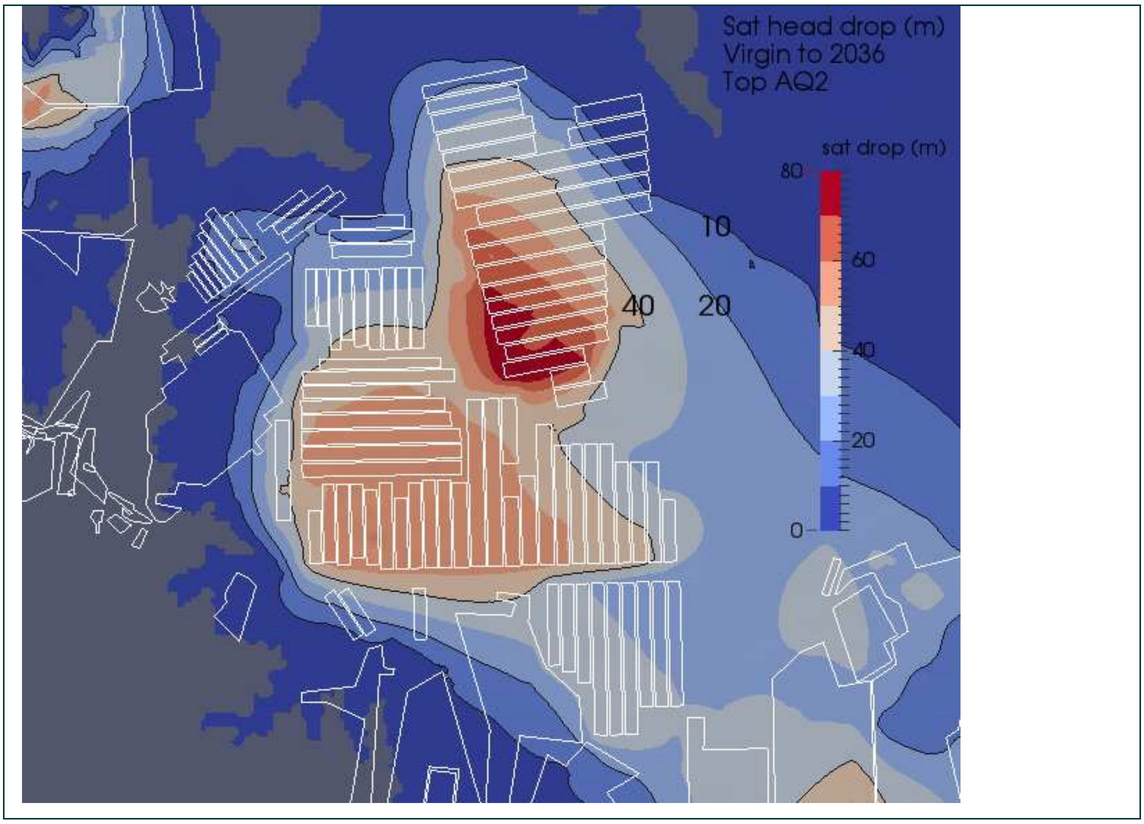


Figure I9 Distribution of drawdowns in AQ2 in 2036 with respect to pre-mining groundwater condition

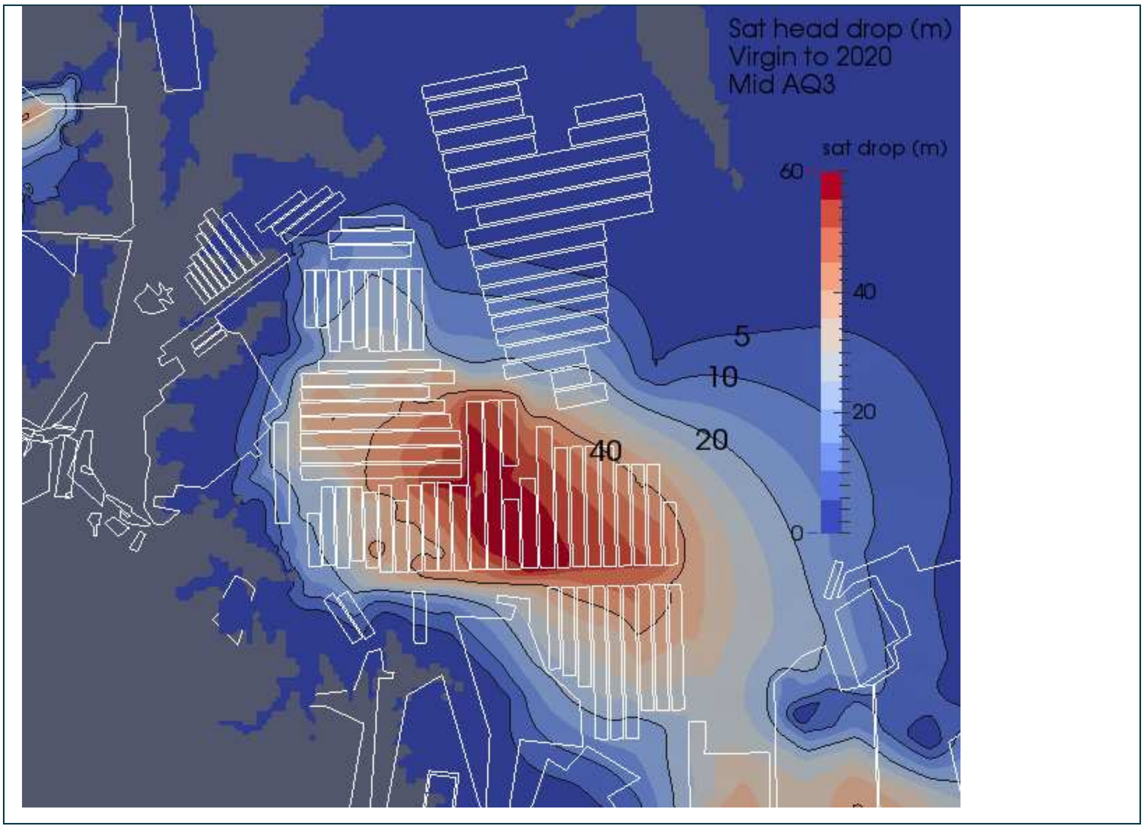


Figure I10 Distribution of drawdowns in AQ3 in 2020 with respect to pre-mining groundwater condition

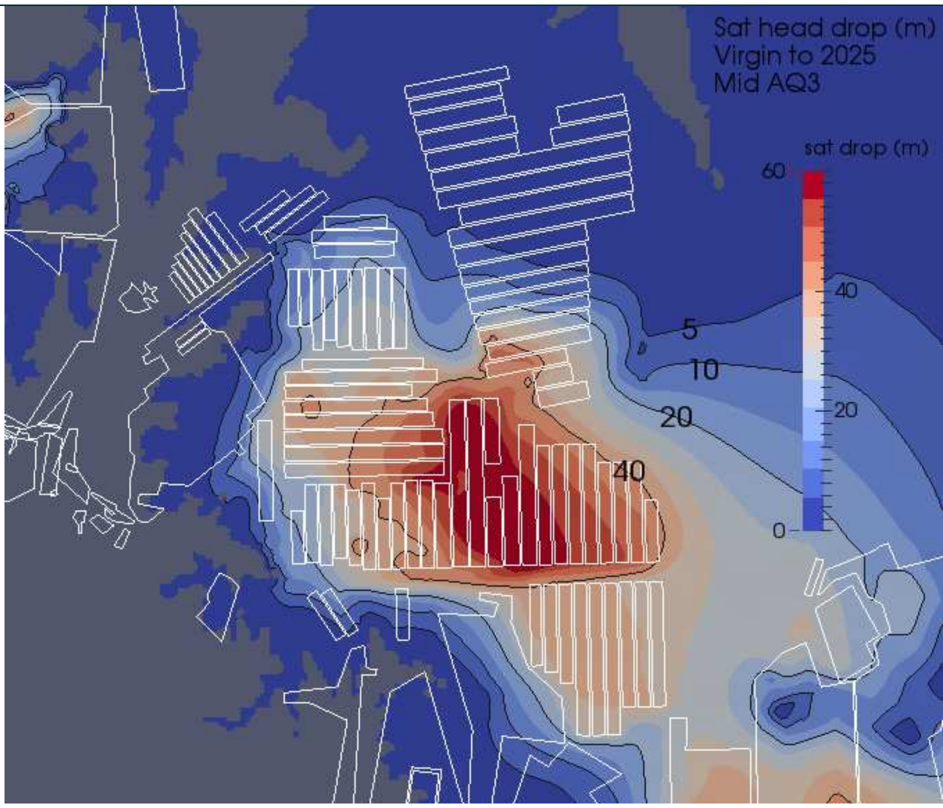


Figure I11 Distribution of drawdowns in AQ3 in 2025 with respect to pre-mining groundwater condition

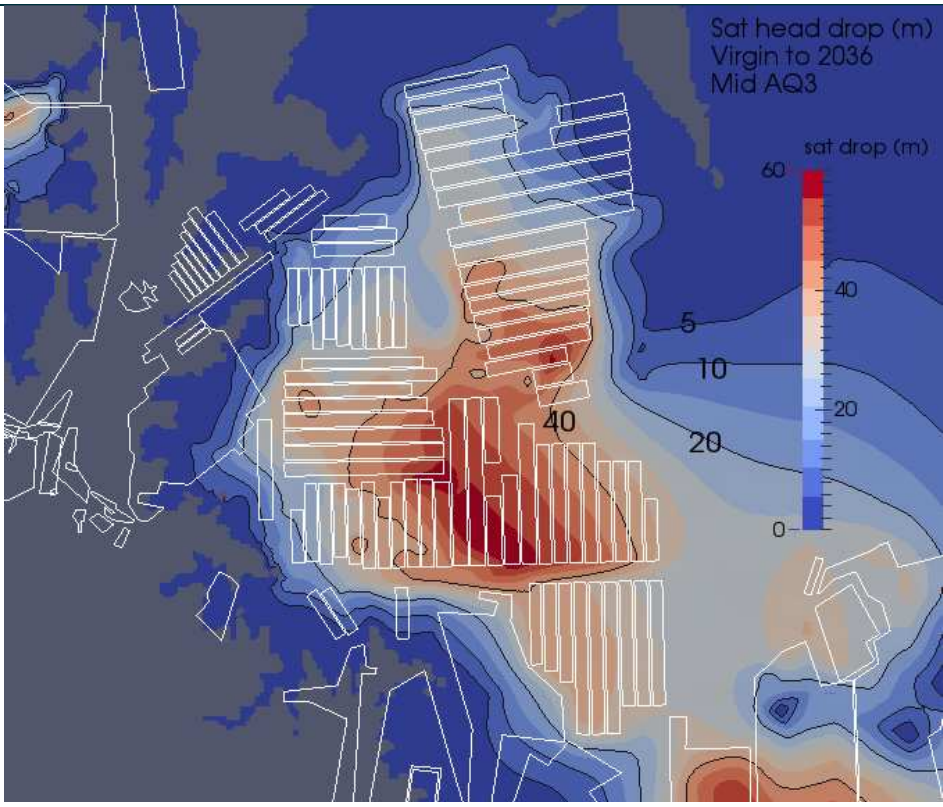


Figure I12 Distribution of drawdowns in AQ3 in 2036 with respect to pre-mining groundwater condition

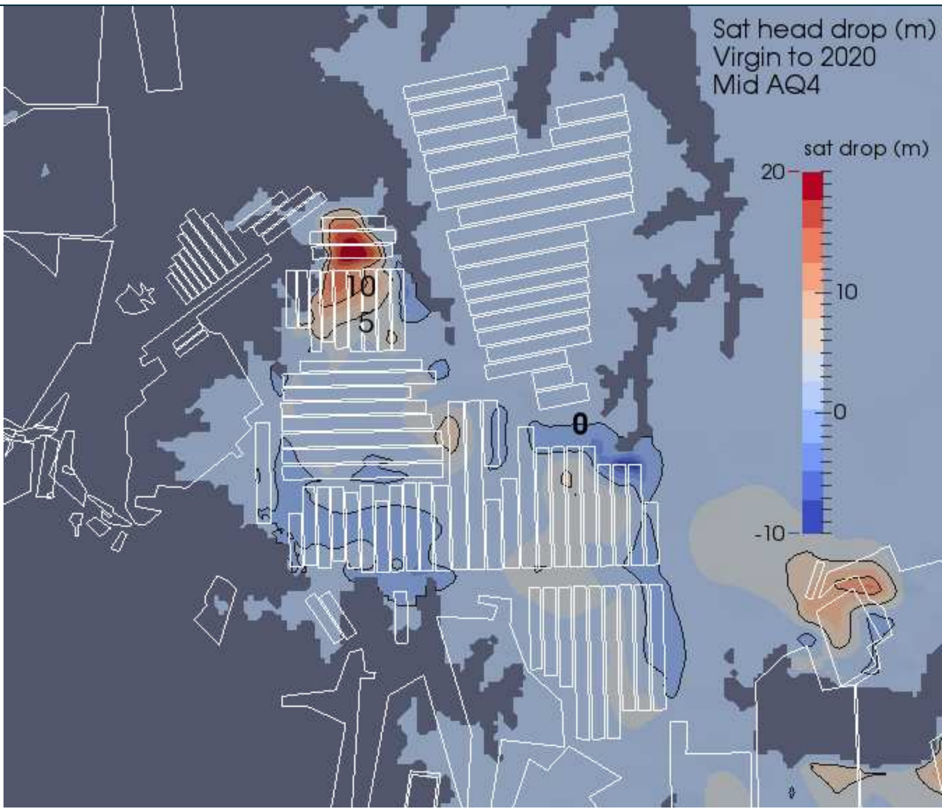


Figure I13 Distribution of drawdowns in AQ4 in 2020 with respect to pre-mining groundwater condition

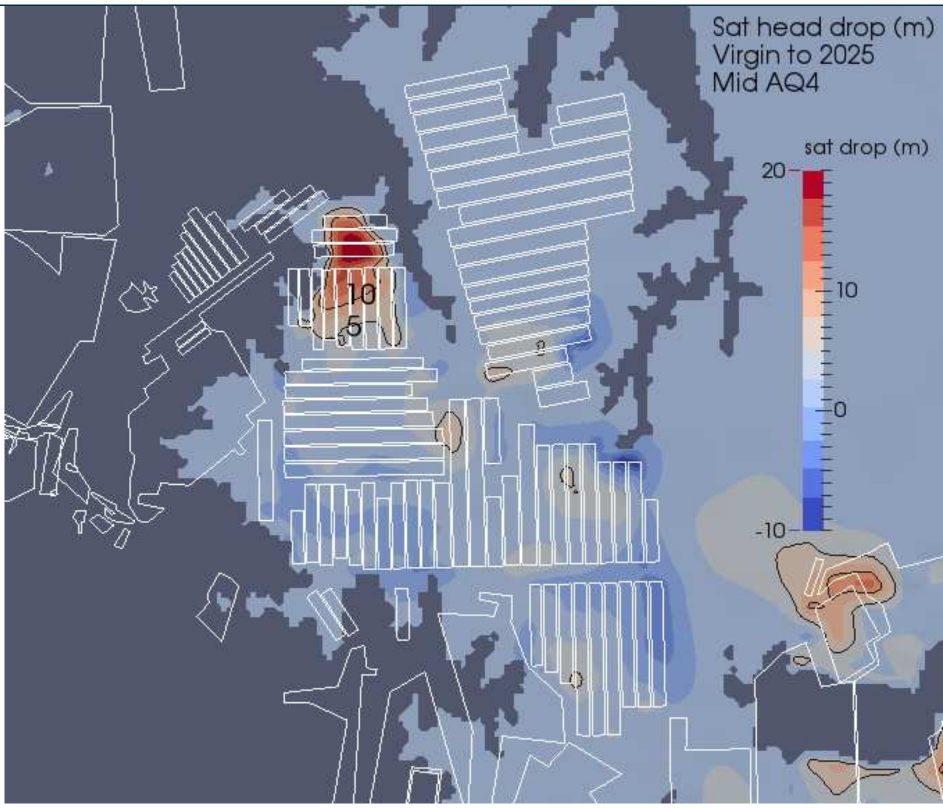


Figure I14 Distribution of drawdowns in AQ4 in 2025 with respect to pre-mining groundwater condition

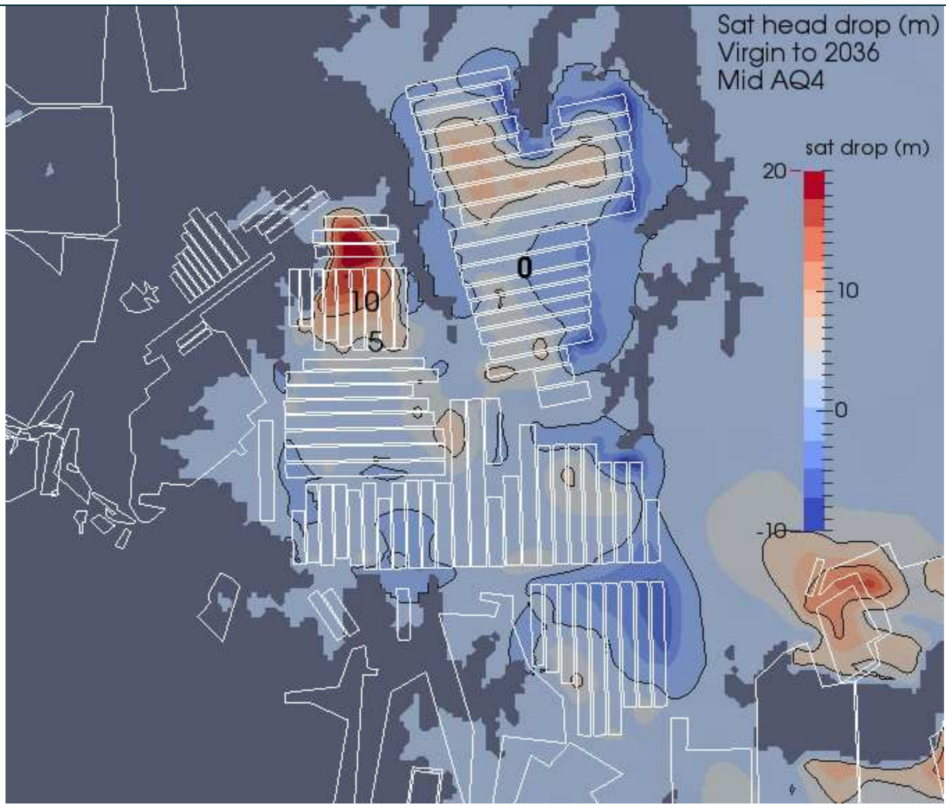


Figure I15 Distribution of drawdowns in AQ4 in 2036 with respect to pre-mining groundwater condition

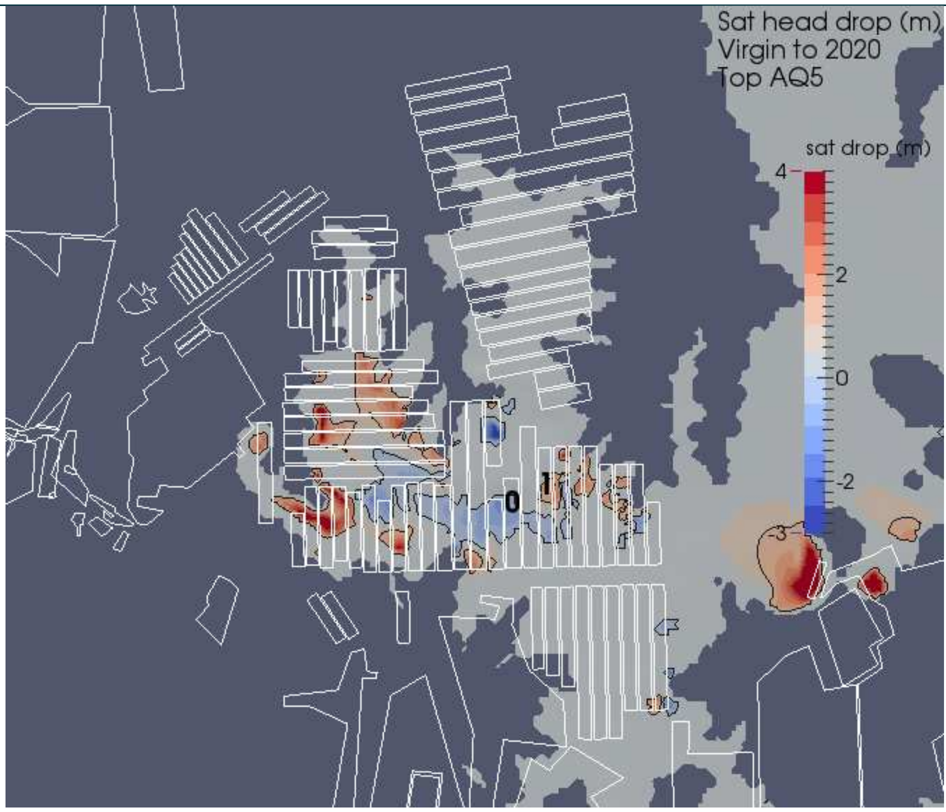


Figure I16 Distribution of drawdowns in AQ5 in 2020 with respect to pre-mining groundwater condition

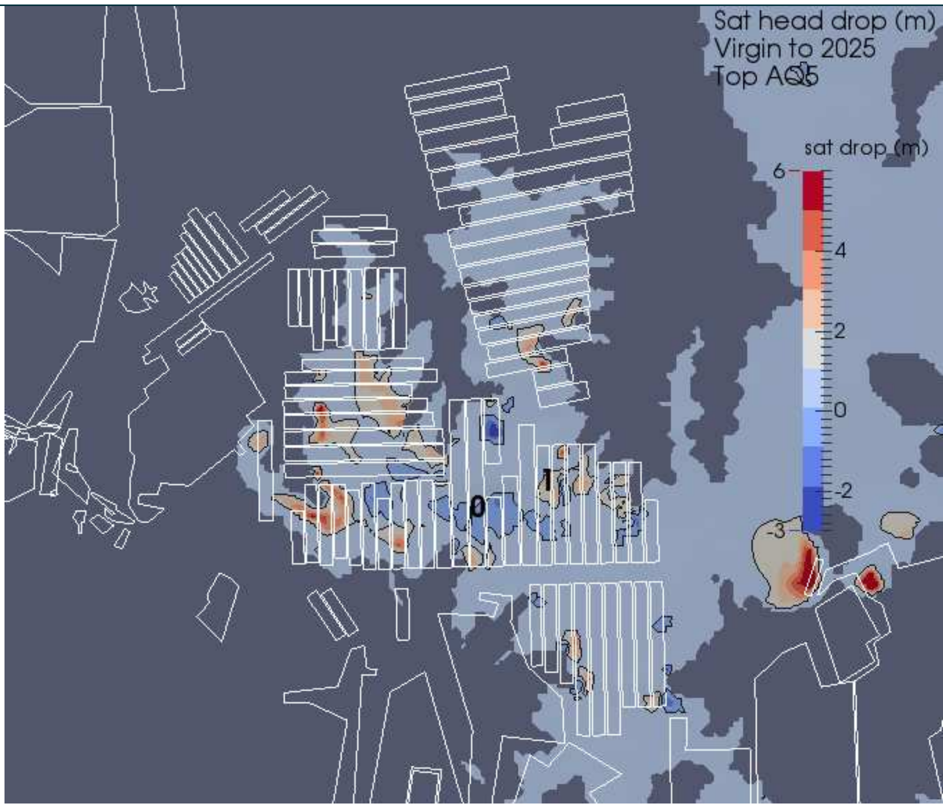


Figure I17 Distribution of drawdowns in AQ5 in 2025 with respect to pre-mining groundwater condition

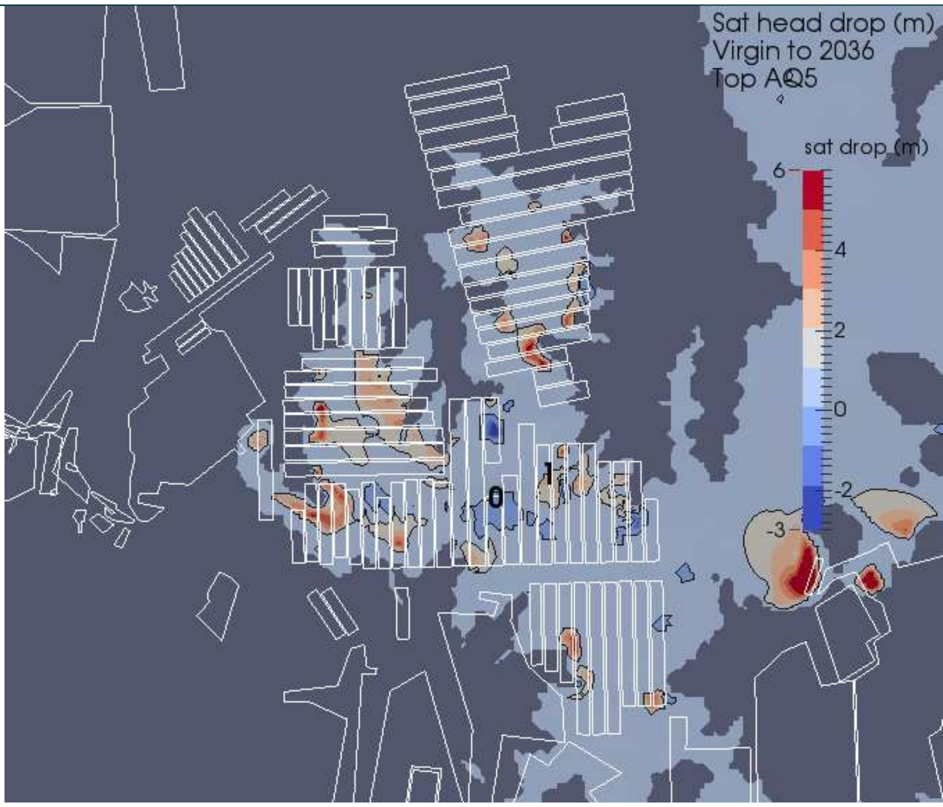
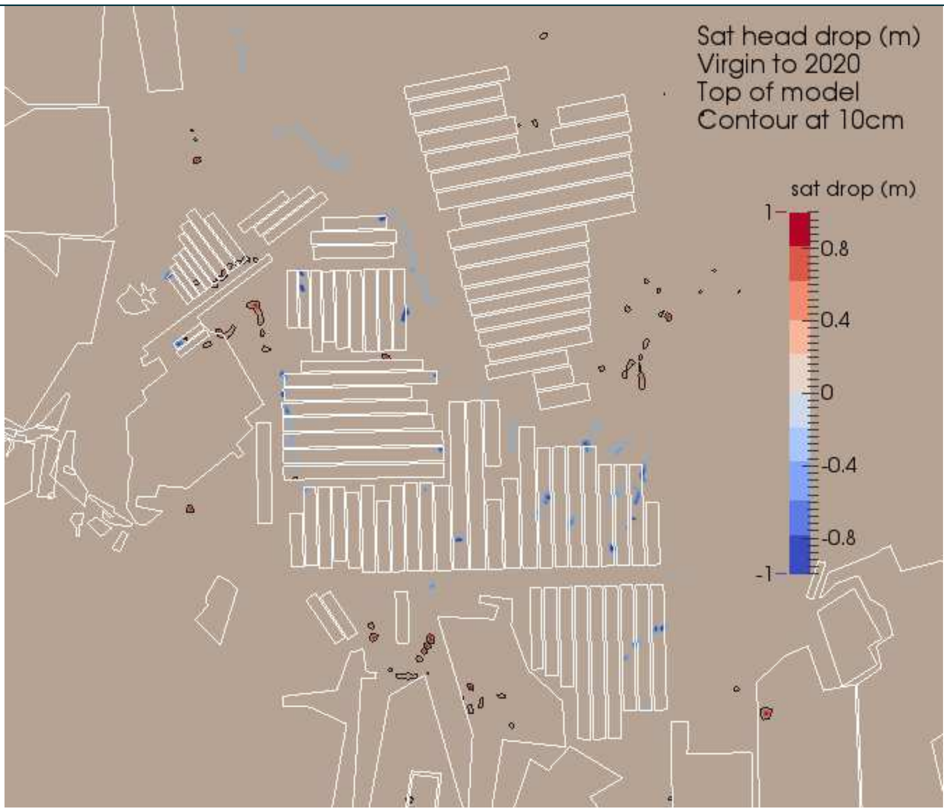


Figure I18 Distribution of drawdowns in AQ5 in 2036 with respect to pre-mining groundwater condition



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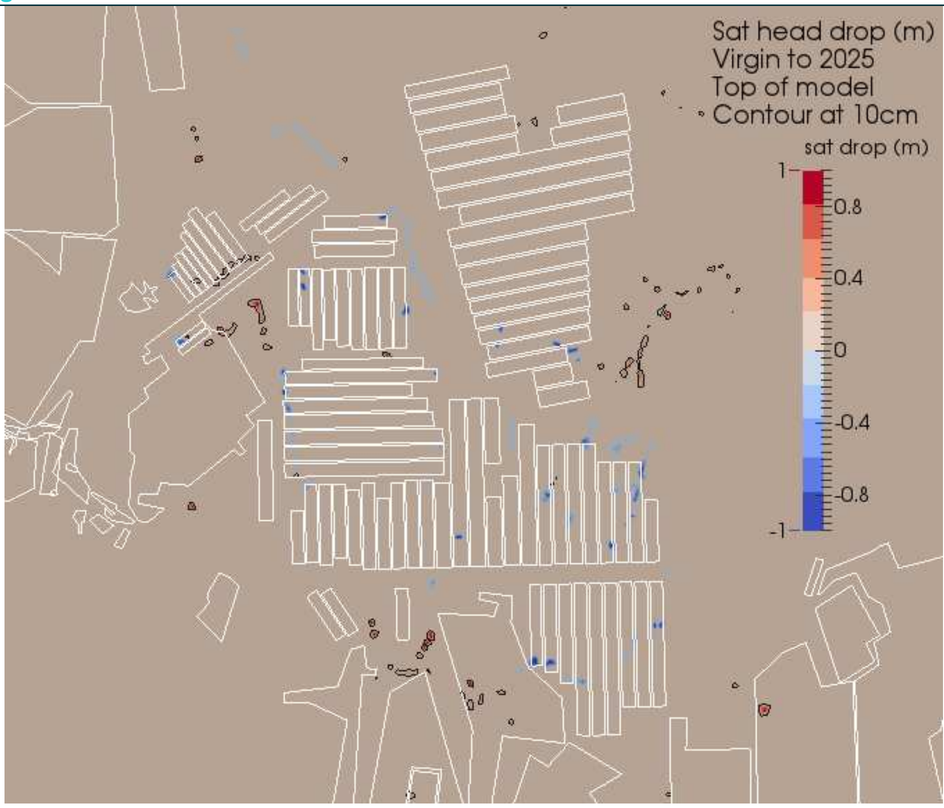

Figure I20 Distribution of head drops at the ground surface in 2025 with respect to pre-mining groundwater condition

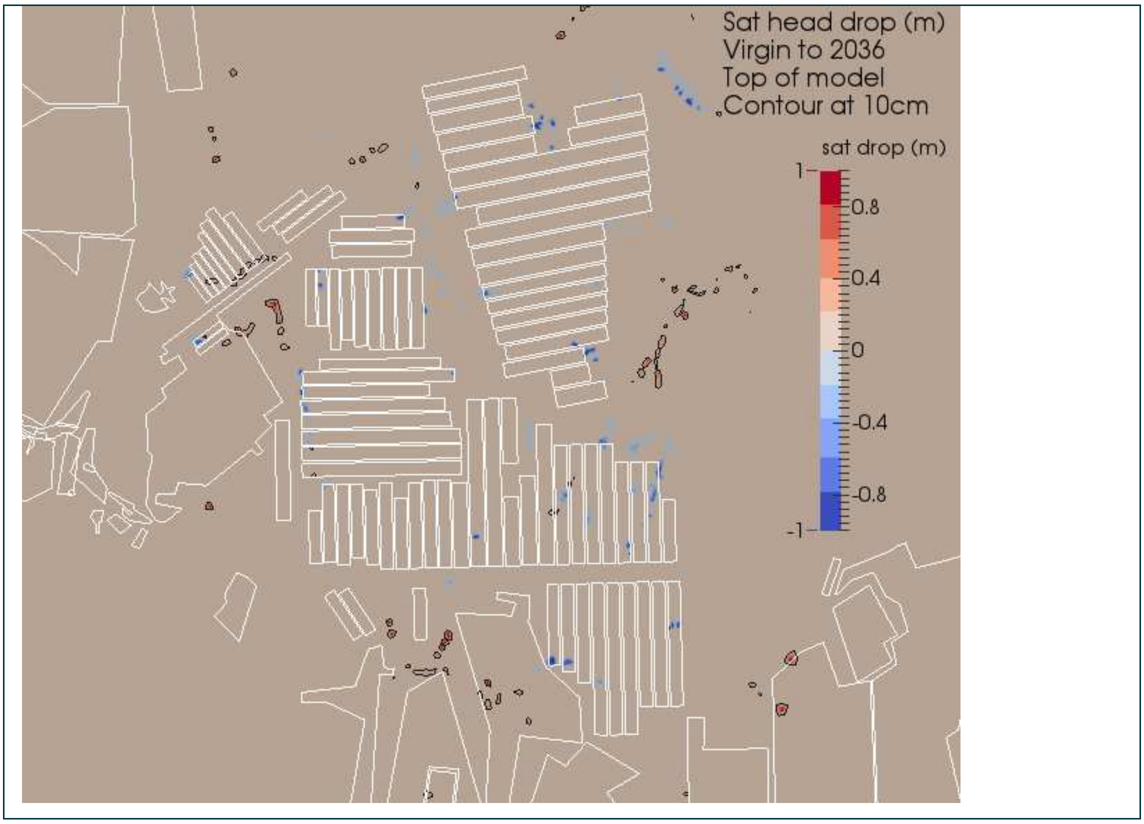

Figure I21 Distribution of head drops at the ground surface in 2036 with respect to pre-mining groundwater condition

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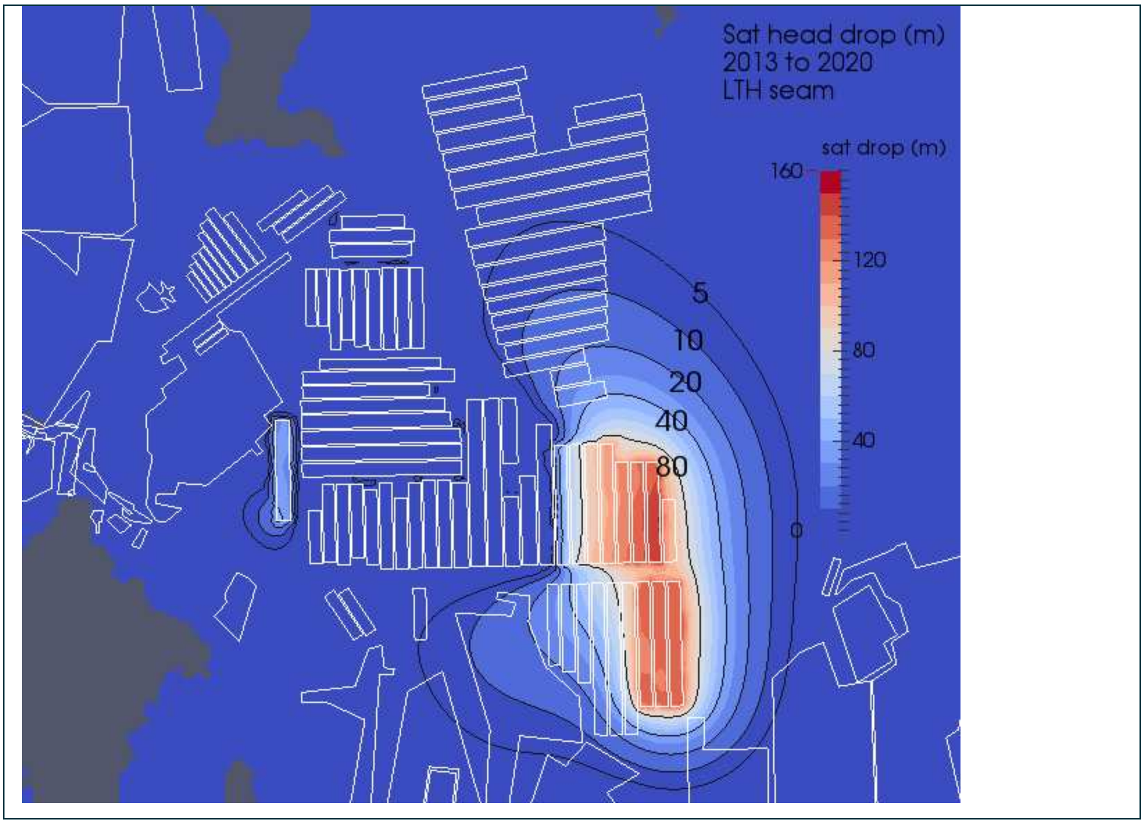

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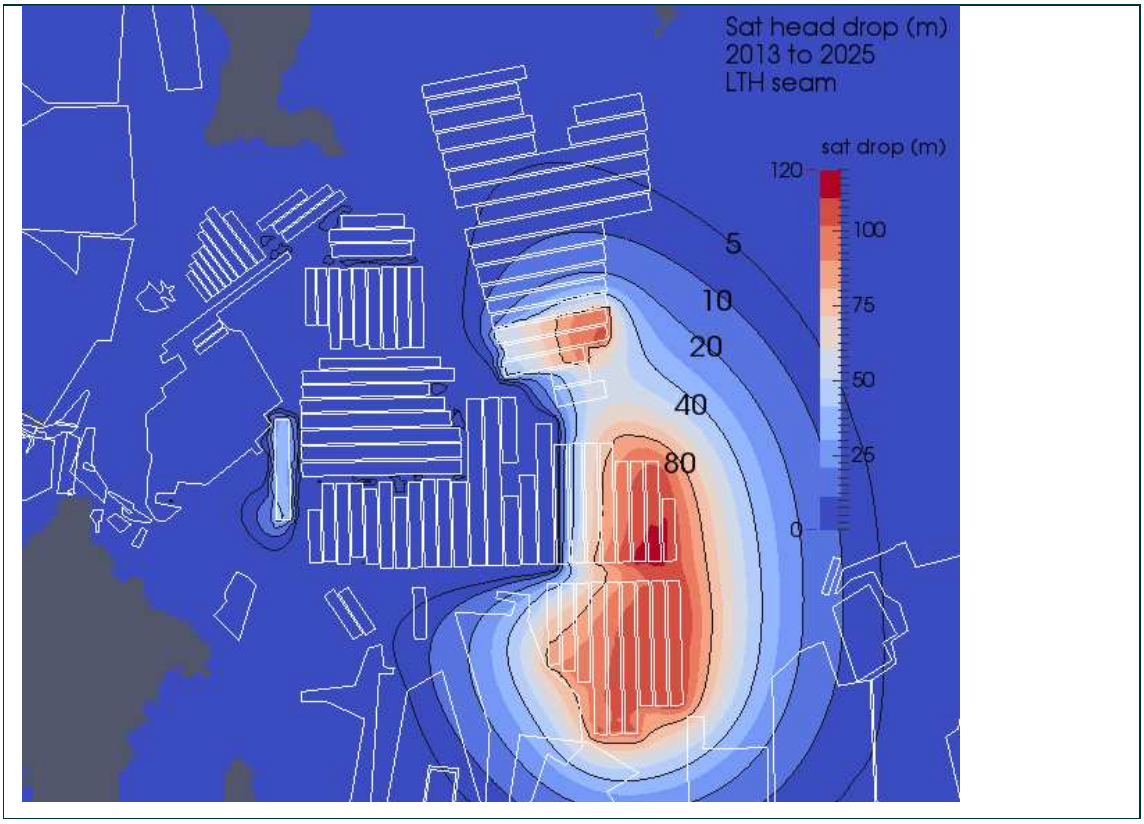


Figure I23 Distribution of drawdowns (m) in the Lithgow Seam in 2025 with respect to groundwater levels in 2013

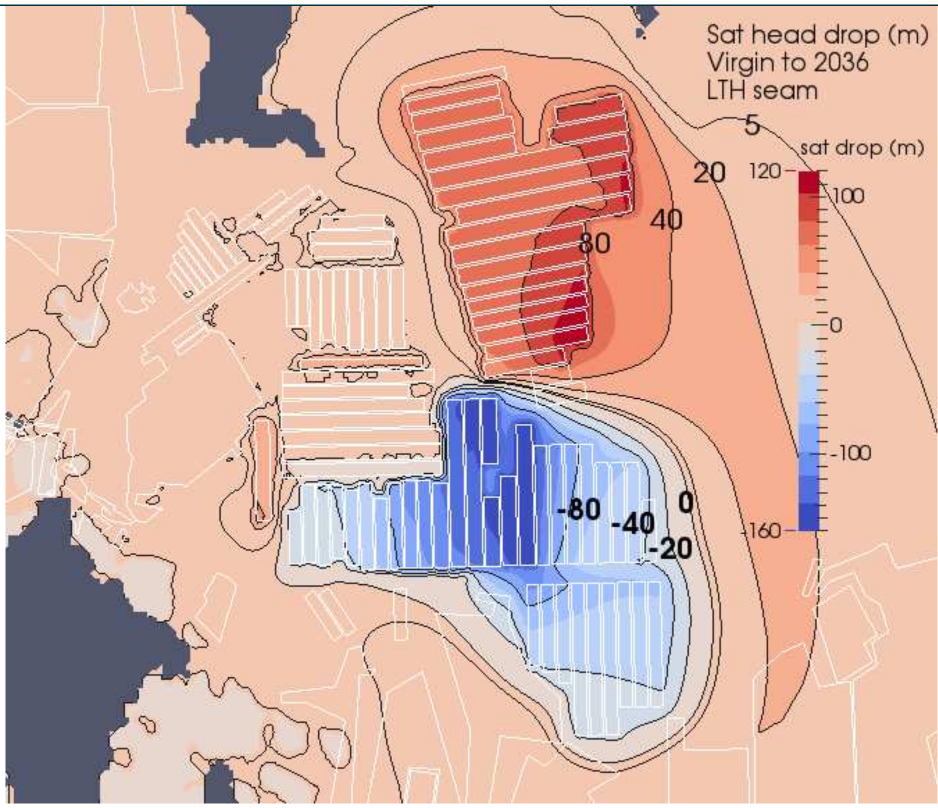


Figure I24 Distribution of drawdowns in the Lithgow Seam in 2036 with respect to groundwater levels in 2013

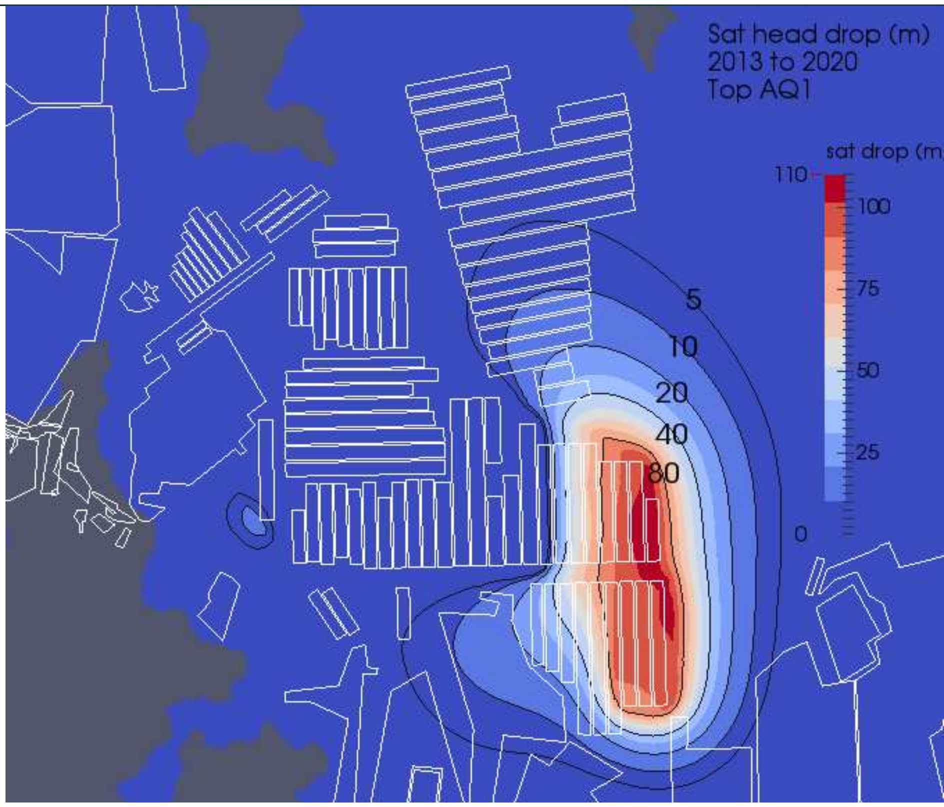
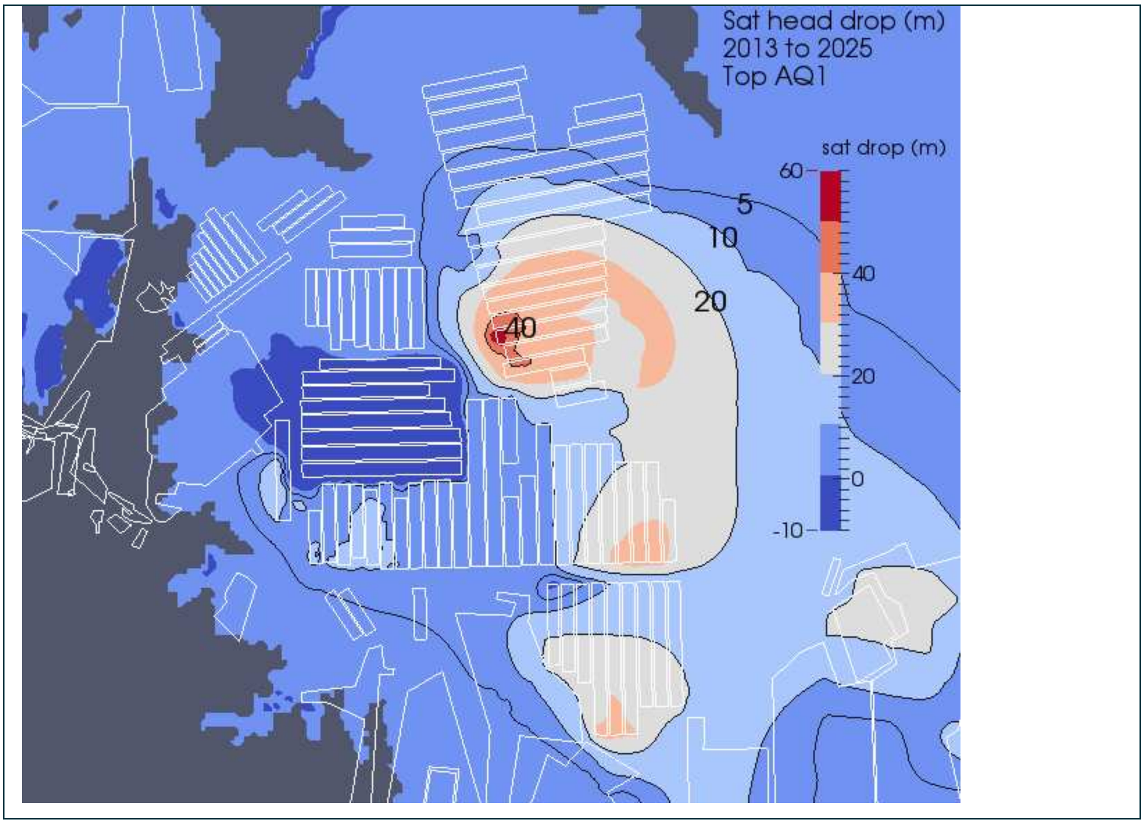


Figure I25 Distribution of drawdowns in AQ1 in 2020 with respect to groundwater levels in 2013



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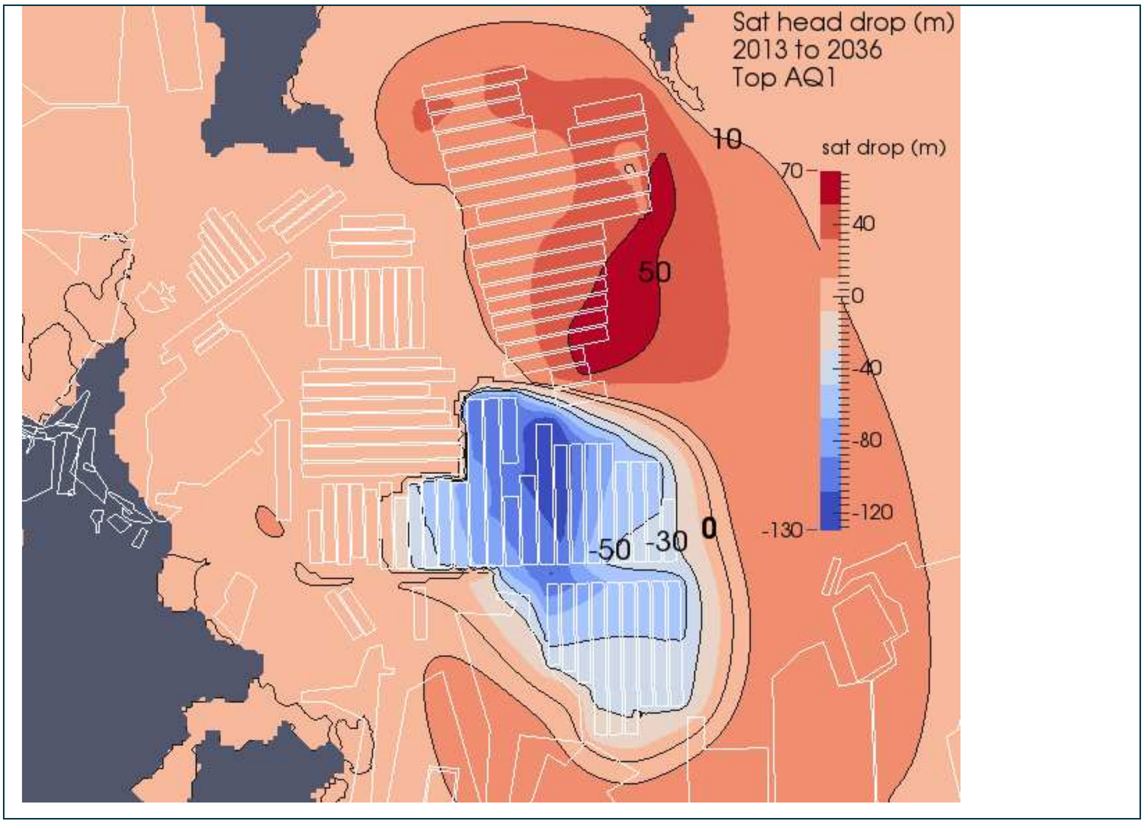

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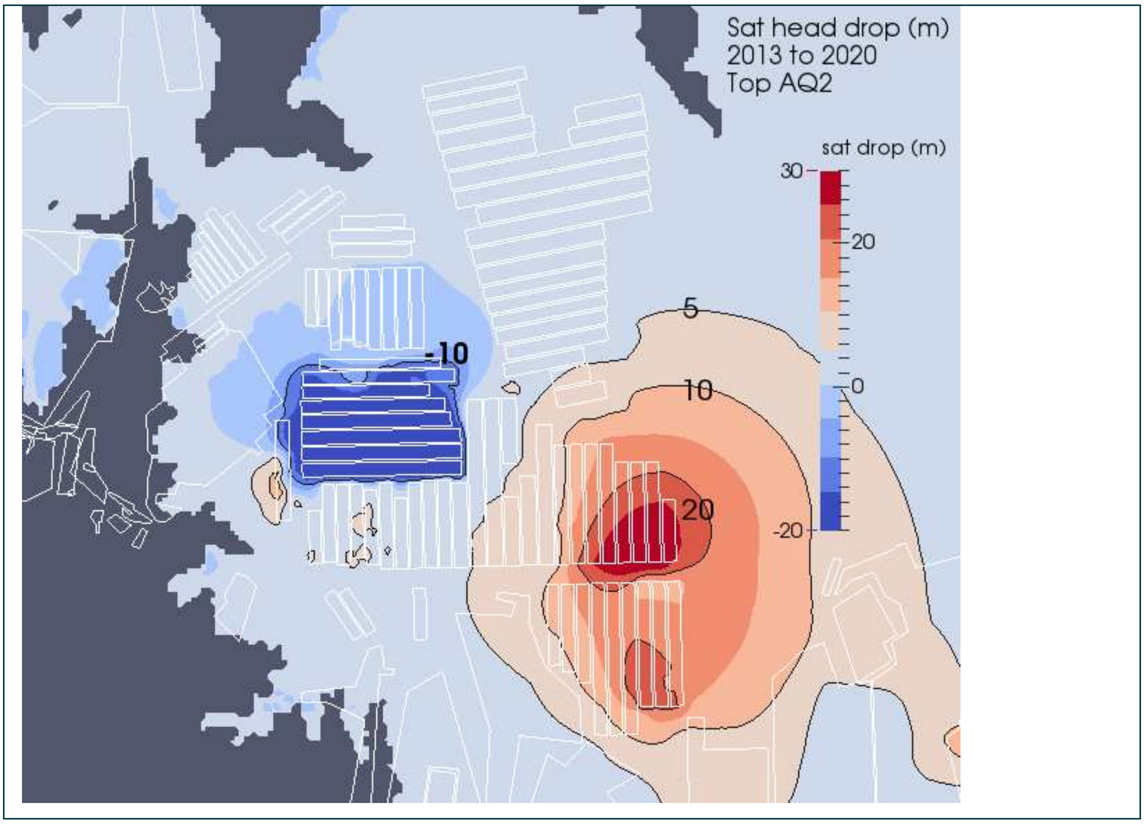

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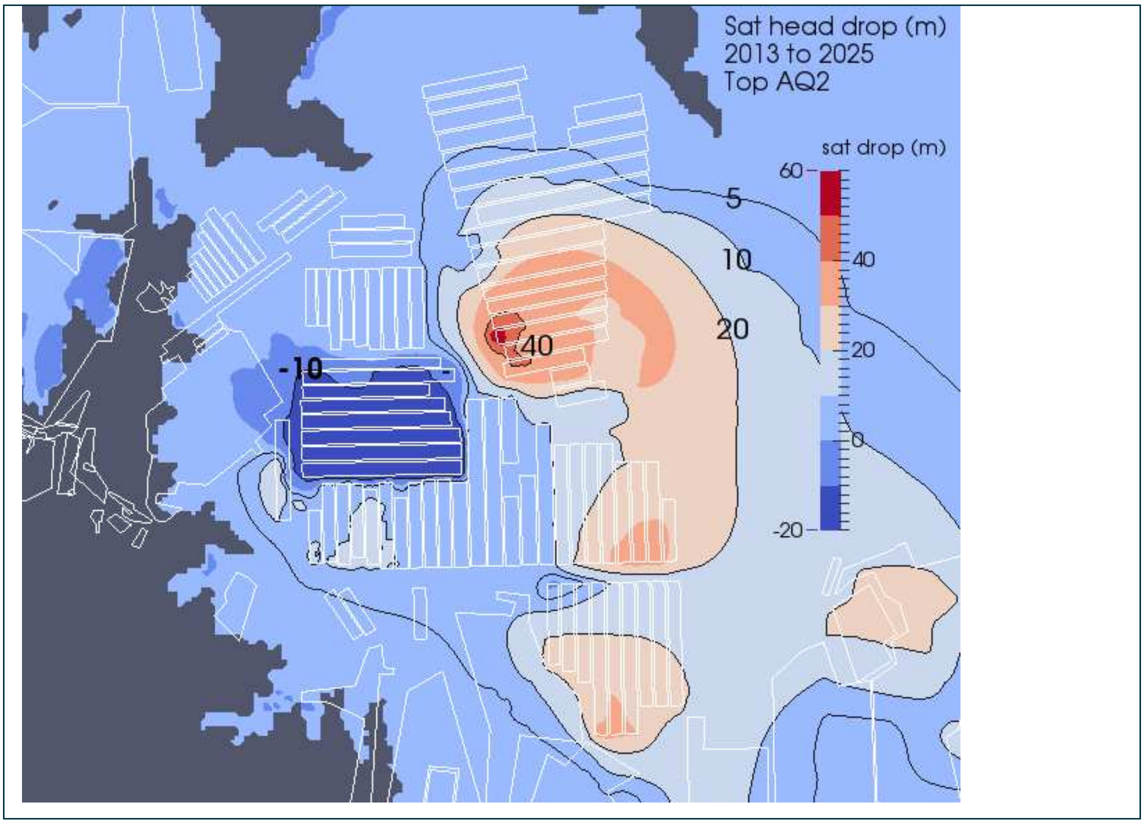

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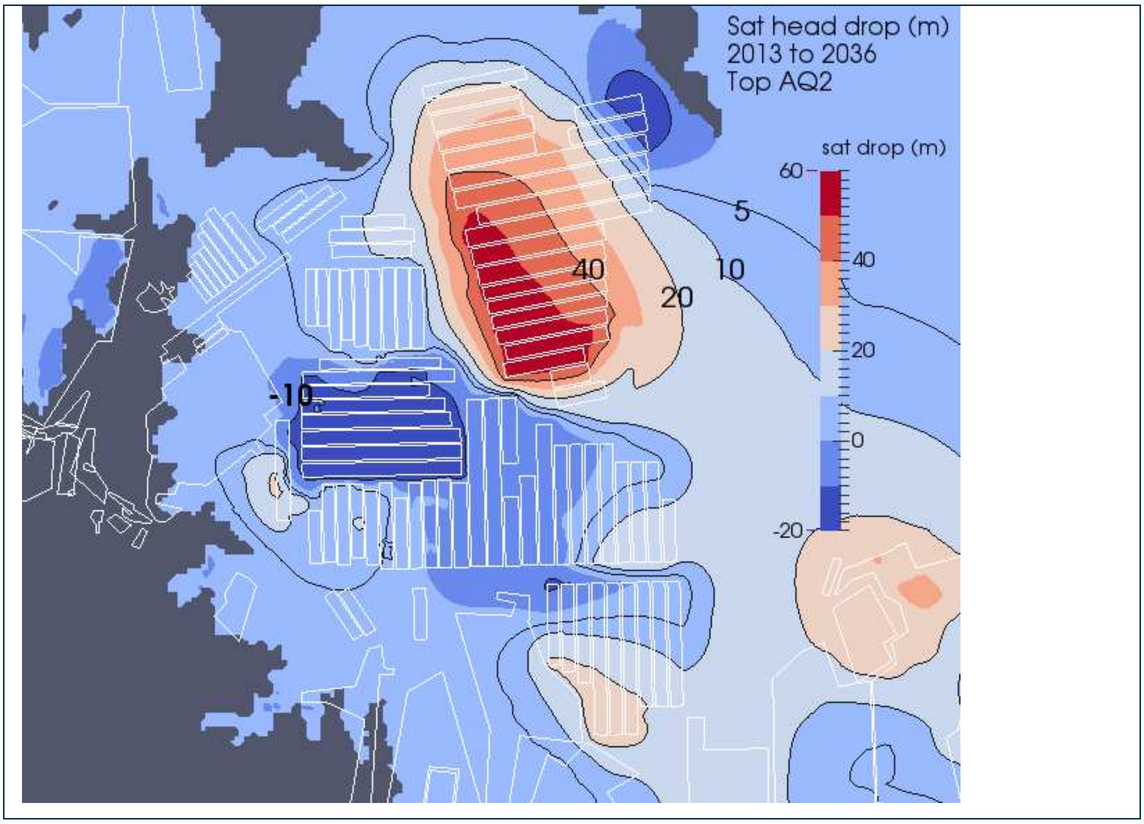
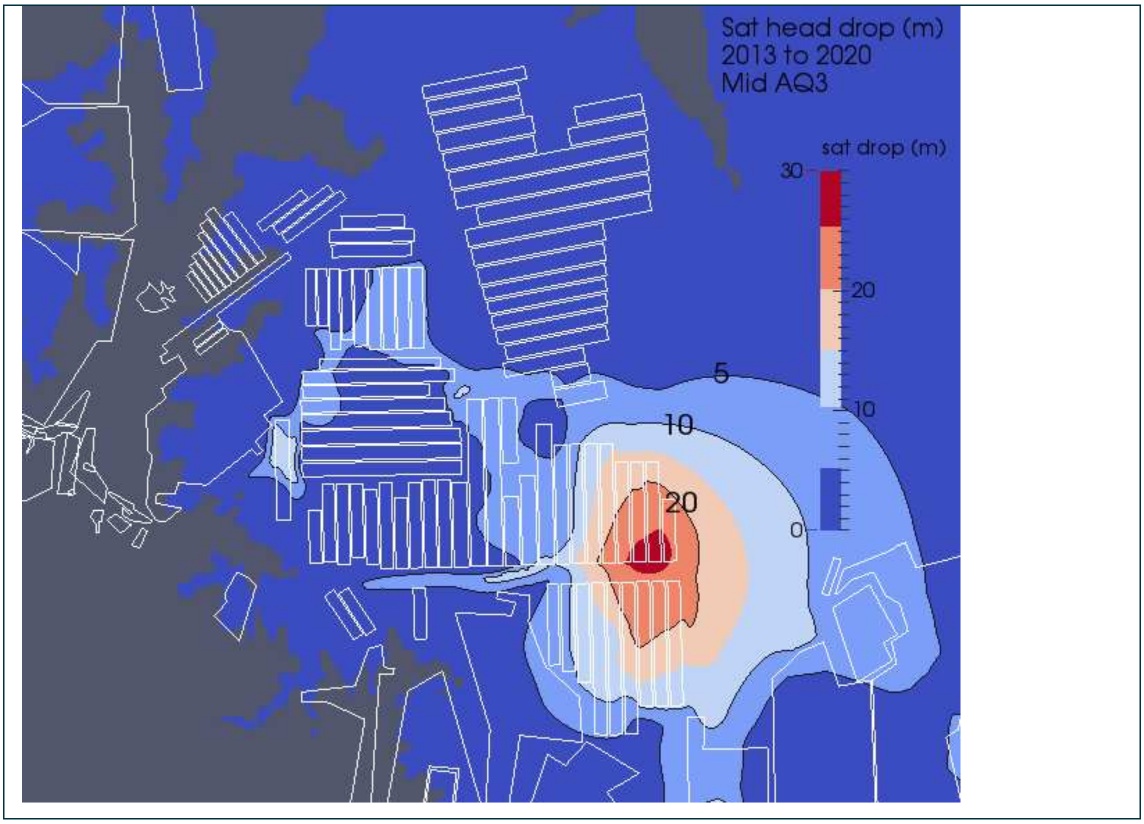


Figure I30 Distribution of drawdowns in AQ2 in 2036 with respect to groundwater levels in 2013



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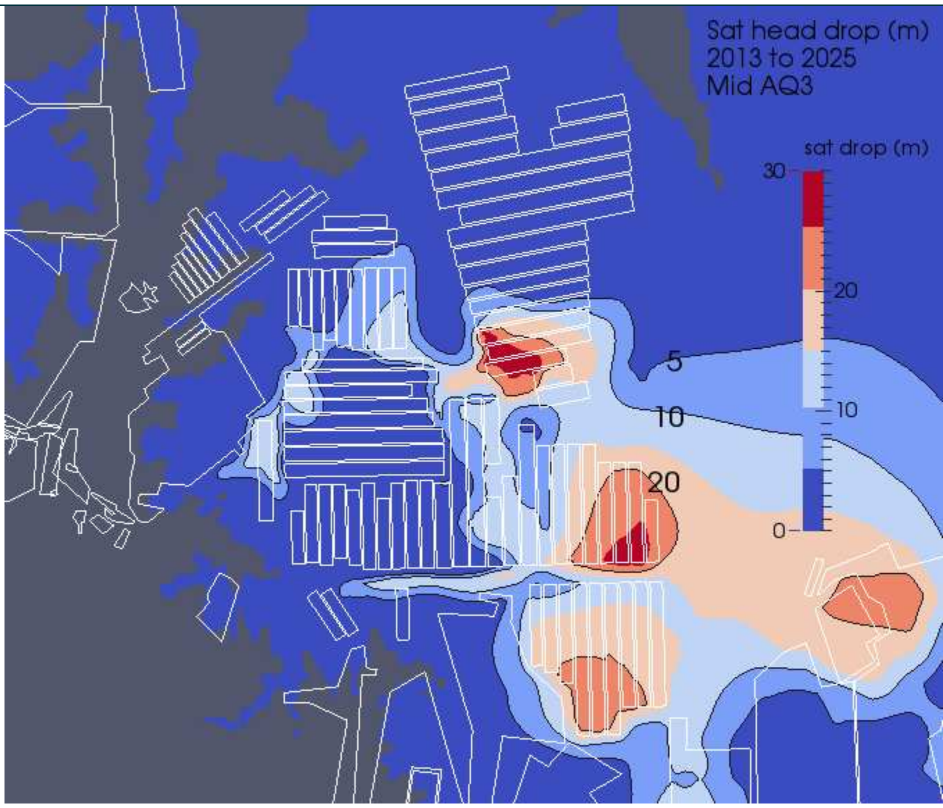

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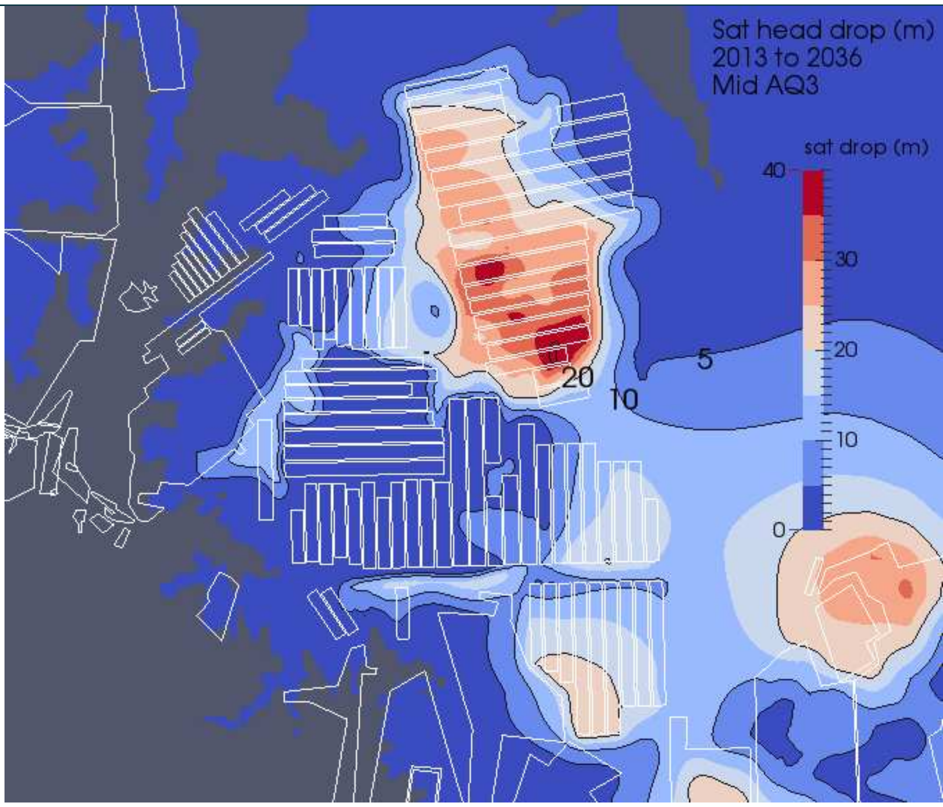
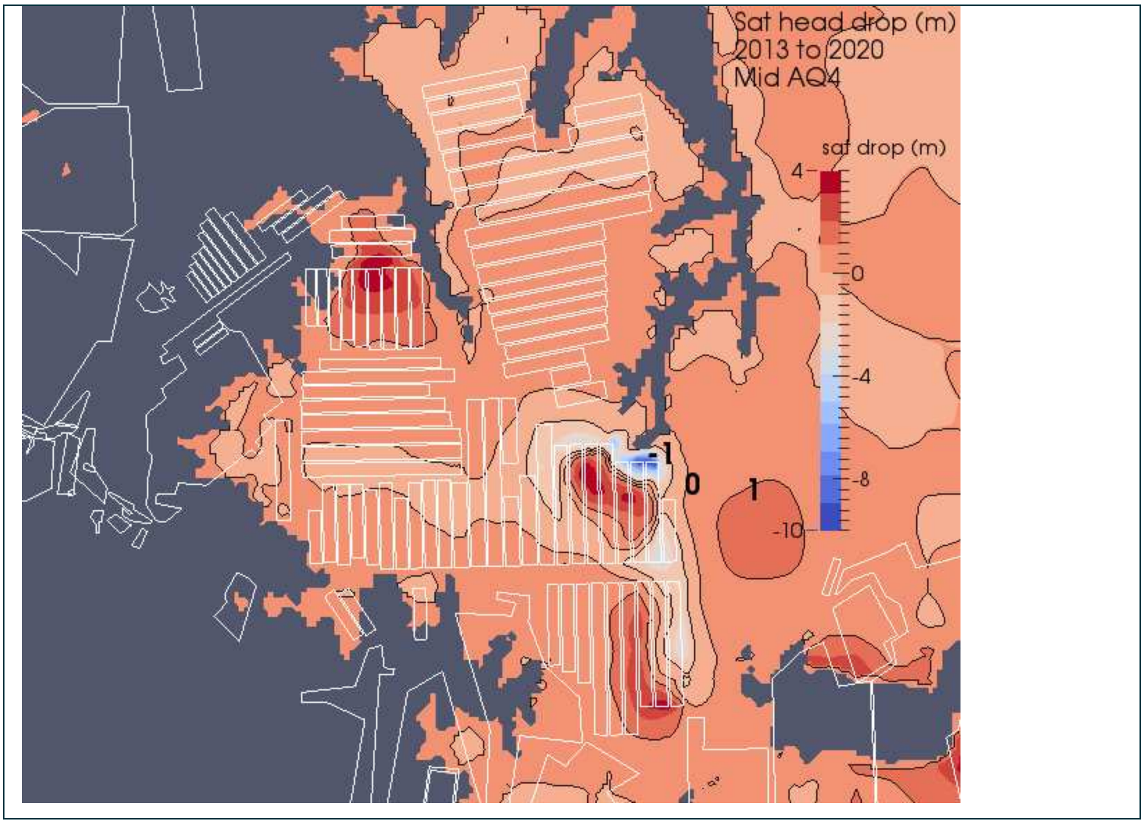


Figure I33 Distribution of drawdowns in AQ3 in 2036 with respect to groundwater levels in 2013



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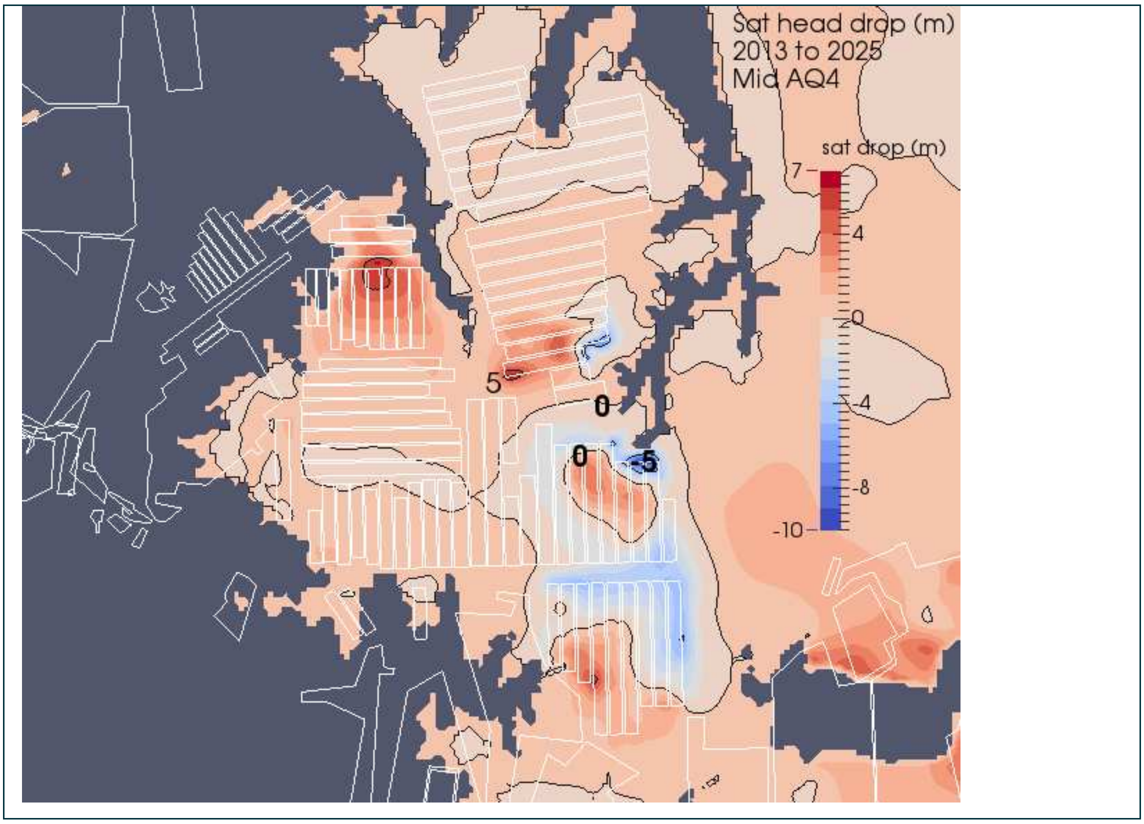

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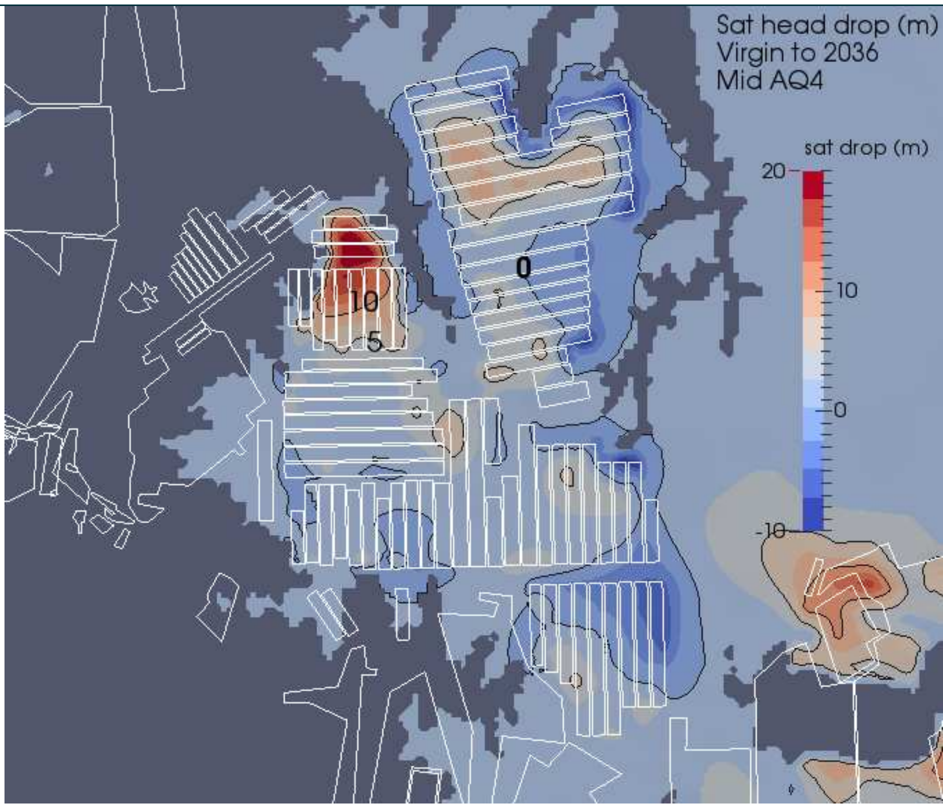

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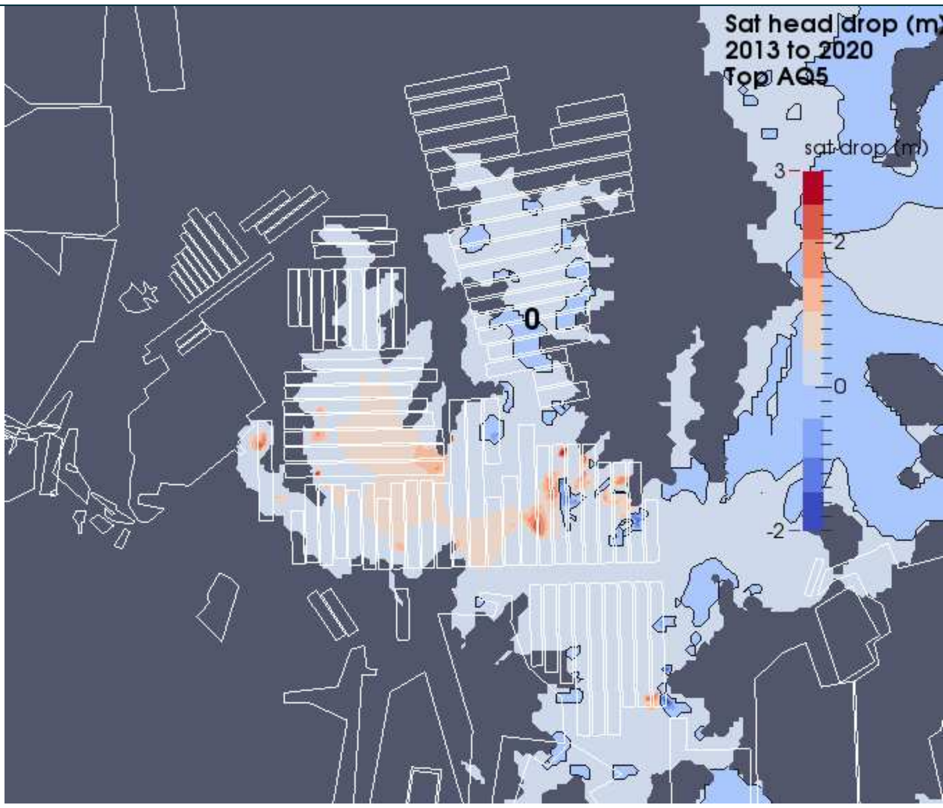

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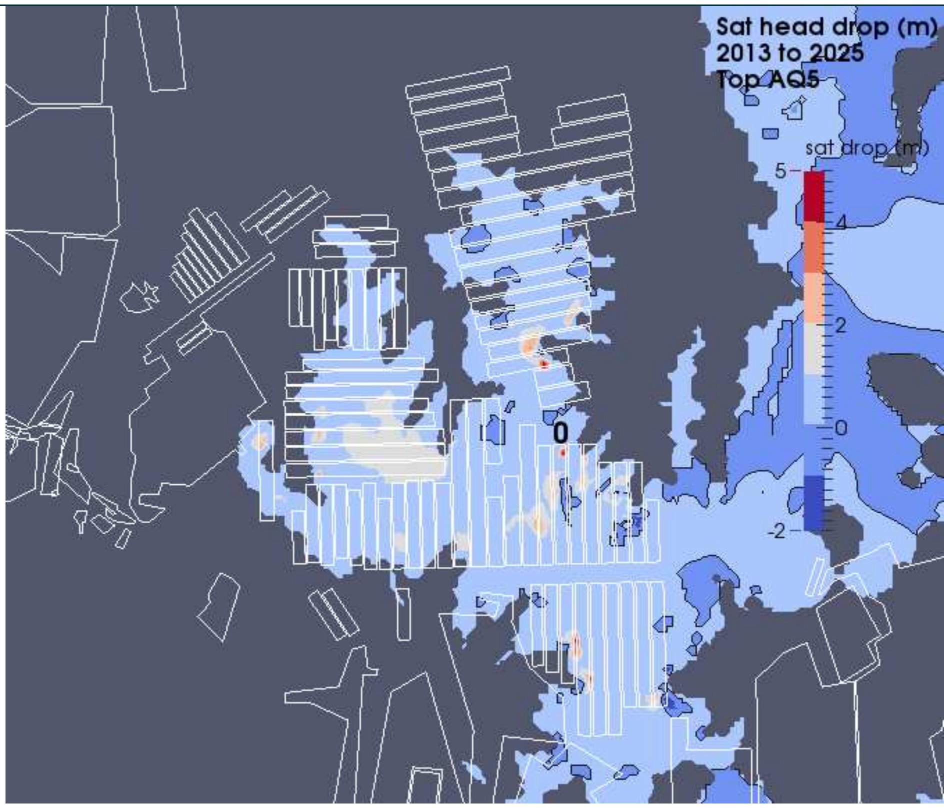

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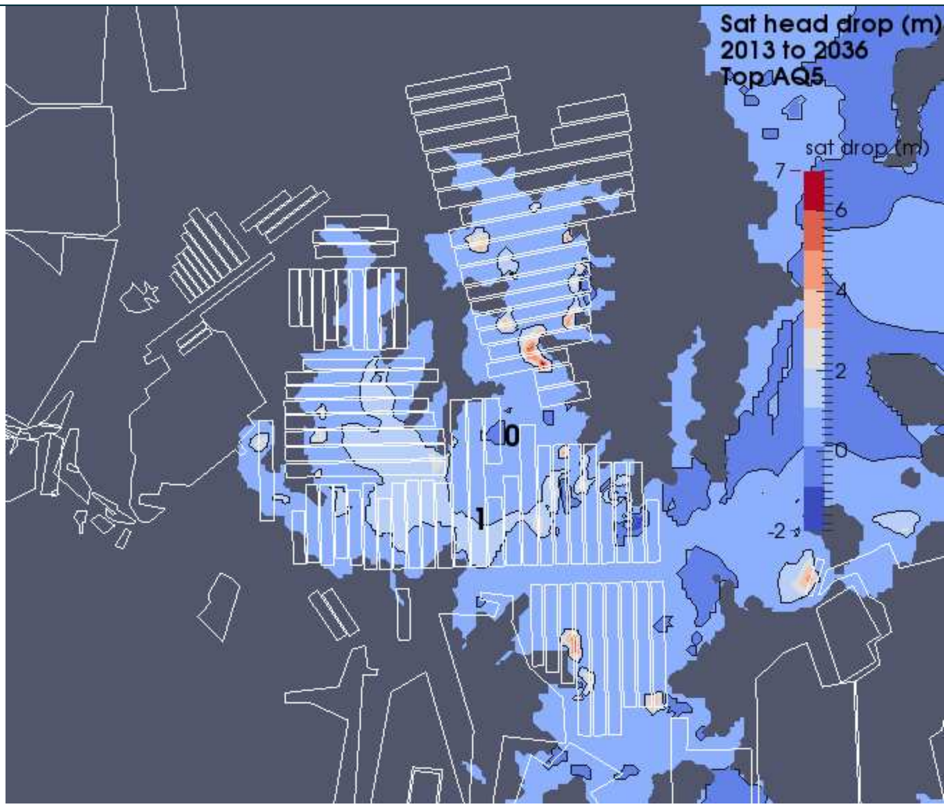

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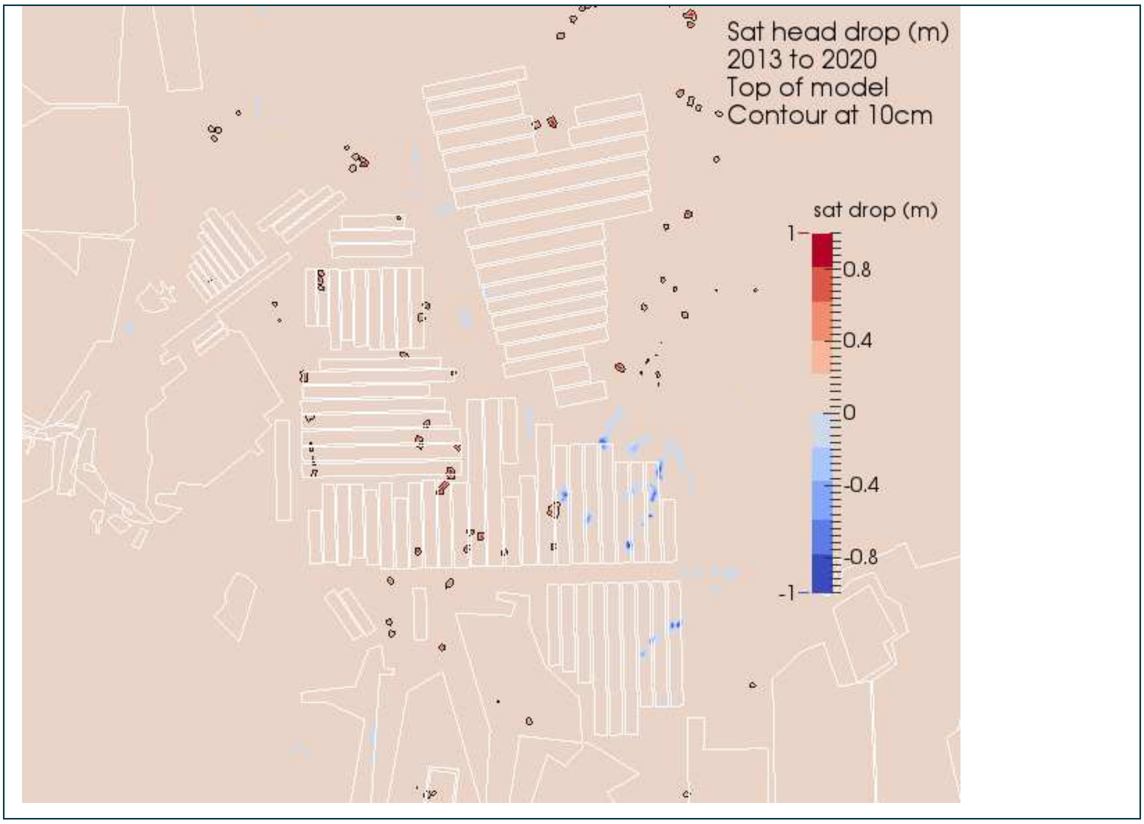

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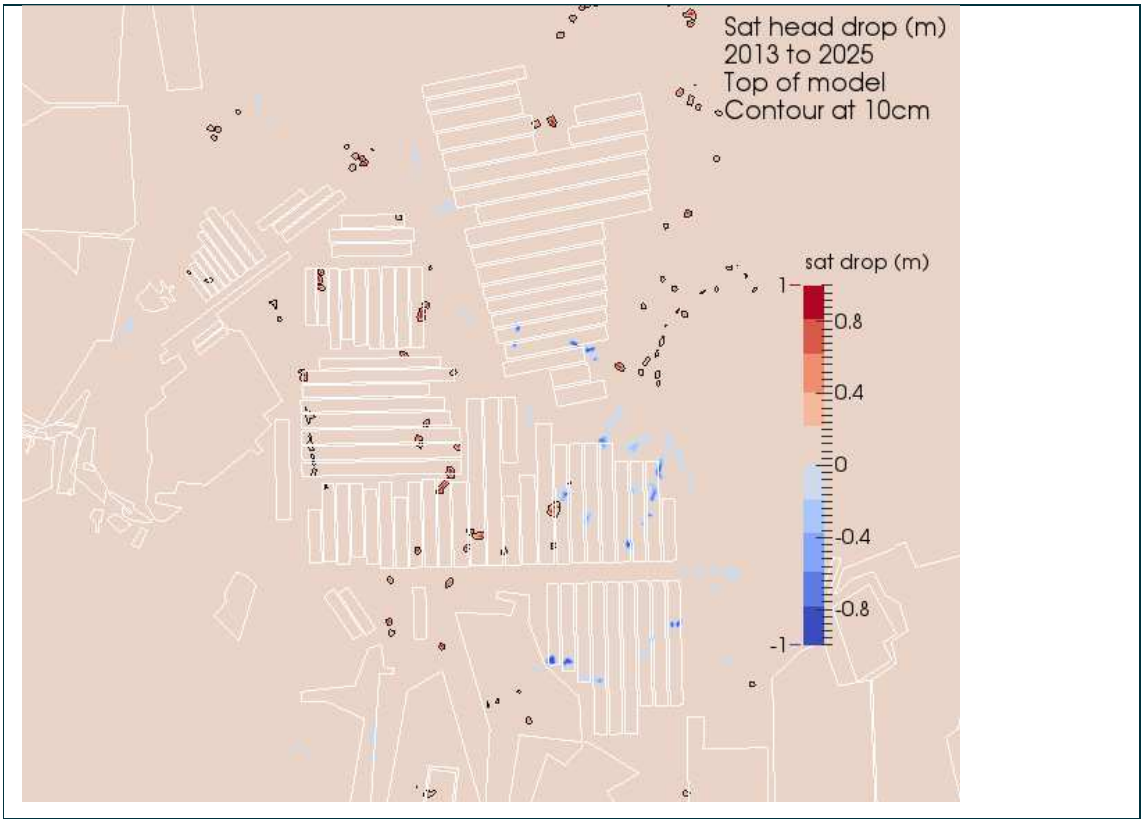

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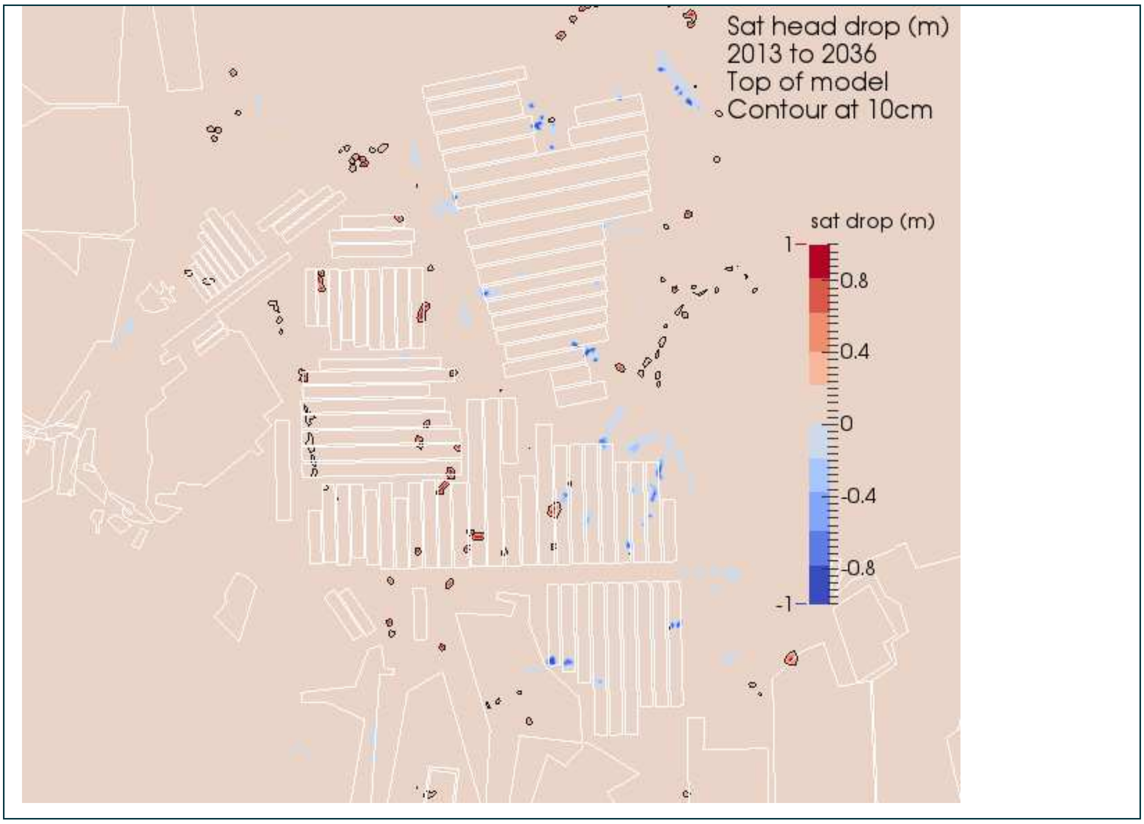


Figure I42 Distribution of head drops at the ground surface in 2036 with respect to groundwater levels in 2013

Recovery Period with respect to Pre-mining Groundwater Condition

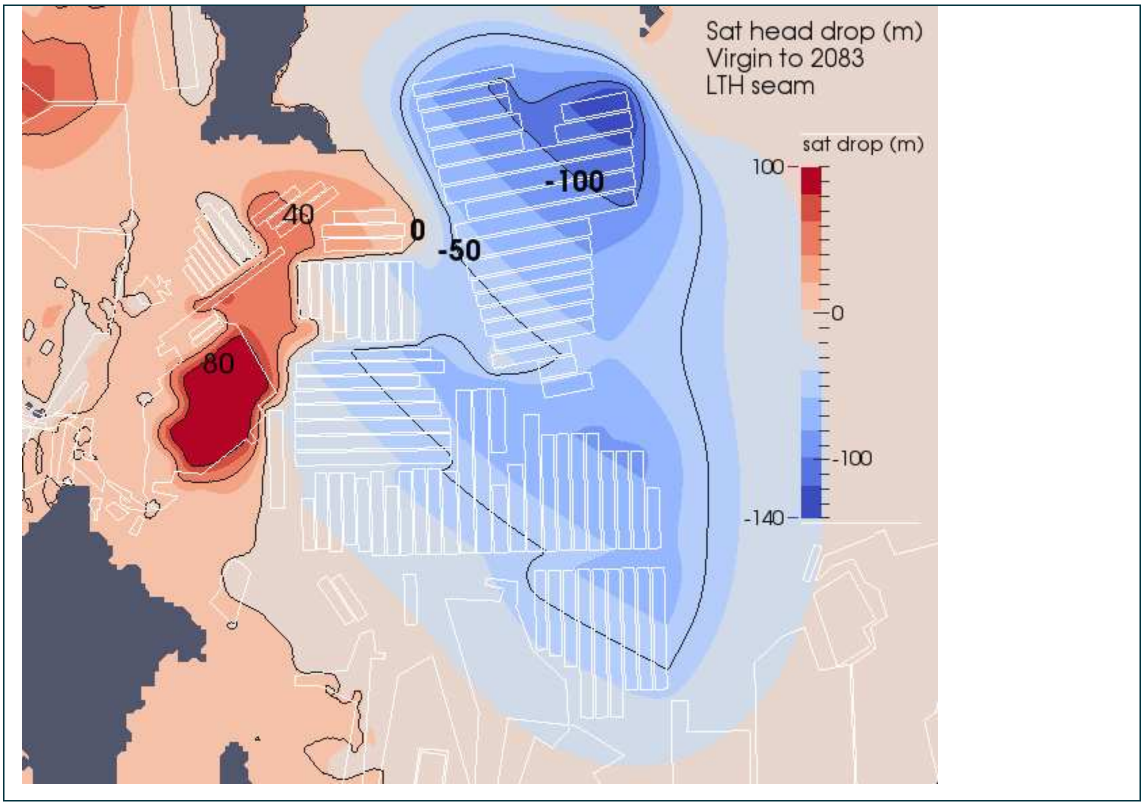


Figure I43 Distribution of head drops in the Lithgow Seam in 2083 with respect to pre-mining groundwater condition

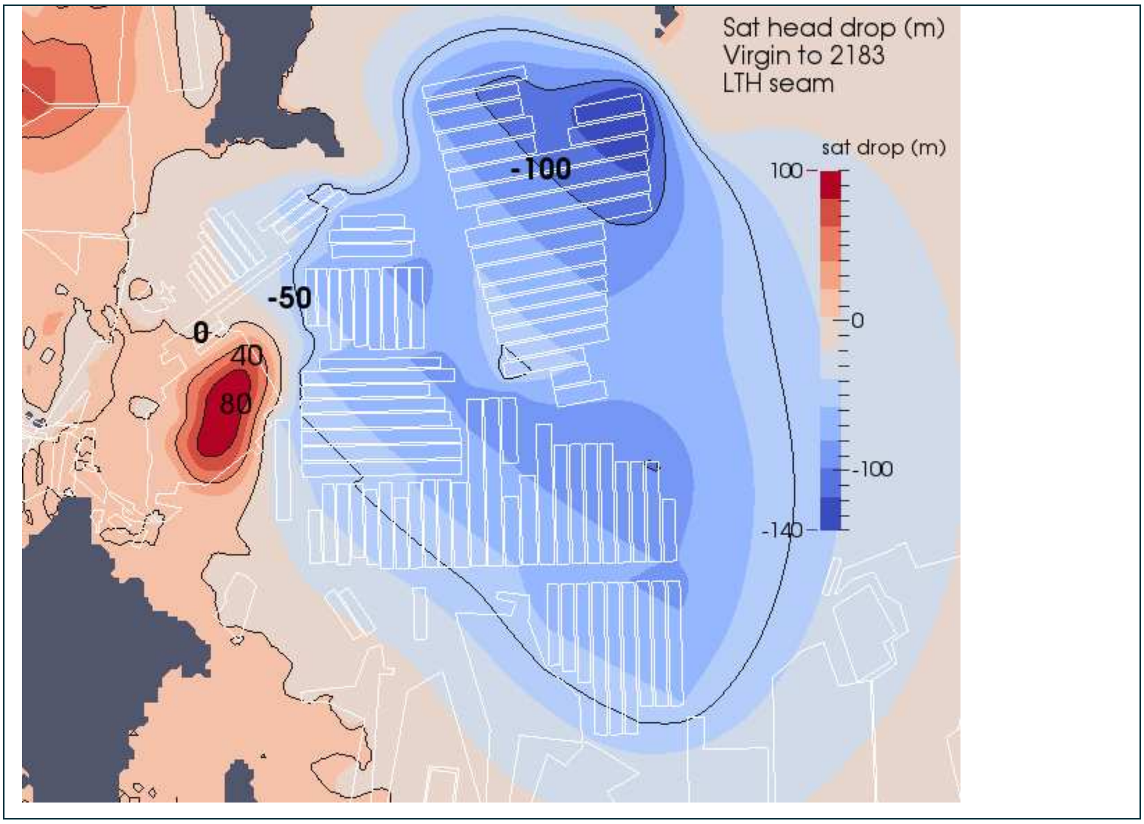


Figure I44 Distribution of head drops in the Lithgow Seam in 2183 with respect to pre-mining groundwater condition

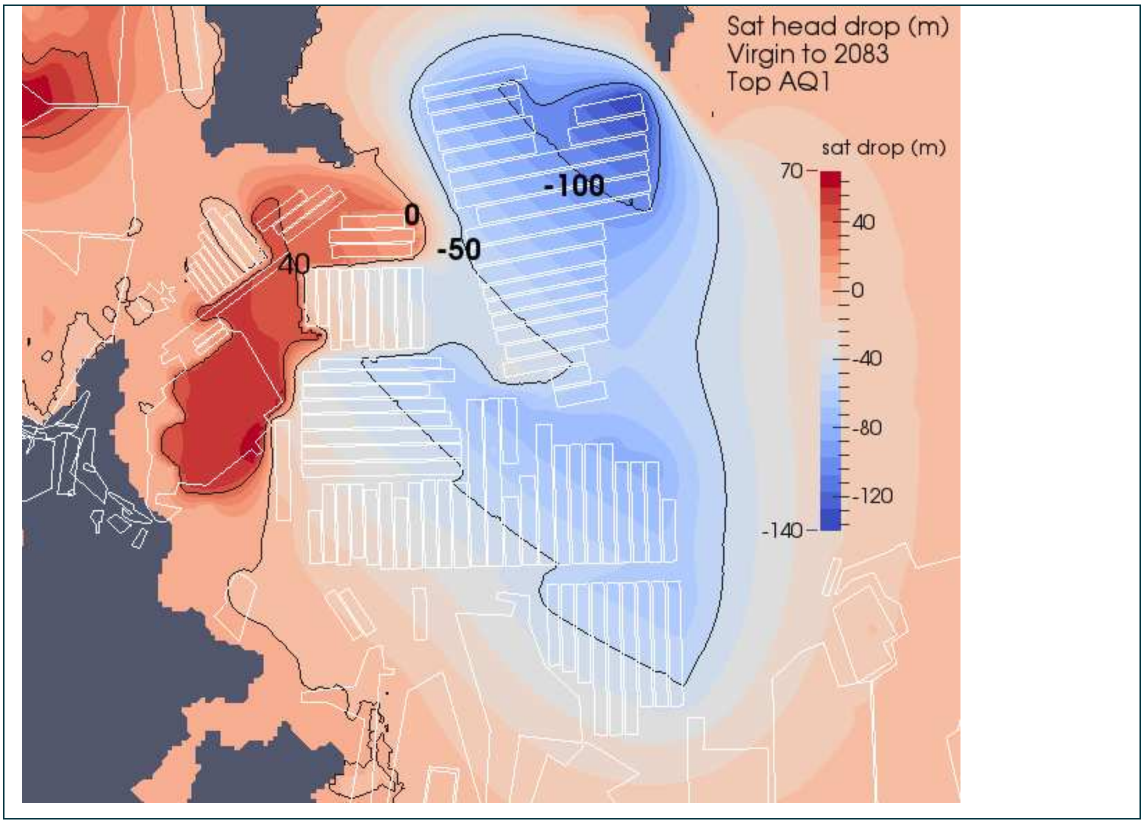


Figure I45 Distribution of head drops in AQ1 in 2083 with respect to pre-mining groundwater condition

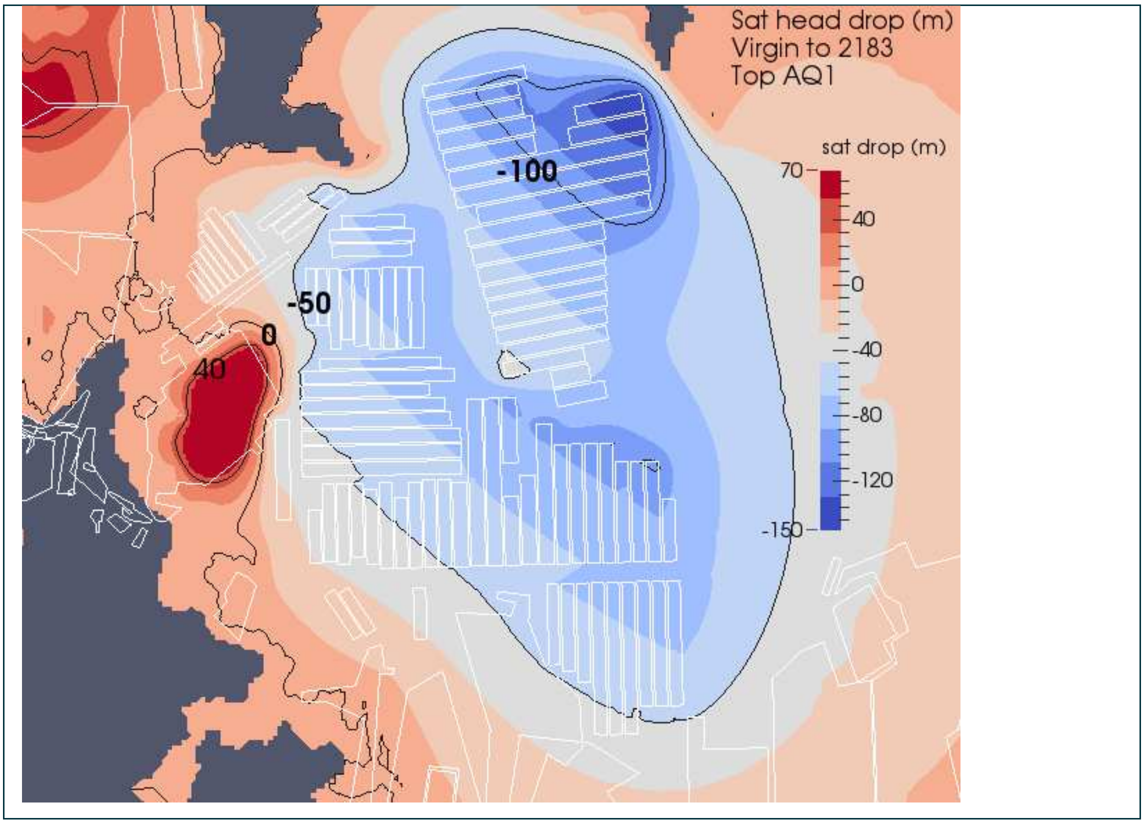
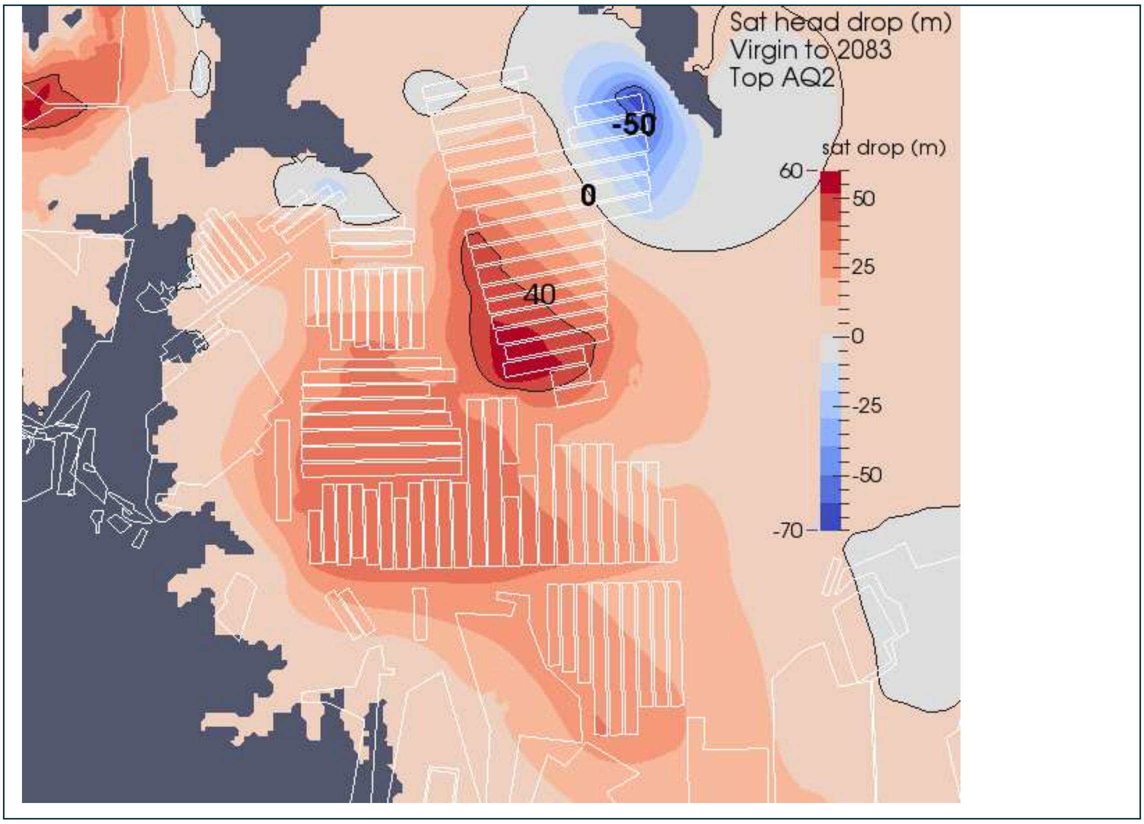


Figure I46 Distribution of head drops in AQ1 in 2183 with respect to pre-mining groundwater condition



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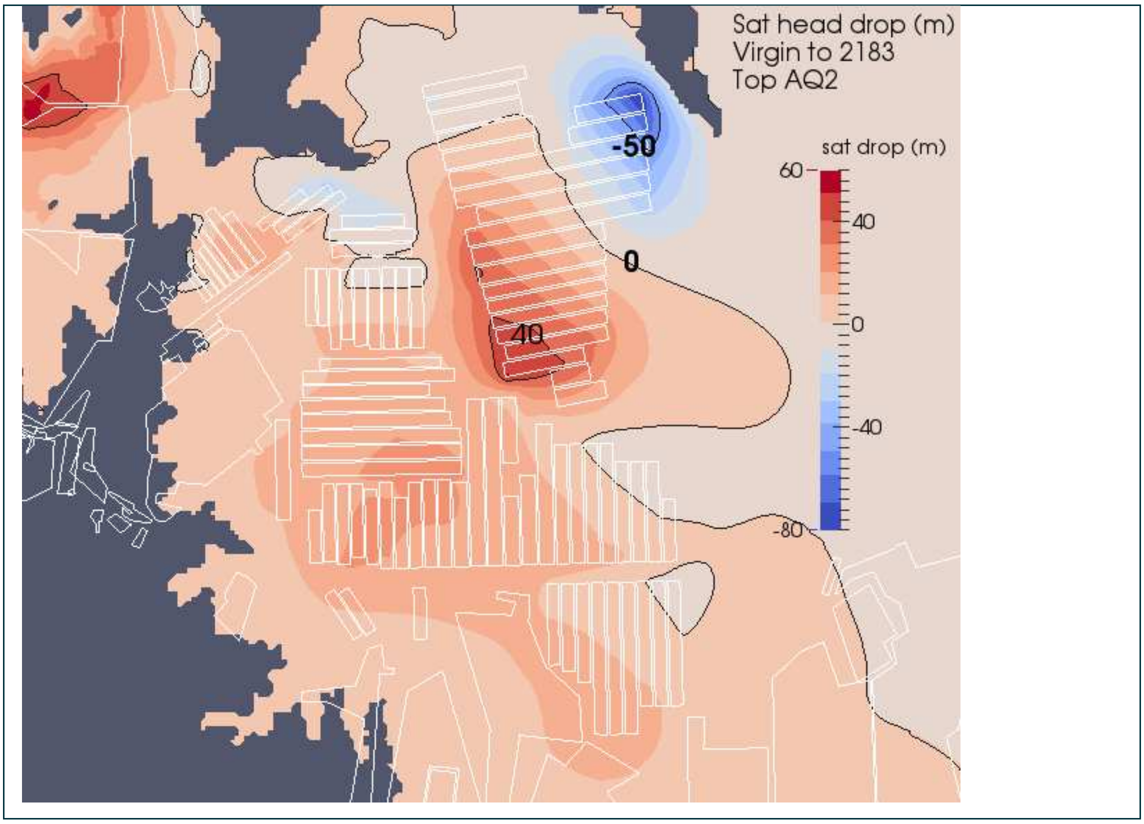
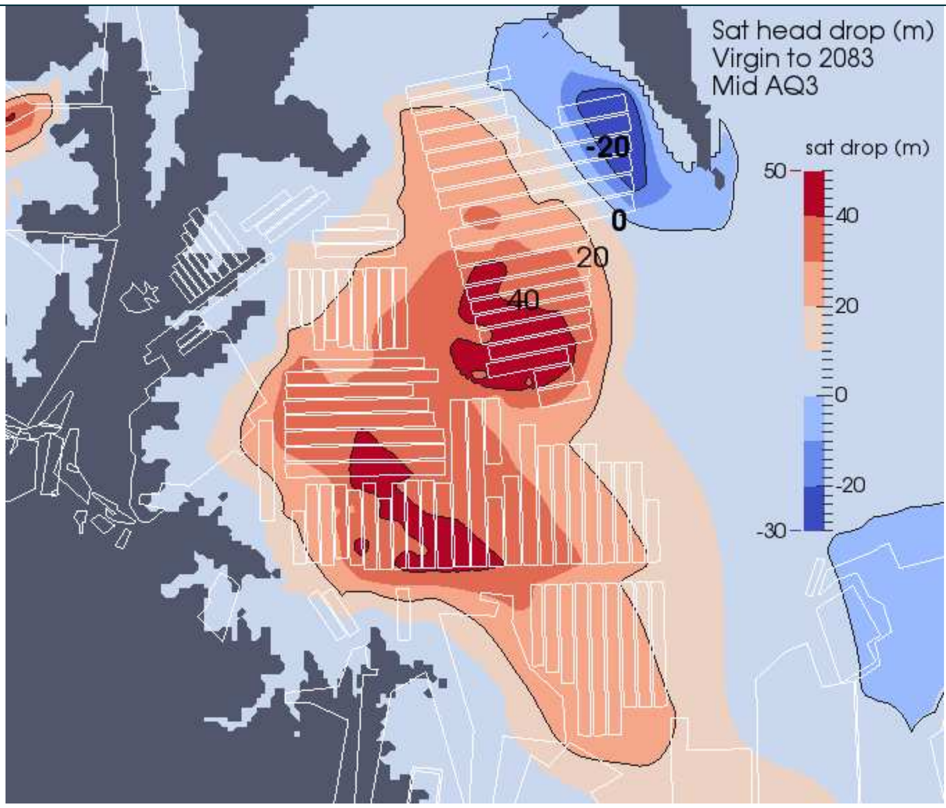


Figure I48 Distribution of head drops in AQ2 in 2183 with respect to pre-mining groundwater condition



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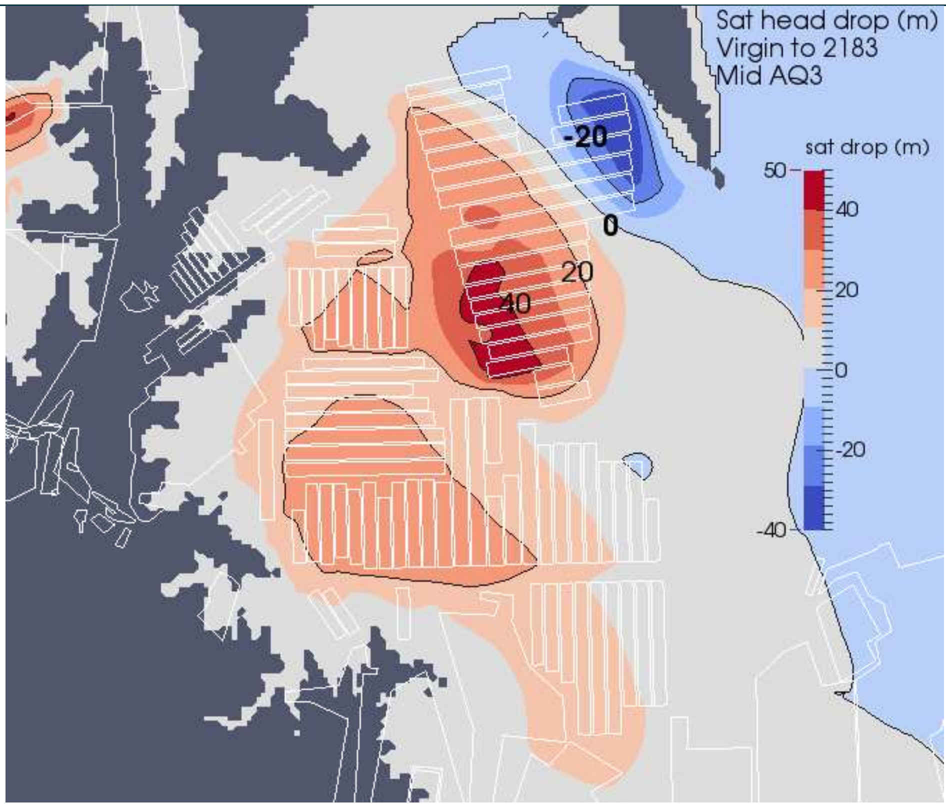


Figure I50 Distribution of head drops in AQ3 in 2183 with respect to pre-mining groundwater condition

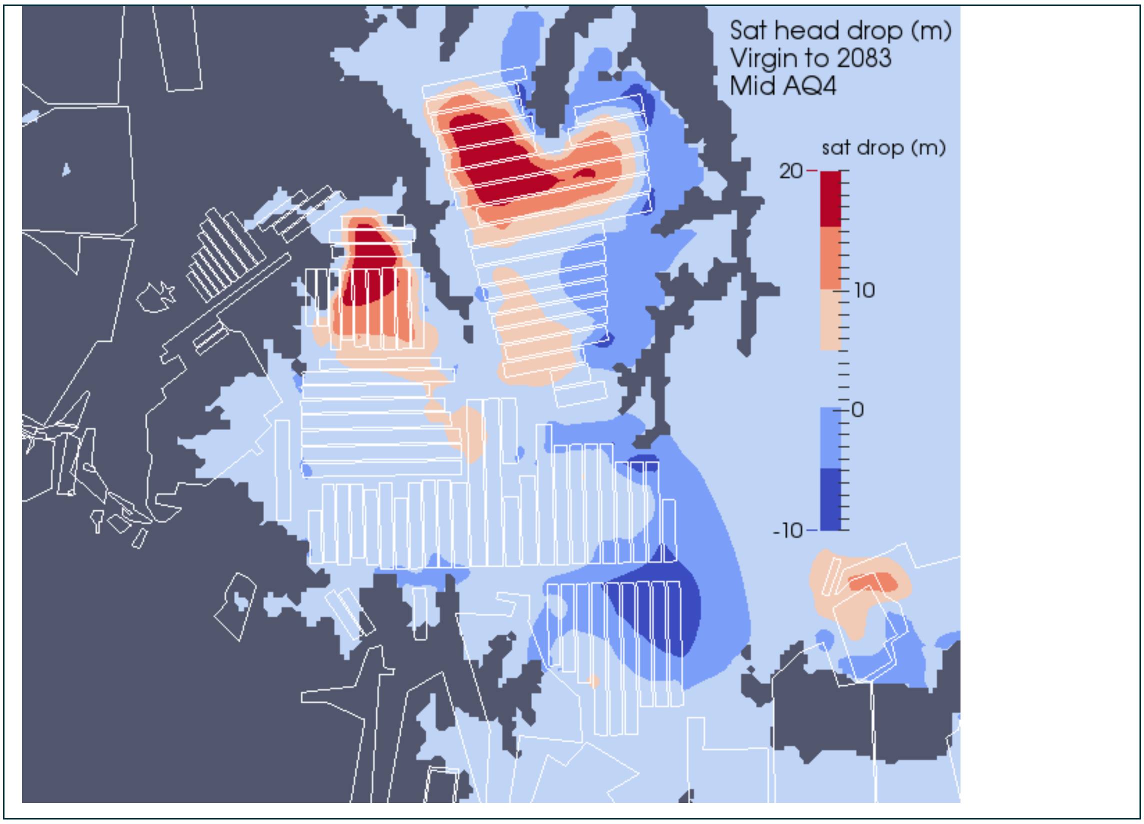


Figure I51 Distribution of head drops in AQ4 in 2083 with respect to pre-mining groundwater condition

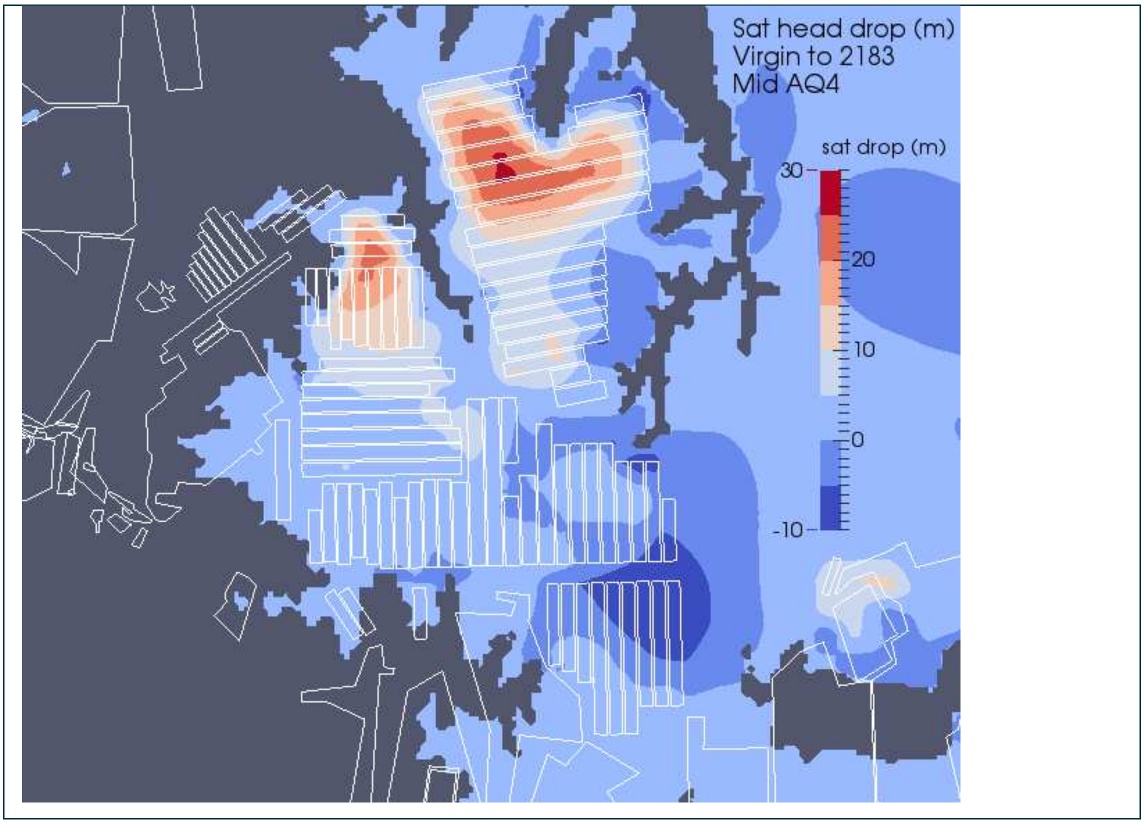
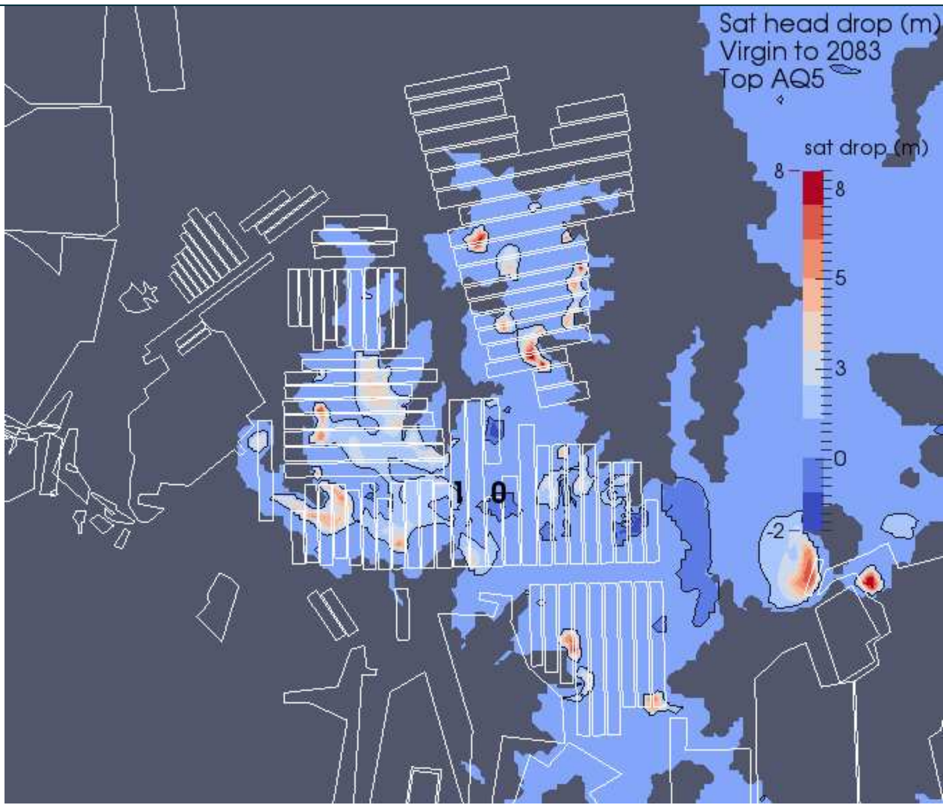


Figure I52 Distribution of head drops in AQ4 in 2183 with respect to pre-mining groundwater condition



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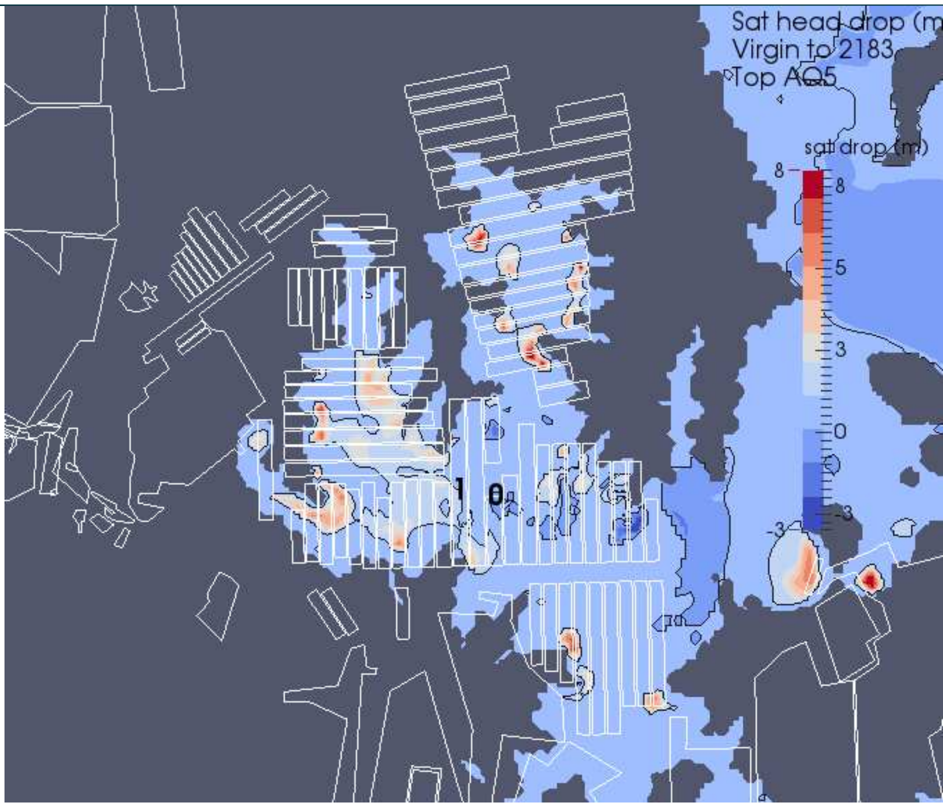


Figure I54 Distribution of head drops in AQ5 in 2183 with respect to pre-mining groundwater condition

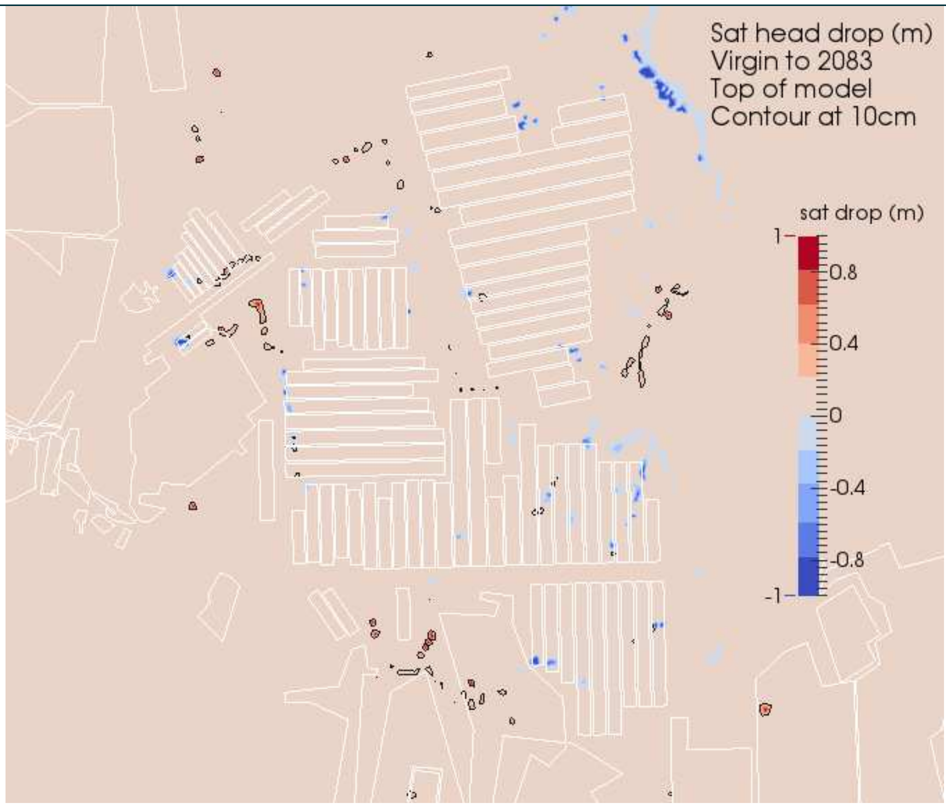
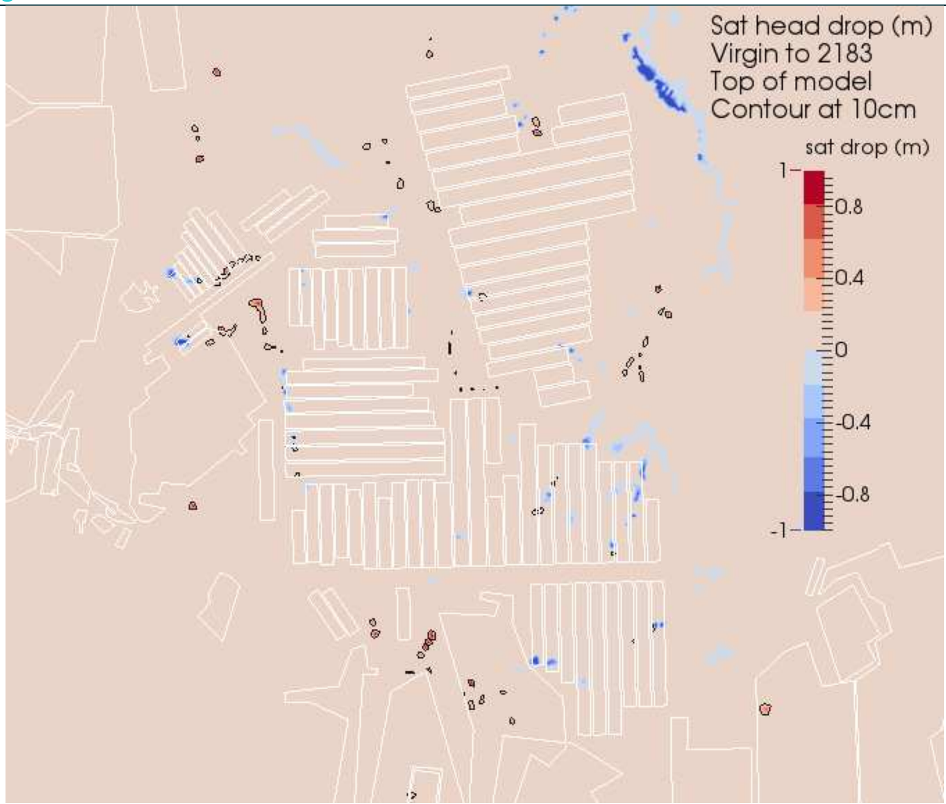


Figure I55 Distribution of head drops at the ground surface in 2083 with respect to pre-mining groundwater condition



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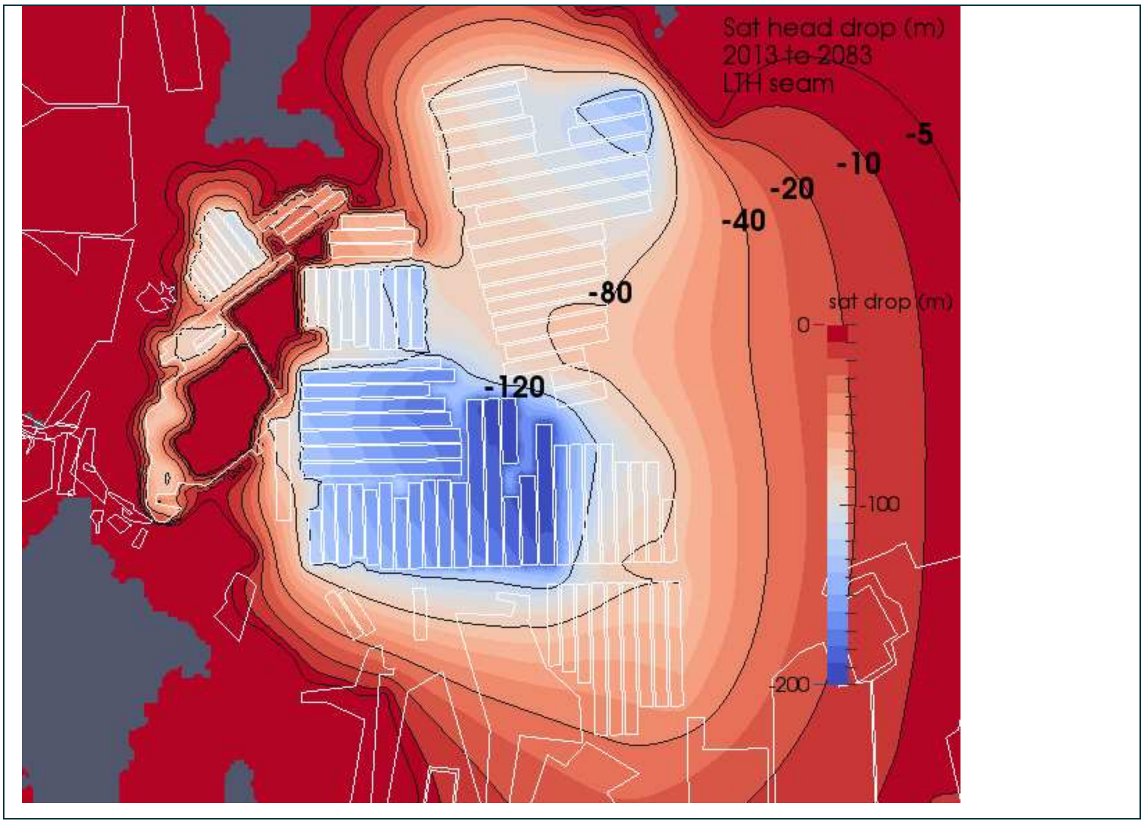


Figure I57 Distribution of head drops in the Lithgow Seam in 2083 with respect to groundwater levels in 2013

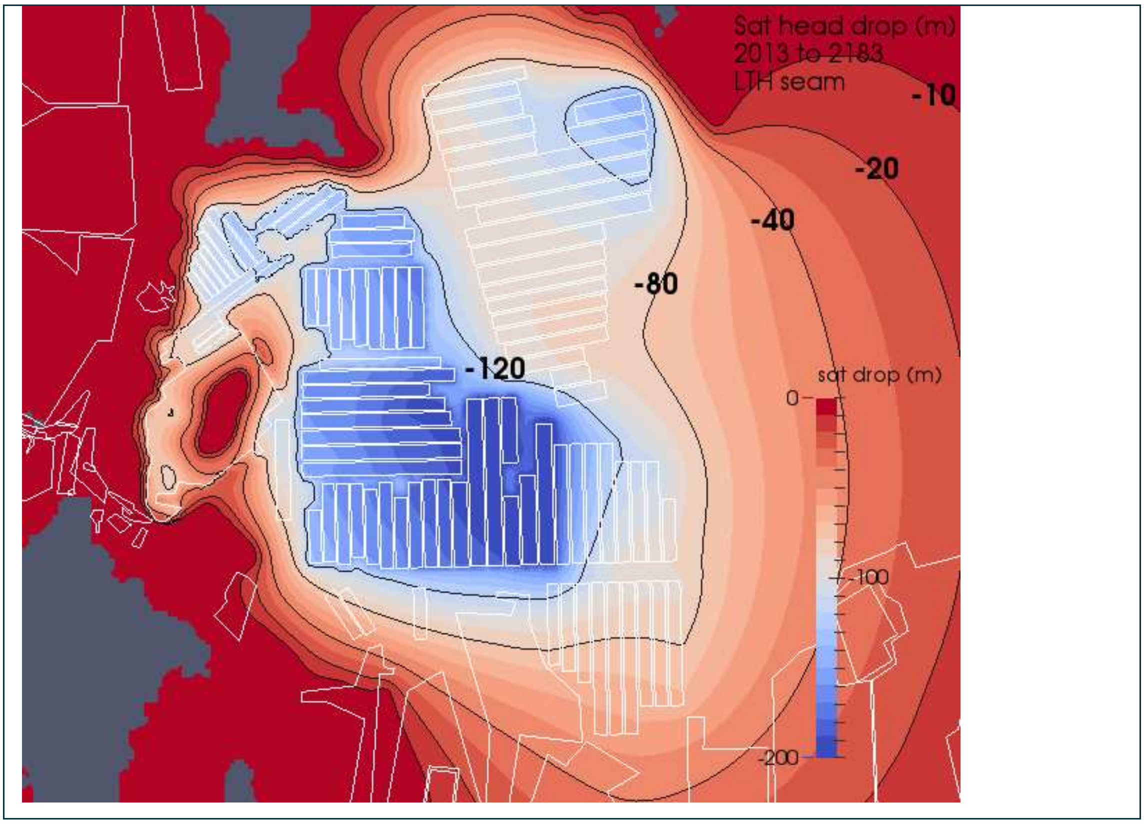
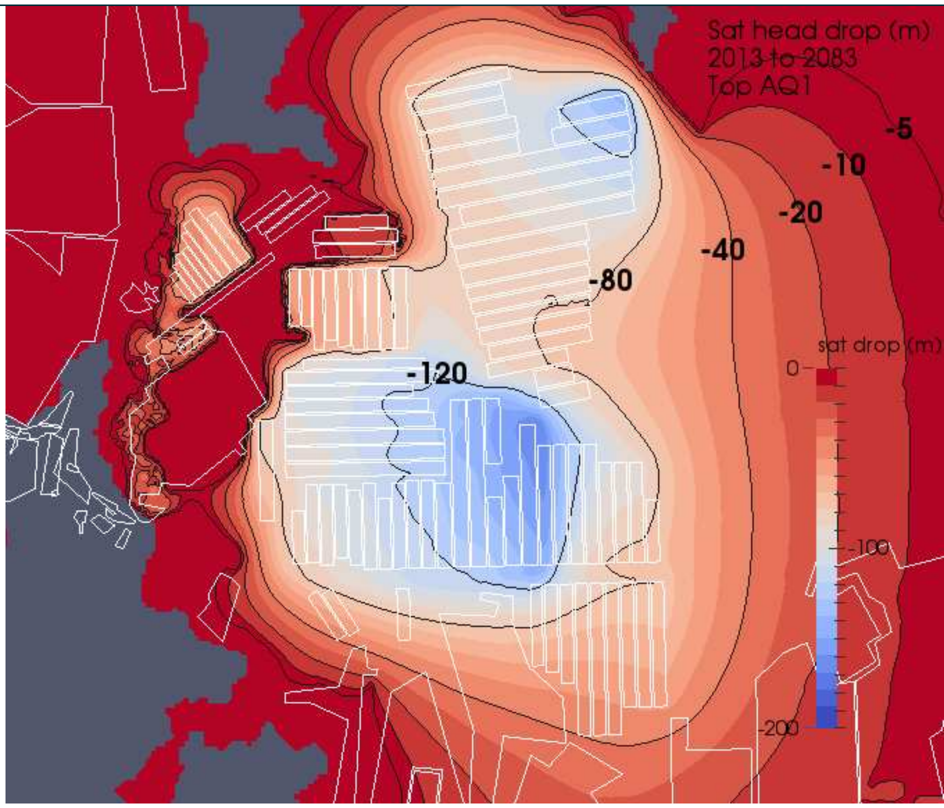


Figure I58 Distribution of head drops in the Lithgow Seam in 2183 with respect to groundwater levels in 2013



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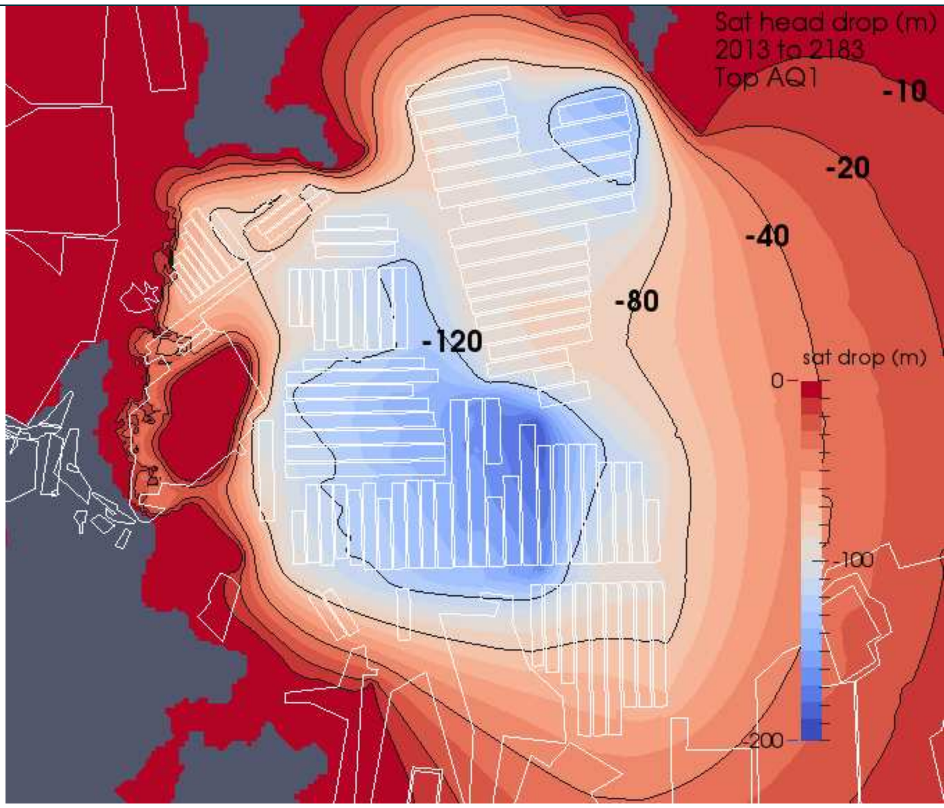

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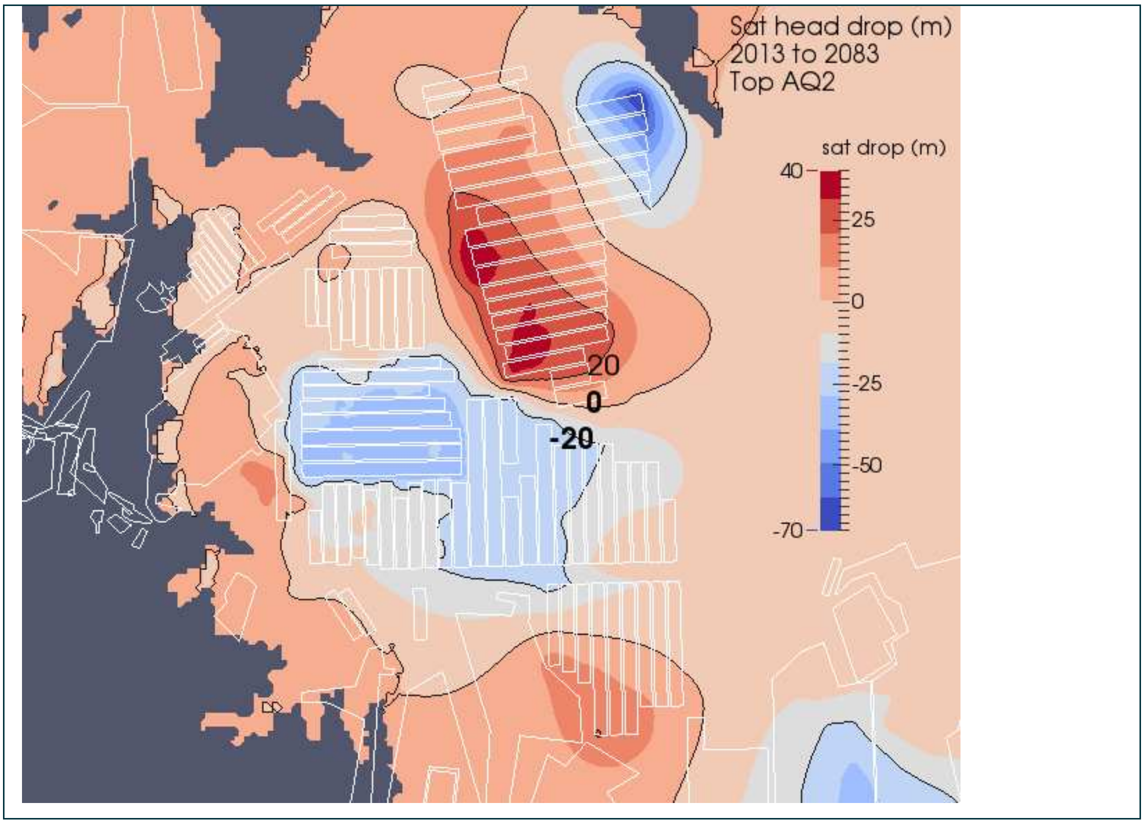

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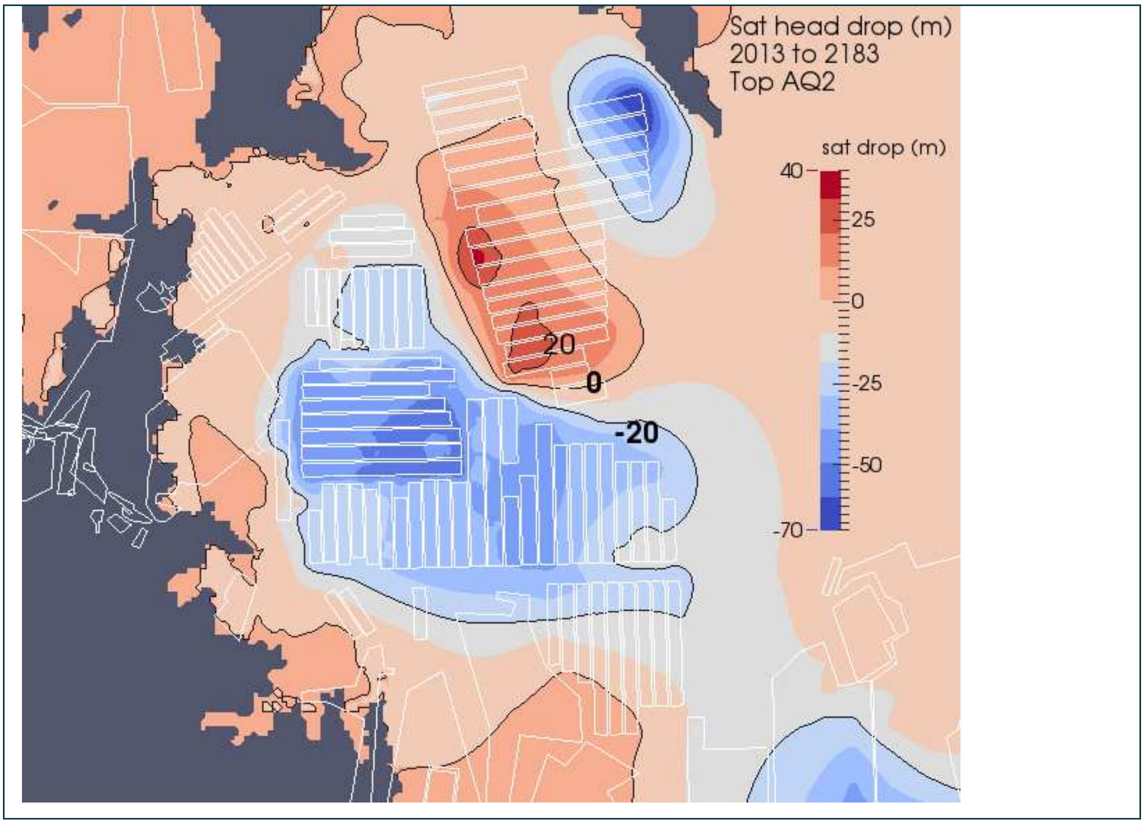

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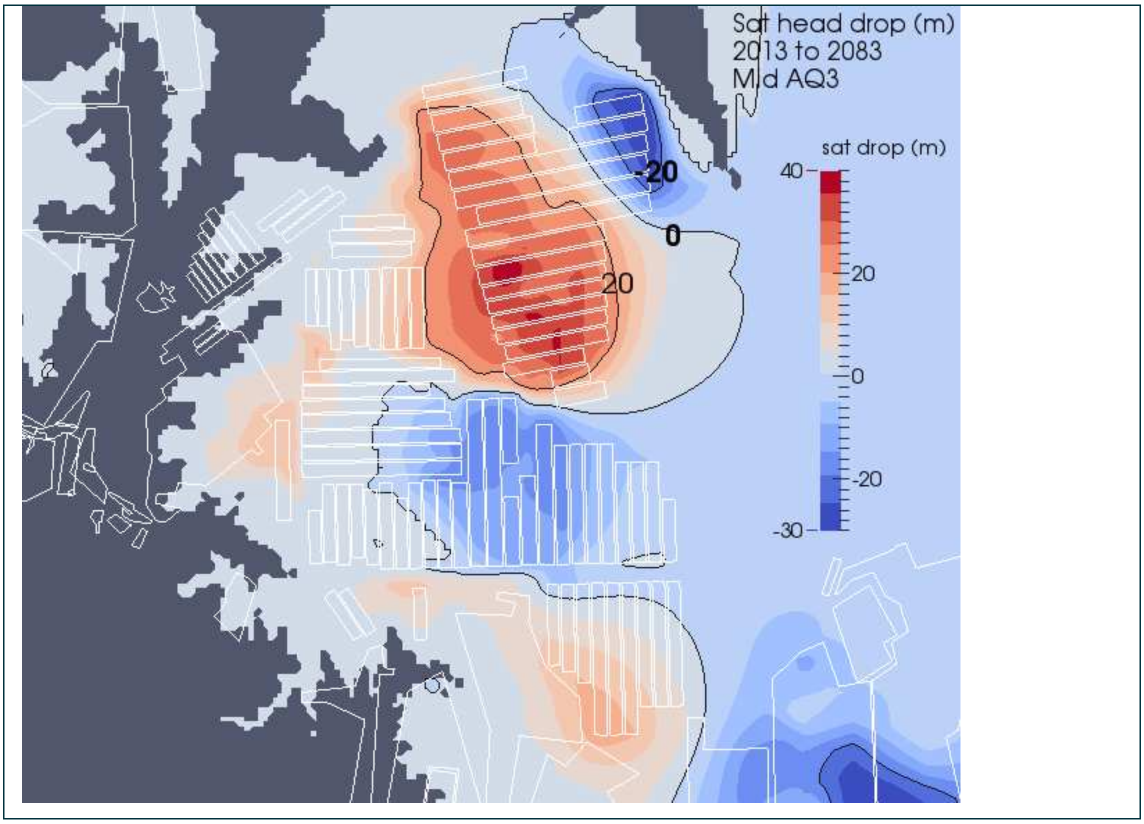

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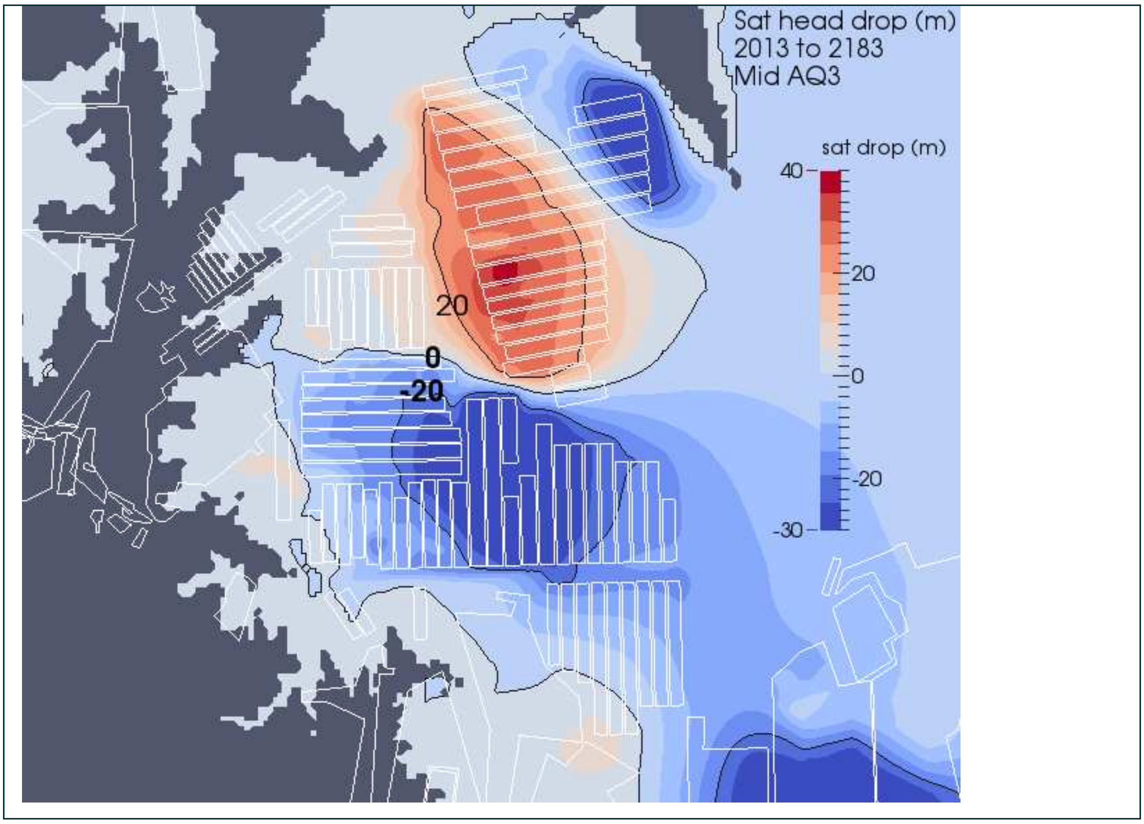

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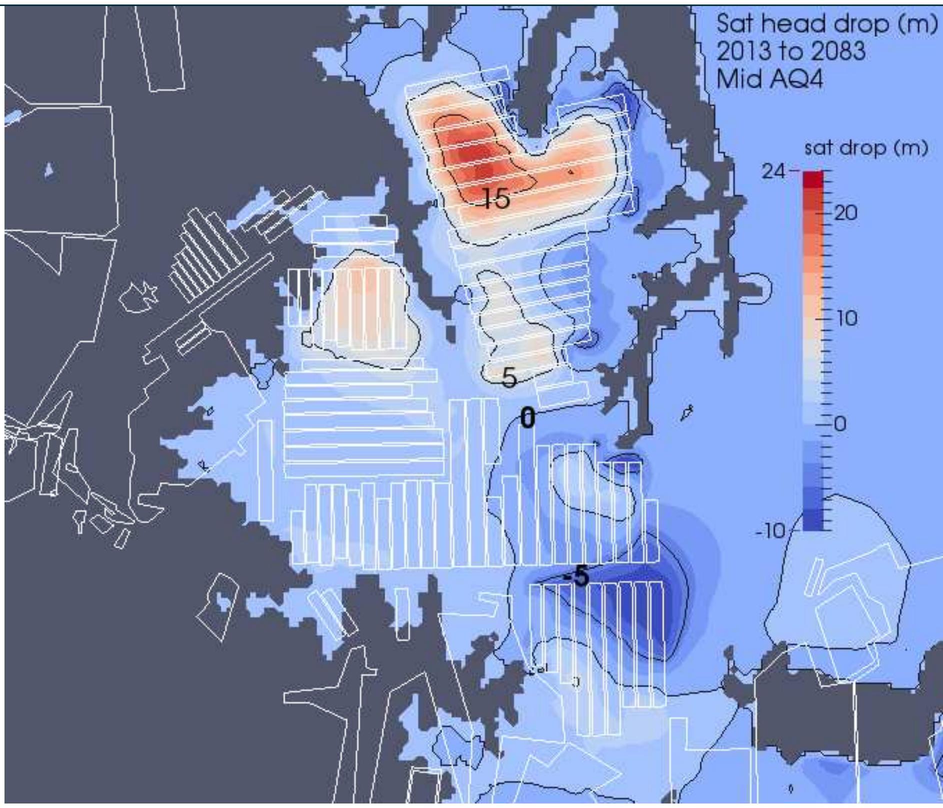

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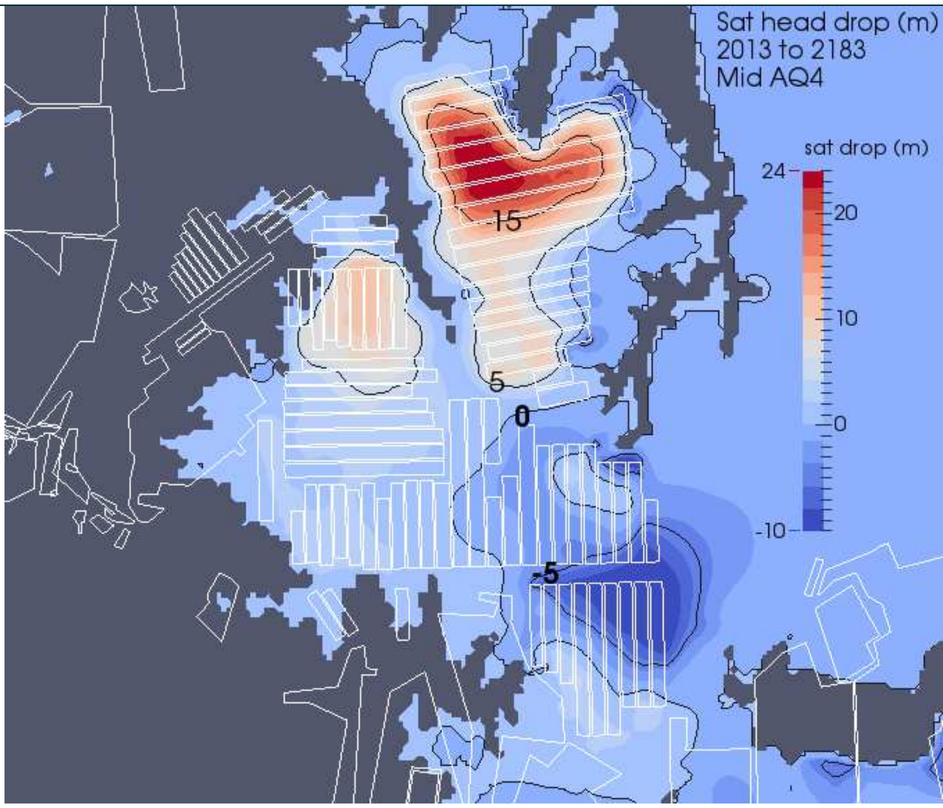

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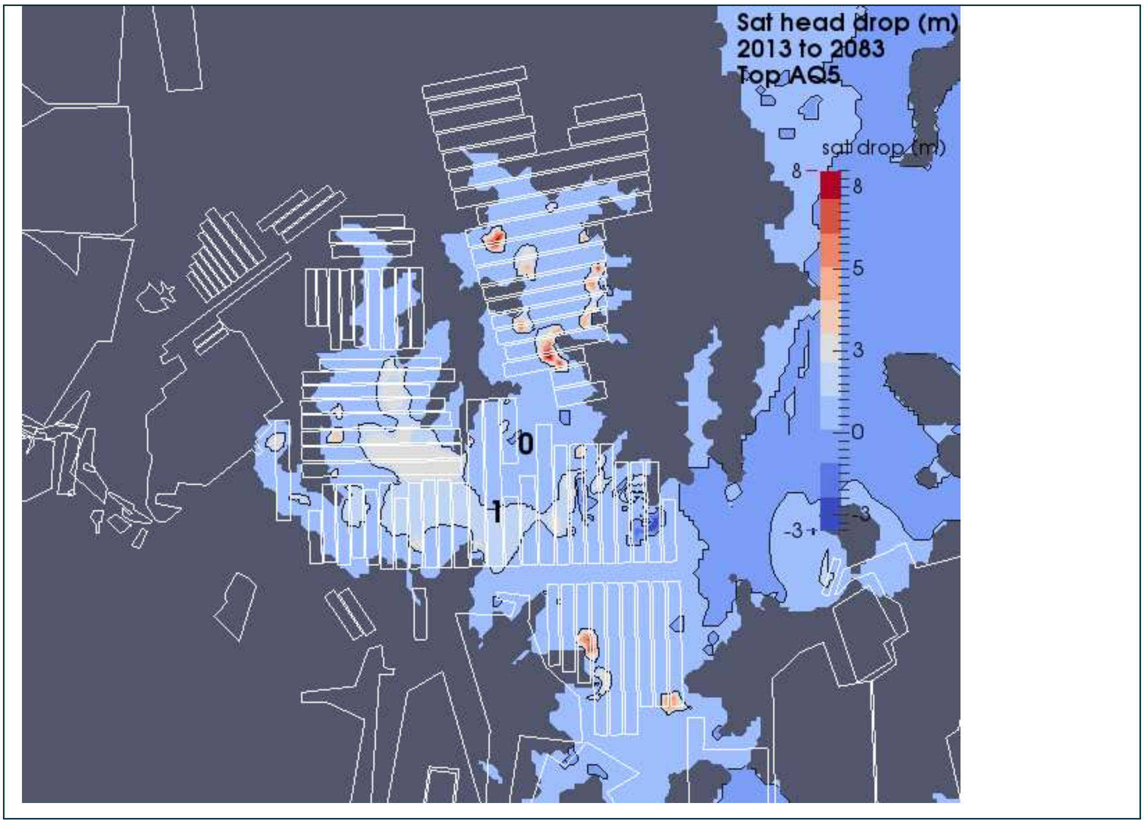

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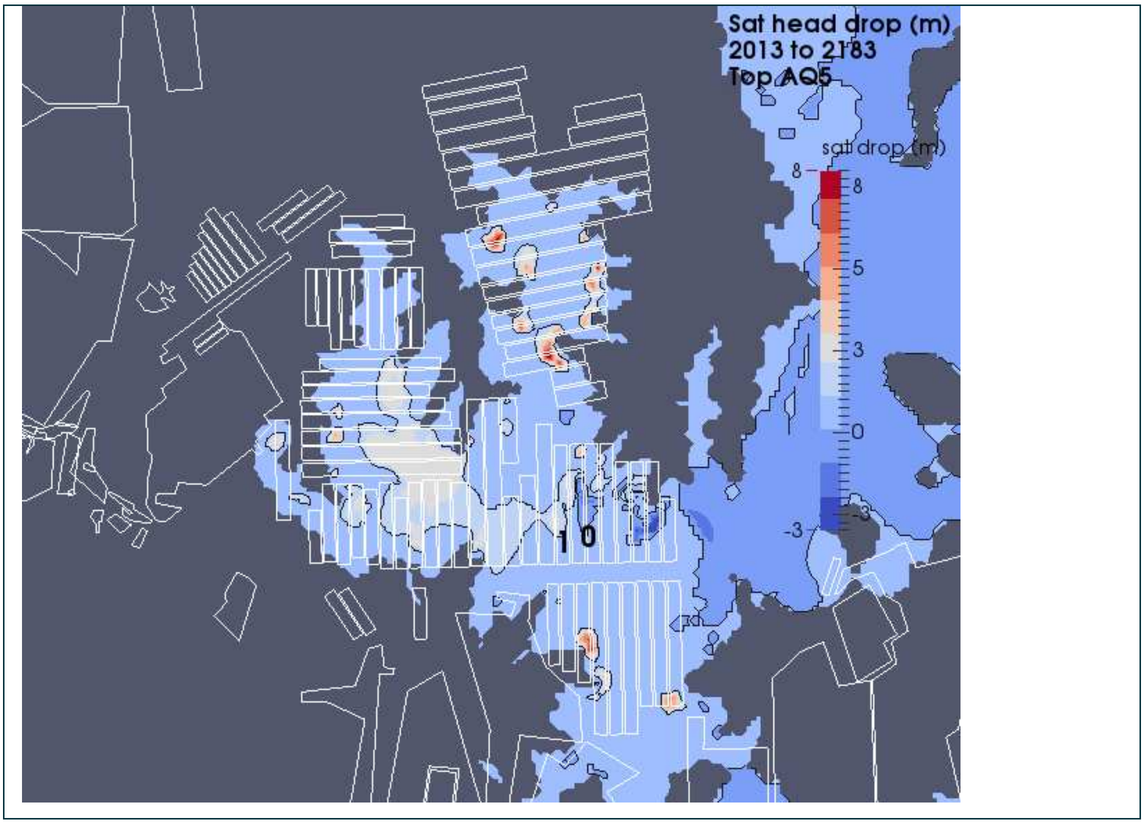

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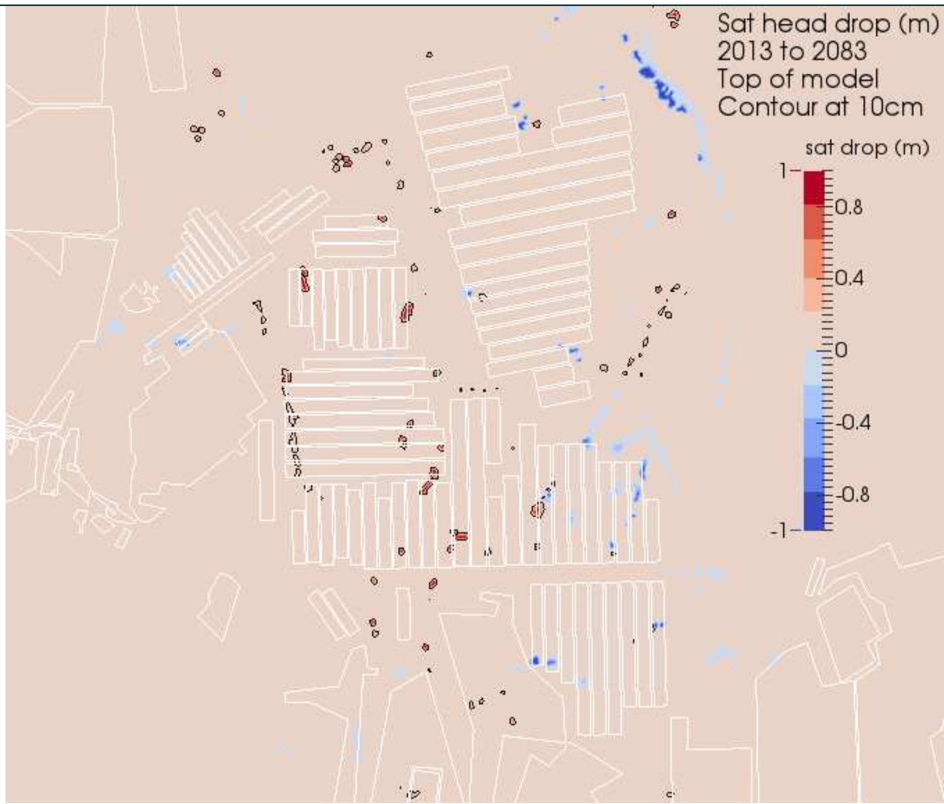

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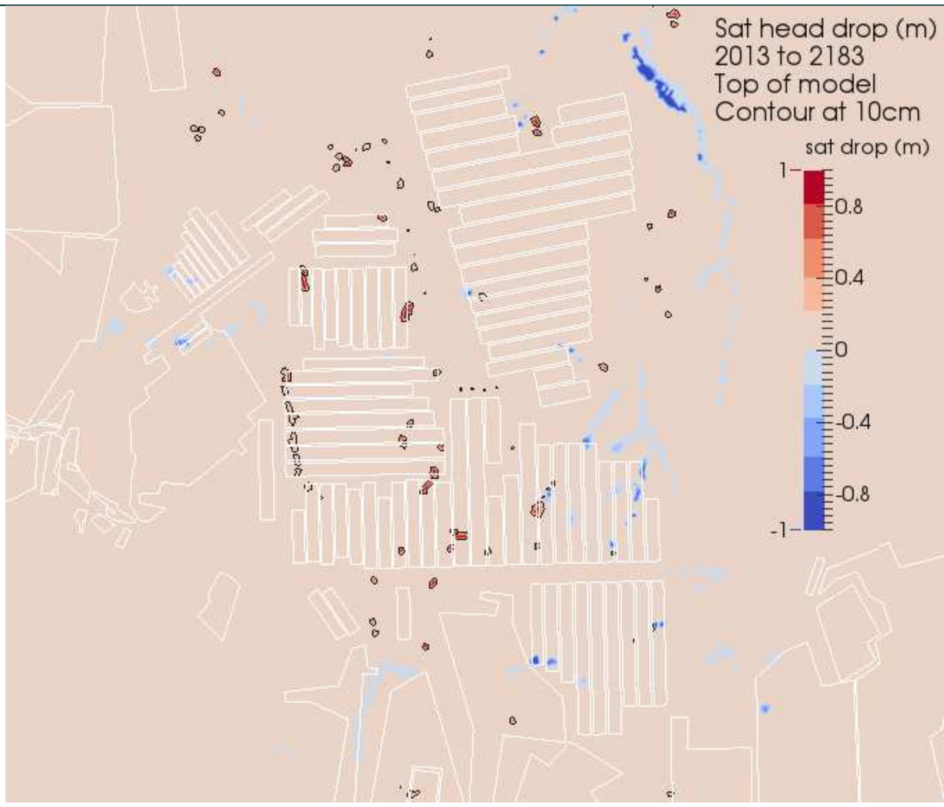

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Surface Water Assessment

APPENDIX – J

Springvale Mine

Springvale Coal Pty Ltd

Surface Water Assessment - SSD5594 Modification 1

IA097101/010c | C

6 July 2016

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Document history and status

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B	23 June 2016	Draft Report	Dr Justin Bell	Brad Woods	N/A
C	6 July 2016	Final Report	Dr Justin Bell	Brad Woods	N/A

Springvale Mine

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Executive Summary

The proposed Modification to current Conditions of Consent (SSD 5594) at Springvale Mine comprises:

- an increase in the workforce from the approved 310 full time equivalent (FTE), including contractors, to 450 FTE personnel
- an increase in run-of-mine (ROM) coal production from the approved 4.5 million tonnes per annum (Mtpa) to 5.5 Mtpa
- an increase in the existing ROM coal stockpile at the pit top from the approved 85,000 tonnes capacity to 200,000 tonnes capacity and an increase in the coal stockpile footprint (by 0.3 ha) northeast of the existing area.

Modelling presented in the Groundwater Assessment, accompanying this modification application, indicates the increase in mining rate does not lead to a significant difference in inflow to underground operations compared to that presented in the Environmental Impact Statement for the Springvale Mine Extension Project (SSD5594). Given that inflows to underground operations dominate the site water balance; there is, accordingly, no change to mine water discharge predicted to Sawyers Swamp Creek associated with the Modification to Consent.

With respect to the proposed Modification to Consent, there are no presented changes to surface water management already in place at Springvale Mine, and/or prescribed in the current Conditions of Consent (SSD 5594). Current infrastructure (with respect to potable supply and sewerage) can accommodate the increase in workforce and review indicates that existing erosion and sediment control infrastructure is sufficient to accommodate the proposed increase in footprint of the ROM stockpile capacity.

Compared to the currently approved project, due to the expected negligible change to flow, level and quality, there are no presented changes to surface water monitoring at Springvale Mine associated with the Modification.

Important note about your report

The sole purpose of this report and the associated services performed by Jacobs is to prepare a report on the expected impacts to surface water of the proposed Modification to Consent (SSD 5594) at Springvale Mine, undertaken in accordance with the Scope of Services set out in the contract between Jacobs and the Client. That Scope of Services, as described in this report, was developed with the Client.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

This report has been prepared on behalf of, and for the exclusive use of, Jacobs's Client, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and the Client. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

1. Introduction

This chapter introduces the project and the proposed modification, provides objectives and purpose of this report and presents the layout of the assessment.

1.1 Overview

Springvale Mine is an underground coal mine located 15km northwest of Lithgow. The Springvale Mine is owned by Centennial Springvale Pty Limited (as to 50%) and Springvale SK Kores Pty Limited (as to 50%) as participants in the Springvale unincorporated joint venture. The Springvale mine is operated by Springvale Coal Pty Limited (Springvale Coal), for and on behalf of the Springvale joint venture participants.

Underground coal mining commenced at Springvale Mine in 1995 and State significant development consent (SSD 5594) for extension of mining operations at Springvale Mine through to 31 December 2028 was granted on 21 September 2015 by the Planning Assessment Commission, under delegation of the Minister of Planning.

The Project Application Area (PAA) for SSD 5594 is presented in

Figure 1.1, together with a topographic map.

Springvale Coal is currently seeking to modify the development consent SSD 5594 (the modification) to allow for increases in its coal production limit, workforce and the coal stockpile capacity at the pit top.

Jacobs Group (Australia) Pty Ltd has been engaged by Springvale Coal to prepare a Surface Water Assessment of the modification. This report has been prepared based on information current at the time of this report.

1.2 Proposed Modification

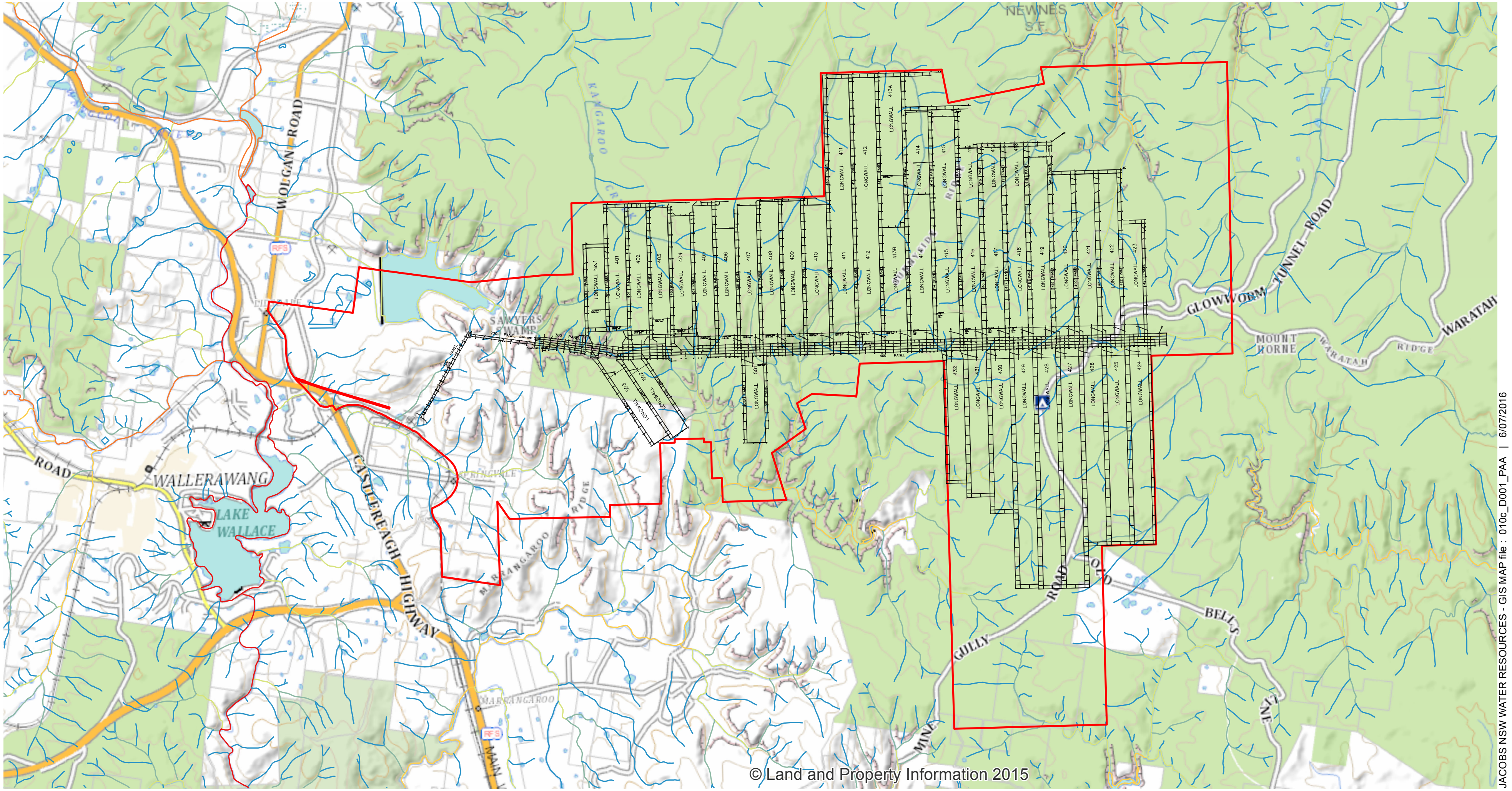
The modification application seeks to allow for:

- an increase in the workforce from the approved 310 full time equivalent (FTE), including contractors, to 450 FTE personnel
- an increase in run-of-mine (ROM) coal production from the approved 4.5 million tonnes per annum (Mtpa) to 5.5 Mtpa
- an increase in the existing ROM coal stockpile at the pit top from the approved 85,000 tonnes capacity to 200,000 tonnes capacity and an increase in the coal stockpile footprint (by 0.3 ha) northeast of the existing area.

There is no proposal to change the approved longwall mining technique or the approved mine plan to achieve the proposed increase in production. The proposed modification does not include any additional physical works or significant changes to the existing underground mining operations. There are no major changes proposed to the surface infrastructure, other than an extension of the existing stockpile area to the northeast, into an area that is already heavily modified from previous surface activities. A diversion drain will be constructed around this stockpile extension area to divert surface run-off from the area to the existing dirty water system at the pit top. There is also no proposal to change the life of the consent or the hours of operation.

The proposed increase in production will be achieved through:

- the proposed increase in workforce
- the installation and operation of additional underground mining equipment
- improved equipment utilisation and availability.



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Project No. IA097101

Figure 1-1 | Springvale Mine Extension Project Project Application Area

Data sources
LPI Web Services 2016, Springvale Coal Pty Ltd

1.3 Water Management Strategy

1.3.1 Current Approach

The project comprises underground operations beneath the Newnes Plateau, with surface operations (pit top, administration and surface water management infrastructure) on the footslopes of the Newnes Plateau.

At present, underground operations involve dewatering of target coal seams in advance of longwall mining, with discharge of mine water make to Sawyers Swamp Creek via the Springvale Delta Water Transfer Scheme (SDTWS). Discharge to Sawyers Swamp Creek occurs at the licensed discharge point, LDP009, on Springvale Mine's Environment Protection Licence 3607.

1.3.2 Future Changes

Modification to development consent is being sought for an increase in workforce, an increase in mining rate and an increase in the capacity of the ROM stockpile.

Modelling presented in the Groundwater Assessment indicates that the increase in mining rate does not lead to a significant difference in inflow to underground operations and, as will be presented below, the increase in workforce and the increase in capacity of the ROM stockpile can be accommodated by existing infrastructure.

The proposed modification, therefore, does not constitute a change to current water management at Springvale.

1.4 Purpose and Scope of the Report

The purpose of this report is to present an assessment of the modification on the surface water environment at Springvale Mine. Given that the Surface Water Assessment for the Springvale Mine Extension Project (RPS, 2014a) was only recently undertaken, this report draws heavily on information already presented in the Environmental Impact Statement (EIS) and subsequent documentation presented during the assessment process in support of the Springvale Mine Extension Project.

1.5 Layout of the Report

The layout of the report is as follows:

- Chapter 1 – presents the background to the proposed modification, the objectives and layout of the report and introduces the water management strategy for the proposed modification
- Chapter 2 – presents the governing legislation and relevant guidelines and policies for the report, including river flow and water quality objectives
- Chapter 3 – presents the environmental setting and describes (including monitoring data, as relevant) the various surface water environments, including site water management infrastructure
- Chapter 4 – presents the water-related components of the proposed modification and describes the expected changes to level, flow and quality as a result of the proposed modification
- Chapter 5 – presents the expected impacts of the proposed modification on site water management, surface water environments, surface water users and surface water/groundwater interaction in the context of governing leg and relevant guidelines and policies
- Chapter 6 – presents licensing, management and monitoring recommendations for the proposed modification
- Chapter 7 – presents relevant references.

2. Legislation, Regulation and Policy

This chapter presents relevant legislation, regulation and policy regarding management of surface water, as it pertains to this project and the proposed modification.

2.1 Commonwealth Legislation

2.1.1 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act* 1999 (Cth) is the main Commonwealth environmental legislation that provides legal framework to protect and manage Matters of National Environmental Significance (MNES) including nationally and internationally important flora, fauna, ecological communities, cultural heritage and water resources.

As per the EIS, Temperate Highland Peat Swamps on Sandstone (THPSS) are federally listed Endangered Ecological Communities (EECs) protected under the EPBC Act and have been mapped within the Project Application Area.

Details of the impact to the THPSS ecosystem is presented in the Groundwater Assessment for this modification, as well as the ecological assessment.

Water resources are also an MNES and the potential impact of the proposed modification is considered in this report through the Significant Impact Guidelines for Coal Seam Gas and Large Coal Mining Developments – Impacts on Water Resources (DoE, December 2013) presented in **Section 2.2.1** below.

2.2 Commonwealth Guidelines and Policy

Guidelines and policies relevant to the Surface Water Assessment are presented below.

2.2.1 Significant Impact Guidelines: Coal Seam Gas and Large Coal Mining Developments – Impacts on Water Resources 2013

The guidelines have been prepared by the Department of Environment for the Australian Government (DoE, 2013). They define a significant impact on hydrological characteristics as follows:

"A significant impact on the hydrological characteristics of a water resource may occur where there are, as a result of the action:

a) changes in the water quantity, including the timing of variations in water quantity

b) changes in the integrity of hydrological or hydrogeological connections, including substantial structural damage (e.g. large scale subsidence)

c) changes in the area or extent of a water resource

where these changes are of sufficient scale or intensity as to significantly reduce the current or future utility of the water resource for third party users, including environmental and other public benefit outcomes." [Page 17 of DoE(2013)].

They define a significant impact on water quality as follows:

"A significant impact on a water resource may occur where, as a result of the action:

a) there is a risk that the ability to achieve relevant local or regional water quality objectives would be materially compromised, and as a result the action:

i. creates risks to human or animal health or to the condition of the natural environment as a result of the change in water quality

ii. substantially reduces the amount of water available for human consumptive uses or for other uses, including environmental uses, which are dependent on water of the appropriate quality

iii. causes persistent organic chemicals, heavy metals, salt or other potentially harmful substances to accumulate in the environment

iv. seriously affects the habitat or lifecycle of a native species dependent on a water resource, or

v. causes the establishment of an invasive species (or the spread of an existing invasive species) that is harmful to the ecosystem function of the water resource, or

b) there is a significant worsening of local water quality (where current local water quality is superior to local or regional water quality objectives), or

c) high quality water is released into an ecosystem which is adapted to a lower quality of water.

For water-dependent ecosystems, a significant impact is likely if the predicted change in water quality is greater than that required for 'moderately to slightly disturbed' systems as described in the relevant local or regional water quality objectives (typically the 80% to 95% ecosystem protection guideline values listed in ANZECC (2000)). Note that other thresholds may apply where changes in water quality may impact on other matters of national environmental significance, such as threatened species or ecological communities." [Page 18 of DoE(2013)].

An assessment of the Proposal against the abovementioned guidelines is presented in **Section 5.1.1**.

2.2.2 Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000

The guidelines are prepared by the Australian and New Zealand Environment and Conservation Council and the Agriculture and Resource Management Council of Australia and New Zealand for the Australian and New Zealand Governments (ANZECC, 2000). They set out a management framework to:

- *"identify the environmental values that are to be protected in a particular water body and the spatial designation of the environmental values*
- *identify management goals and then select the relevant water quality guidelines for measuring performance, tailored to local environmental conditions. Based on these guidelines, set water quality objectives that must be met to maintain the environmental values*
- *develop statistical performance criteria to evaluate the resulting of the monitoring programs*
- *develop tactical monitoring programs focussing on the water quality objectives*
- *initiate appropriate management response to attain or maintain the water quality objectives."* [Page 2-1 of ANZECC(2000)].

The selected water quality objectives for the Springvale Mine Extension Project were presented in the EIS and are discussed in **Section 2.4.1** below. An assessment of the modification against these objects is presented in **Section 5.2.3**.

2.2.3 Australian Drinking Water Guidelines 2011

The guidelines are prepared by the National Health and Medical Research Council for the Australian Government (NHMRC, 2016) and are:

"…*intended to provide a framework for good management of drinking water supplies that, if implemented, will assure safety at point of use. The ADWG have been developed after consideration of the best available scientific evidence. They are designed to provide an authoritative reference on what defines safe, good quality* *water, how it can be achieved and how it can be assured. They are concerned both with safety from a health point of view and with aesthetic quality.*

The ADWG are not mandatory standards; however, they provide a basis for determining the quality of water to be supplied to consumers in all parts of Australia. These determinations need to consider the diverse array of regional or local factors, and take into account economic, political and cultural issues, including customer expectations and willingness and ability to pay.

The ADWG are intended for use by the Australian community and all agencies with responsibilities associated with the supply of drinking water, including catchment and water resource managers, drinking water suppliers, water regulators and health authorities." [Page 2 of NHMRC(2016)].

An assessment of the modification against the ADWG is presented in **Section 5.2.3**.

2.3 NSW Legislation

2.3.1 Water Management Act 2000

The *Water Management Act* 2000 (NSW) presents the framework for sustainable and integrated water management in NSW and its objectives are as follows:

- *"to apply the principles of ecologically sustainable development, and*
- *to protect, enhance and restore water sources, their associated ecosystems, ecological processes and biological diversity and their water quality, and*
- *to recognise and foster the significant social and economic benefits to the State that result from the sustainable and efficient use of water, including:*
  - *benefits to the environment, and*
  - *benefits to urban communities, agriculture, fisheries, industry and recreation, and*
  - *benefits to culture and heritage, and*
  - *benefits to the Aboriginal people in relation to their spiritual, social, customary and economic use of land and water,*
- *to recognise the role of the community, as a partner with government, in resolving issues relating to the management of water sources,*
- *to provide for the orderly, efficient and equitable sharing of water from water sources,*
- *to integrate the management of water sources with the management of other aspects of the environment, including the land, its soil, its native vegetation and its native fauna,*
- *to encourage the sharing of responsibility for the sustainable and efficient use of water between the Government and water users,*
- *to encourage best practice in the management and use of water."* [Chapter 1, Section 3 of the Water Management Act 2000 (NSW)].

The primary instruments applied to achieve these objectives are the Water Sharing Plans.

Water Sharing Plans

Water Sharing Plans provide the basis for equitable sharing of surface water and groundwater between water users, including the environment, and are regulations under the *Water Management Act* 2000 (NSW).

The majority of NSW is now covered by Water Sharing Plans. If an activity leads to a take from a groundwater or surface water source covered by a Water Sharing Plan, then an approval and/or licence is required.

In general, the *Water Management Act* 2000 (NSW) requires:

- a water access licence to take water
- a water supply works approval to construct a work
- a water use approval to use the water.

For surface water, the project resides within the *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources* 2011 (NSW). As presented in the EIS, Springvale Mine is bisected by the Upper Nepean and Upstream Warragamba Water Source (Wywandy Management Zone) (southwest) and the Hawkesbury and Lower Nepean Rivers Water Source (Colo River Management Zone) (northeast).

Figure 2.1 presents the boundaries of the Water Sharing Plan (Surface Water).

For groundwater, the project lies within the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011* (NSW). As presented in the EIS, Springvale Mine is bisected by the Sydney Basin Coxs River Groundwater Source (southwest) and the Sydney Basin Richmond Groundwater Source (northeast). The Sydney Basin Coxs River Groundwater Source is designated by DPIWater to be a Less Productive Groundwater Source (Porous Rock) and the Sydney Basin Richmond Groundwater Source is designated as a Highly Productive Groundwater Source (Porous Rock).

Figure 2.2 presents the boundaries of the Water Sharing Plan (Groundwater).

There is no direct extraction from surface water sources at Springvale Mine and the modification, similarly, does not include direct surface water extraction.

Due to indirect change to groundwater contribution to surface watercourses, as a result of mining activity, there is a requirement for water access licences from surface water sources. In accordance with advice received from DPIWater to Springvale Coal (DPIWater, 2015), in limited circumstances, a zero share licence from the relevant groundwater source can be obtained and, upon application, will be considered by DPIWater with respect to licensing of estimated take from overlying intersected surface water source. As it is understood, these zero share water access licence (groundwater) applications were submitted by Springvale Coal to DPIWater on 7 October 2015, and are in the process of being obtained. It is also understood, from DPIWater (2015), that upon granting of those licences, application for a dealing can be lodged to transfer entitlement from the relevant Springvale Coal existing water access licences (groundwater) to the new licences.

Current water licences (surface water take assigned to groundwater source, in accordance with advice received from DPIWater (2015)) held by Springvale Coal are presented in **Table 2.1**.

The licence holding in the Sydney Basin Coxs River Groundwater Source is assigned to the estimated take from the Upper Nepean and Upstream Warrangamba Water Source (Wywandy Management Zone) is expected to be a 0ML/y share, with a subsequent dealing to transfer entitlement from relevant water access licence (groundwater).

Similarly, the licence holding in the Sydney Basin Richmond Groundwater Source is assigned to the estimated take from the Hawkesbury and Lower Nepean Rivers Water Source (Colo River Management Zone) is expected to be 0ML/y, with a subsequent dealing to transfer entitlement from Springvale Coal's current water access licence (groundwater).

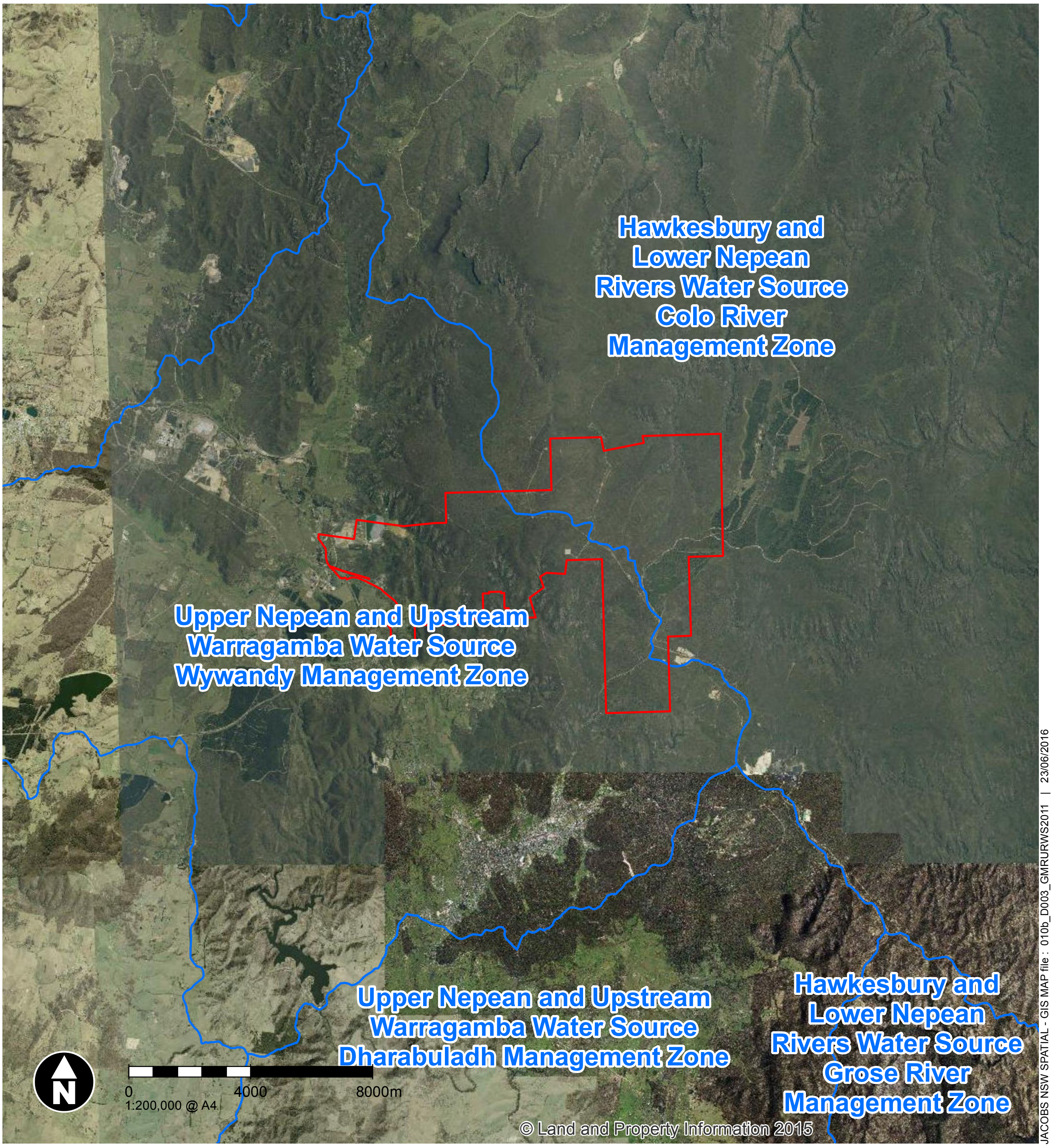

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Figure 2-1 | Water Sharing Plan of the Greater Metropolitan Region Unregulated River Water Sources 2011

Data sources
NSW LPI Web Services 2016

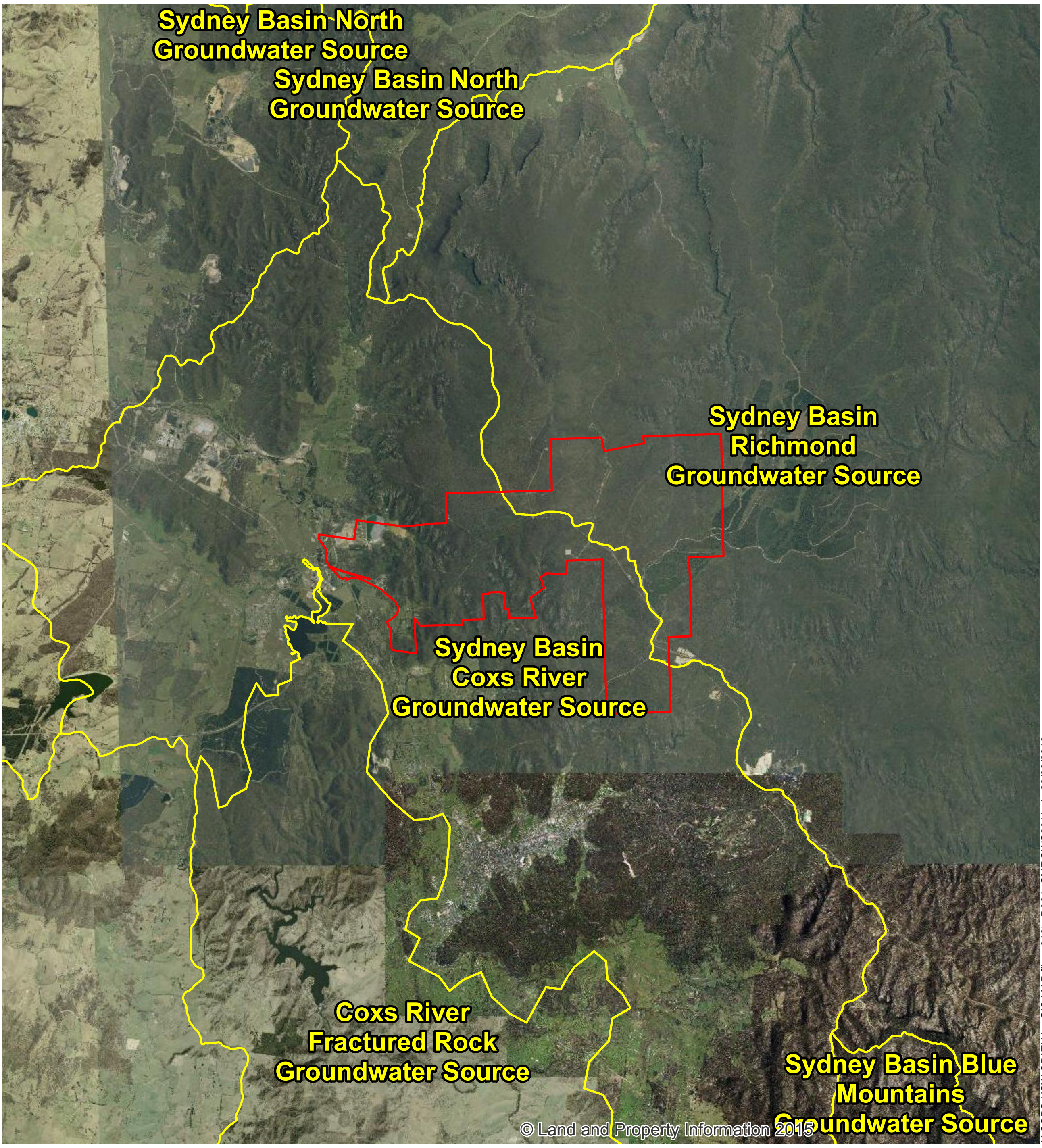

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Figure 2-2 | Water Sharing Plan of the Greater Metropolitan Region Groundwater Sources 2011

Data sources
NSW LPI Web Services 2016

Table 2.1 : Water Access Licences (Surface Water[1]) held by Springvale Coal

Current Licence	Works Approval No.	Sydney Basin Coxs River Groundwater Source (assigned to modelled take from Upper Nepean and Upstream Warragamba Water Source (Wywandy Management Zone)[1]	Sydney Basin Richmond Groundwater Source (assigned to modelled take from Hawkesbury and Lower Nepean Rivers Water Source (Colo River Management Zone)[1]
TBA	TBA	0ML/y and then updated	-
TBA	TBA	-	0ML/y and then updated

Note 1. Water Access Licence held in relevant Groundwater Source to be used to accommodate modelled take from intersecting surface water source/s.

Table 2.2 presents the distribution of access licences in 2015/2016 in the Upper Nepean and Upstream Warragamba Water Source of the Water Sharing Plan (surface water). Detailed breakdown of the Wywandy Management Zone is not available.

Table 2.2 : Distribution of Access Licences – Upper Nepean and Upstream Warragamba Water Source (2015/2016)

Access Licence Category	No. of WALs	Total Share Component[1]
Domestic and Stock	19	110.5
Domestic and Stock (Domestic)	16	21.3
Domestic and Stock (Stock)	14	65
Domestic and Stock (Town Water Supply)	4	1839
Local Water Utility	2	6000
Major Utility (Power Generation)	1	25000
Major Utility (Urban Water)	1	620000
Unregulated River	350	15663

Note 1. Share component is 1 share = 1ML, when Available Water Determination (AWD) is 100%.

Table 2.3 presents the distribution of access licences in 2015/2016 in the Hawkesbury and Lower Nepean Water Source of the Water Sharing Plan (surface water). Detailed breakdown of the Colo River Management Zone is not available.

Table 2.3 : Distribution of Access Licences – Hawkesbury and Lower Nepean Water Source (2015/2016)

Access Licence Category	No. of WALs	Total Share Component[1]
Domestic and Stock	75	746
Domestic and Stock (Domestic)	56	88.7
Domestic and Stock (Stock)	37	287.5
Local Water Utility	1	1293
Major Utility (Urban Water)	2	26075
Unregulated River	1326	92210.7

Note 1. Share component is 1 share = 1ML, when Available Water Determination (AWD) is 100%.

Details of licences held by Springvale Coal in groundwater sources is presented in the Groundwater Assessment accompanying this application for modification to consent.

2.3.2 Environmental Planning and Assessment Act 1979

State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011

The *State Environmental Planning Policy (Sydney Drinking Water Catchment)* 2011 (NSW) is an environmental planning instrument under the *Environmental Planning and Assessment Act* 1979 (NSW).

The southwesterly catchments within the PAA reside within the Upper Nepean and Upstream Warragamba Water Source (Wywandy Management Zone). Surface water catchments within the Upper Nepean and Upstream Warragamba Water Source are declared by the *State Environmental Planning Policy (Sydney Drinking Water Catchment)* 2011 (NSW) to be within the Sydney Drinking Water Catchment.

Part 2, Clause 10 of the *State Environmental Planning Policy (Sydney Drinking Water Catchment)* 2011 (NSW) requires that:

"*10 Development consent cannot be granted unless neutral or beneficial effect on water quality*

(1) A consent authority must not grant consent to the carrying out of development under Part 4 of the Act on land in the Sydney drinking water catchment unless it is satisfied that the carrying out of the proposed development would have a neutral or beneficial effect on water quality.

(2) For the purposes of determining whether the carrying out of the proposed development on land in the Sydney drinking water catchment would have a neutral or beneficial effect on water quality, the consent authority must, if the proposed development is one to which the NorBE Tool applies, undertake an assessment using that Tool.

Note. The NorBE Guideline provides information and guidance for consent authorities in the use of the NorBE Tool." [Part 2, Clause 10 of State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011]

The NorBE Guideline is published by WaterNSW. From Section 3.1 of WaterNSW(2015):

"*A neutral or beneficial effect on water quality is satisfied if the development:*

(a) has no identifiable potential impact on water quality, or

(b) will contain any water quality impact on the development site and prevent it from reaching any watercourse, waterbody or drainage depression on the site, or

(c) will transfer any water quality impact outside the site where it is treated and disposed of to standards approved by the consent authority." [Section 3.1 of WaterNSW(2015)]

As noted in Section 2.2 of WaterNSW(2015), State Significant Development, which is assessed under Part 4.1 of the *Environmental Planning and Assessment Act* 1979 (NSW), is not subject to the *State Environmental Planning Policy (Sydney Drinking Water Catchment)* 2011 (NSW), however, it is suggested by WaterNSW(2015) that the neutral or beneficial effect on water quality guideline may provide a framework to consider State Significant Development. As noted by WaterNSW (2015), under Part 2, Clause 11(4)(a) of the *State Environmental Planning Policy (Sydney Drinking Water Catchment)* 2011 (NSW), concurrence of the Regulatory Authority, in this case WaterNSW, is not required if the Minister is the consent authority.

Evaluation of the impact of mine water discharge to the Coxs River is presented in **Section 5.2.2**.

It is noted that the assessment did not use the NorBE Tool (WaterNSW, 2015) because it was not suitable for the assessment of the project at the time. This was permissible under Clause 10 of the *State Environmental Planning Policy (Sydney Drinking Water Catchment)* 2011 (NSW), as established above, i.e. the requirement that neutral or beneficial effect on water quality must be assessed using the NorBE Tool does not apply.

The NorBE Tool is an online assessment tool for use in determining whether the effect test is met. The NorBE Tool is primarily tailored to the assessment of the impact of urban development (land use change) by delegated authorities, in general, constituent councils and was not suitable for the assessment of the project. In its place, a regional water quality and flow assessment was prepared and is discussed further in **Section 4.4** below.

2.3.3 Protection of the Environment Operations Act 1997

The *Protection of the Environment Operations Act* 1997 (NSW) is the key piece of environment protection legislation administered by the NSW Environment Protection Authority.

Relevant features of this legislation include:

- protection of the environment policies (PEPs)
- integrated environment protection licensing
- regulation of scheduled and non-scheduled activities:
  - the NSW Environment Protection Authority is the regulatory authority for scheduled activities (activities declared under Schedule 1 of the *Protection of the Environment Operations Act* 1997(NSW))
  - the NSW Environment Protection Authority is also the regulatory authority for non-scheduled activities, where activities are undertaken by a public authority.

Springvale Coal has been granted an EPL for mining for coal and associated works (EPL 3607). The EPL covers the mining operation, surface facilities and overland conveyors at the Springvale Mine and other related sites.

The provisions of EPL 3607 prescribe water quality and volumetric concentration discharge limits of various surface water pollutants to designated Licensed Discharge Points (LDP). The location of LDPs under EPL 3607 (latest revision, 26 February 2016) is presented in **Table 2.4**.

Table 2.4 : Location of Licenced Discharge Points (LDPs) – Current (EPL 3607)

Discharge Point	Location and Function	Limit of discharge (kL/d)	Oil & Grease (mg/L)	pH	TSS (mg/L)	Conductivity (µS/cm)
LDP001	Main discharge point of Springvale pit top facilities, collecting the overflows from the Fire Dam, the Primary (or Stockpile) and the Secondary Ponds.	10,000	10	6.5 – 9.0	30	N/A
LDP002	Irrigation area on the north west extend of the site for the discharge of treated waste water effluent	N/A	N/A	N/A	N/A	N/A
LDP004	Emergency discharge point from dewatering bores to unnamed creek leading to Wolgan River.	15,000[a]	N/A	N/A	N/A	N/A
LDP005	Emergency discharge point from dewatering bores to unnamed creek leading to Wolgan River	15,000[a]	N/A	N/A	N/A	N/A
LDP006	Condition P1.3 of EPL 3607 is intended to be updated to remove LDP006 and be transferred to a new EPL for the Western Coal Services Project					
LDP007	Condition P1.3 of EPL 3607 will be updated to remove LDP007 and transfer to a new EPL for the Western Coal Services Project					
LDP009	Springvale Coal's Springvale Delta Water	30,000	10	6.5 – 9.0	50	1,200[c]

Discharge Point	Location and Function	Limit of discharge (kL/d)	Oil & Grease (mg/L)	pH	TSS (mg/L)	Conductivity (µS/cm)
	Transfer System (SDWTS) bypass point east of Kerosene Vale Ash Dam					
LDP010	Emergency/maintenance discharge from Springvale Coal's SDWTS upstream of the settling ponds. Formerly Delta Electricity's LDP020.	N/A	10	6.5 – 9.0	N/A	1,200[b]

Note: a) Combined daily limit must not exceed 30,000kL/d; b) Additional constituents include 100 percentile concentration limit: Al 0.45mg/L, As 0.024mg/L, B 0.37mg/L, Cu 0.007mg/L, F 1.8mg/L, Fe 0.4mg/L, Mn 1.7mg/L, Ni 0.047mg/L, Zn 0.05mg/L; c) as for b) as well as TSS 50mg/L and Turbidity 50NTU.

2.3.4 Threatened Species Conservation Act 1995

The Threatened Species Conservation Act 1995 (TSC Act) is NSW state legislation that provides for conservation of threatened species, populations and ecological communities.

Newnes Plateau Shrub Swamp communities within the Project Application Area fall under the jurisdiction of the TSC Act.

There is no predicted change to subsidence predictions as a result of the modification. This is discussed in **Section 4.5**.

Further details on these groundwater dependent ecosystems are presented in the Groundwater Assessment accompanying this application for modification to consent.

2.4 NSW Guidelines and Policy

Guidelines and policies relevant to the Surface Water Assessment are presented below.

2.4.1 NSW Water Quality and River Flow Objectives 2006

Environmental values have been identified for various catchments within NSW (OEH, 2006).

There are no specific environmental values set for the Hawkesbury-Nepean catchment due to the transition at that time from the Healthy Rivers Commission to the Natural Resources Commission. However, catchments in the vicinity have identified water quality and river flow objectives that are appropriate for the purpose of presenting the impact of the project, and modification, and these are presented below.

It is noted that the environmental values identified in the NSW Water Quality and River Flow Objectives are consistent with the National Water Quality Management Framework presented in ANZECC (2000).

Table 2.5 presents the adopted Water Quality and River Flow Objectives for the various water sources.

Table 2.5 : NSW Water Quality and River Flow Objectives within the PAA – Surface Water

Water Source	Water Quality and River Flow Objective
Wywandy Management Zone	Water Quality Objective: • aquatic ecosystems • visual amenity • drinking water – disinfection only (not relevant) • drinking water – clarification and disinfection only (not relevant)

Water Source	Water Quality and River Flow Objective
	• drinking water – groundwater • aquatic foods (cooked) (not relevant) • industrial water supply (not listed but relevant to the Project) River Flow Objective: • protect natural pools in dry times • protect natural low flows • maintain wetland and floodplain inundation (not listed but relevant to this case) • maintain natural flow variability (not listed but relevant to this case) • minimise effects of weirs and other structures (not relevant)
Colo River Management Zone	As above with exception: • industrial water supply (not relevant)

An assessment of the impact of the modification against the NSW Water Quality and River Flow Objectives is presented in **Section 5.2.3**.

2.4.2 Managing Urban Stormwater 2004 & 2008

Erosion and sediment control of projects in NSW is guided by the 'Blue Book', Volume 1 of which was prepared by Landcom (2004). The 'Blue Book' was extended by DECC (2008) for use in other areas in Volume 2, including mines and quarries.

Analysis of the potential for erosion was presented in the EIS, including assessment of sediment capture capacity of existing infrastructure. Verification that existing erosion and sediment control infrastructure is sufficient to retain additional stockpile footprint (increase of 0.3ha) is presented in **Section 4.5** below.

2.4.3 Guidelines on Controlled Activities on Waterfront Land 2012

Development within 40m of waterfront land requires a controlled activity approval under the *Water Management Act* 2000 (NSW). The *Water Management Act* 2000 (NSW) defines waterfront land as the bed of any river, lake or estuary and any land within 40 metres of the river banks, lake shore or estuary mean high water mark.

The project is not located within 40m of a watercourse or waterbody and the modification does not comprise additional physical works. Therefore the project or the modification does not require a controlled activity approval.

2.4.4 Maximum Harvestable Right Dam Capacity 2006

Licences are not required for harvestable rights dams built on minor streams that capture 10 per cent of the average regional rainfall run-off on land in the Central and Eastern Divisions of New South Wales, and up to 100 per cent on land in the Western Division. The total capacity of all dams on a property allowed under the harvestable right is called the Maximum Harvestable Right Dam Capacity (MHRDC). If a dam is constructed that is larger than the MHRDC, then a licence will be needed for the volume of water that exceeds the MHRDC, unless it is taken under a basic landholder right. An approval for a dam which exceeds the MHRDC is also needed.

Minor watercourses, under the *Water Management (General) Regulation* 2011 (NSW), are defined by the Strahler stream ordering method as first-order and second-order watercourses that do not permanently flow. Watercourses shown as broken or continuous on topographic maps listed in the *Water Management (General) Regulation* 2011 (NSW) are deemed to be continuous, even if they lose definition and then reappear.

Dams for the control or prevention of soil erosion (gully control structures), where no water is reticulated or pumped from them and the size of the structure is the minimum necessary to fulfil the erosion control function, are exempt from the MHRDC.

It is noted that construction of the dams listed above may require a water supply work approval from DPIWater.

Sediment control structures associated with the project are constructed consistent with the abovementioned definition and therefore a water access licence is not required and given they already exist, a water supply work approval is assumed is also not required.

As noted in **Section 2.4.3**, the modification does not comprise additional physical works; therefore there is no proposed change to erosion and sediment control infrastructure.

2.4.5 NSW Aquifer Interference Policy 2012

Surface water processes can lead to interference to groundwater sources.

Table 2.6 presents the Level 1 Minimal Harm Considerations for the various water sources relevant to the project.

An assessment of the impact of the modification against the NSW Aquifer Interference Policy is presented in **Section 5.2.5**.

Table 2.6 : Level 1 Minimal Harm Considerations (DPIWater, 2012)

Water Source	Level 1 Minimal Harm Consideration
Sydney Basin Coxs River Groundwater Source	Water table: • less than 10 per cent cumulative variation in the water table, allowing for typical climatic "post-water sharing plan" variations, 40 metres from any high priority groundwater dependent ecosystem or high priority culturally significant site listed in the Schedule of the relevant water sharing plan • a maximum of a 2 metres decline cumulatively at any water supply work Water pressure: • a cumulative pressure head decline of not more than a 2 metres decline, at any water supply work Water quality: • any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity.
Sydney Basin Richmond Groundwater Source	As above

3. Hydrological Setting

This chapter presents the environmental and hydrological setting of the project, including the modification, as well as available environmental monitoring data with respect to flows and quality.

3.1 Environmental Setting

3.1.1 Climate

The climate at Springvale Mine is typical of a cool temperate mountain climate, characterised by cold winters and warm summers. The highest temperatures occur throughout December, January and February, with the coolest temperatures occurring in July. Snow and/or sleet are common in winter months.

Rainfall

Rainfall throughout the year is relatively uniform; however, rainfall is higher during the months of October through to March. Summer months are generally the wettest months. It is noted that the intensity of the rainfall is locally affected by the orographic influence of the Great Dividing Range.

A number of Bureau of Meteorology (BoM) weather stations are located in the vicinity of Springvale Mine. BOM Station No. 063062 (Lithgow (Newnes Forest Centre)) represents the most complete historical rainfall dataset with respect to the Newnes Plateau (elevation above 1,000mAHD). Monitoring at this station ceased in 1999.

The distribution of the average monthly rainfalls through the year is shown in **Table 3.1**.

Table 3.1 : Distribution of Average Monthly Rainfall at the Newnes Plateau (mm/month)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
BOM Station No. 063132 (Lidsdale (Maddox Lane)) (1959 to present)													
Mean	85.1	78.7	64.2	42.4	51.1	48.8	51.6	65.5	53.7	68.4	73.4	72.9	766
Lowest	8.6	5.6	3.8	1.2	2.6	2.6	2.7	1.8	3.4	2.4	7.6	0.0	330
Highest	214	270	270	203	131	229	214	364	123	228	165	217	1260
BOM Station No. 063062 (Lithgow (Newnes Forest Centre)) (1938 to 1999)													
Mean	121	114	102	79.9	81.3	83.0	68.3	83.5	67.9	91.5	89.0	90.4	1070
Lowest	18.8	5.6	5.1	6.2	11.0	0.0	2.0	4.6	0.0	6.4	4.7	2.6	496
Highest	281	339	519	299	287	320	241	412	207	267	209	303	1890
Springvale (New Prison Farm) (2004 to present)													
Mean	89.8	140.0	88.0	70.0	42.4	82.2	46.1	55.2	52.0	68.5	111.5	101	986
Lowest	19.5	36.5	29.5	10.5	14.6	21.5	18.0	19.0	12.5	13.0	33.5	37.5	572
Highest	153	273	196	202	105	254	100	107	92.2	144	196	207	1290

Evapotranspiration

Daily Pan A evaporation has been recorded at the Bathurst Agricultural Station (BOM Station 63005) from 1966 to present. The average monthly evaporation rate is presented in **Table 3.2**. The annual average daily Pan A evaporation rate is 3.7mm/day. The Bathurst Agricultural Station is the closest monitoring station to Springvale Mine and is 47km to the west.

Pan A evaporation is usually used for estimating evaporation losses from open water surfaces of sediment ponds and dams. In forested areas, evaporation tends to be low compared to Pan A evaporation, but this is

Table 3.2 : Average Daily Pan A Evaporation (BOM Station No. 063005, Bathurst Agricultural Station) (mm/day)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	6.8	5.8	4.5	2.9	1.7	1.1	1.2	1.8	2.8	4.0	5.2	6.5	3.7

offset by increased transpiration. Analysis of flow gauging at Sunnyside Swamp on the Newnes Plateau suggest actual evaporation may be 35% of Pan A evaporation.

3.1.2 Topography

The topography around Springvale Mine comprises narrow gorges with high ridgelines, and steep sided slopes of sandstone cliffs. The cliffs rise above incised valleys, and hilly areas with relatively flat crests and some spurs with moderately sloped ephemeral drainage lines occur within the valleys.

Rivers and streams, such as Coxs Creek, Kangaroo Creek, the Wolgan River, Carne Creek and their tributaries are found in the vicinity (refer to

Figure 1.1).

3.1.3 Hydrology

The majority of the land surface above Springvale Mine's operations lies within the Newnes Plateau, which forms part of the divide between the Wolgan and Coxs River catchments. The Wolgan River, of which Carne Creek is a tributary, eventually feeds into the Colo River and then the Hawkesbury River. The Coxs River is one of the tributaries of Lake Burrogorang. Lake Burrogorang discharges into the Nepean River and then the Hawkesbury River. Lake Burrogorang is the main drinking water supply catchment for Sydney.

The catchment divide between these surface water catchments runs in a northwest – southeast direction above Springvale Mine's operations. Swamps occur within the headwater valleys on the Newnes Plateau and are controlled by the flat topography and impervious shale layers. There is no direct extraction or discharge to surface watercourses on the Newnes Plateau by Springvale Mine or others. All mine water make from Springvale Mine is currently discharged to the Coxs River via a licensed discharge point located in Sawyers Swamp Creek, adjacent the Sawyers Swamp Creek Ash Dam. The licensed discharge point is referred to as Springvale LDP009.

Figure 1.1 presents the hydrological setting above Springvale Mine, including the Strahler Order.

3.1.4 Geology

Springvale Mine is located in the southwest corner of the NSW Western Coalfields. The Illawarra Coal Measures are relatively thin in this area, with an average thickness of 110m from the Katoomba to the Lithgow Seam. Above the coal measures, the Narrabeen Group is the only member of the Triassic sequence present in the area, having a maximum thickness of 340m. Depth of cover to the Lithgow Seam generally ranges between 350m and 420m, hence, the upper Narrabeen Group comprises the surface strata above the existing and future workings at Springvale Mine.

The sedimentary strata (Illawarra Coal Measures and Narrabeen Group) lies above older Silurian and Devonian Proterozoic rocks of the Lachlan Fold Belt. The Lithgow Coal Seam at Angus Place Colliery and Springvale Mine is stratigraphically the lowest economic seam, with the depth to the older basement strata beneath this seam being shallow, up to 100m, compared to other parts of the Sydney Basin, which can be many hundreds of metres. The Lithgow Seam ranges in thickness from less than one metre (where only the lower ply of the Lithgow Seam is present) to up to 9m (where it coalesces with the overlying Lidsdale Seam) with some thin carbonaceous or tuffaceous claystone layers present in the upper half of the seam. The Lithgow Seam generally dips at 1 - 2 degrees to the east northeast. The Katoomba and other seams at Springvale Mine (and Angus Place Colliery) are too thin to be viably extracted.

Non coal-bearing Triassic strata directly overlie the Illawarra Coal Measures. These strata comprise the Narrabeen Group of rocks which have the following sequence of rock formations in descending order:

- Burralow Formation
- Banks Wall Sandstone
- Mount York Claystone
- Burra-Moko Head Sandstone
- Caley Formation.

These formations comprise interbedded siltstone, sandstone and conglomeratic sandstone, with occasional claystone bands, as observed in the characteristic cliffs that occur throughout the area.

Within the Narrabeen Group of rocks, the Burralow Formation and the Mount York Claystone are key stratigraphic horizons in terms of their hydrogeological significance.

3.1.5 Soil

Soil Landscapes

The 1:100,000 soil landscape sheet (Wallerawang) designates the Pit Top at Springvale Mine as the Cullen Bullen soil unit and is considered to be formed by erosional processes. Australian soil classification is yellow karosols and kandosols (soils with strong texture contrast between A horizons and strongly acid B horizons; generally have unusual subsidence-soils chemistry features such as high Mg, Na and Al). The landscape information sheet indicates moderate gully erosion evident along some drainage lines and minor sheet erosion is common where ground cover has been cleared.

On hillcrests within the Newnes Plateau, the soil landscape is designated the Newnes Plateau soil unit and is considered to be formed by residual process (in-situ soil formation). Australian soil classification is tenosols (generally weak pedologic organisation apart from A horizon) and yellow kandosols (soils which lack strong text contrast). The landscape information sheet indicates minor sheet and track erosion is present and particular susceptibility to erosion following bushfire or logging.

The 100,000 soil landscape sheet designates the location of THPPS as the Deanes Creek soil unit and is considered to be formed by swamp processes. Australian soil classification is stratic rudosols (soils that have negligible pedologic organisation) and hydrosols (seasonally or permanently wet soils). The landscape information sheet indicates dense sedge and swamp vegetation largely restricts erosion with minor sheet erosion on less protected swamp margins.

3.1.6 Ecology

Landscape Units

The Cullen Bullen Landscape Unit comprises extensively cleared, open-woodland, with small isolated remnants of origin vegetation comprising various gums (Eucalypt). There is a grass understorey with shrubs such as wattle (Acacia). It is noted that forestry operations have cleared native vegetation and reseeded with pine (Radiata Pine).

The Newnes Plateau Landscape Unit is described as partially cleared low open forests and woodlands, with some areas replaced by pine plantations.

For the Deanes Creek Landscape Unit, vegetation comprises uncleared closed-heath and closed-sedgeland, with open woodland on swamp margins.

A copy of the Landscape Unit information sheets are presented in **Appendix B**.

Temperate Highland Peat Swamps on Sandstone

Newnes Plateau shrub swamps and hanging swamps occur above the Springvale Mine area of activity. Shrub swamps occupy the bases of valleys whereas hanging swamps develop higher up on the flanks of the valleys.

The shrub swamps are listed as EECs under the TSC Act and provide important habitat for a range of plants and animals. The shrub swamps and the hanging swamps are referred to collectively as the Temperate Highland Peat Swamps on Sandstone (THPSS) in accordance with the *Environment Protection and Biodiversity Conservation Act* 1999 (Cth).

3.2 Hydrological Environment

3.2.1 Conceptual Model

Rainfall/runoff on the Newnes Plateau discharges through the THPSS, where present. The Newnes Plateau is a relatively undisturbed landscape, however, it is noted there are a multitude of access tracks on the plateau that are used as both fire trails and by recreational motorbike riders.

There is minimal development in the Wolgan River catchment in the vicinity of the PAA and comprises more rugged terrain than the Coxs River. The majority of the Wolgan River catchment is designated as State Forest or National Park

In the Coxs River catchment, there has been historical disturbance due to past mining activity, including mining within the watercourse directly (such as within Wangcol Creek), as well as construction of several water supply reservoirs for power generation and waste disposal facilities (wet and dry ash deposition). The Coxs River eventually discharges into Lake Burrogorang, some 80km downstream of the PAA.

3.2.2 Site Water Management

As presented in the Surface Water Assessment at the time of the EIS (RPS, 2014a), the Pit Top consists of structures and facilities such as offices, storage areas, workshops, bathhouse, coal stockpile and mine access amongst others. **Figure 3.1** presents a flow diagram from RPS (2014a).

From **Figure 3.1**, inflows sourced from underground via the Pit Top Collection System are stored in Fire Dam for use as process water.

Potable Water Supply

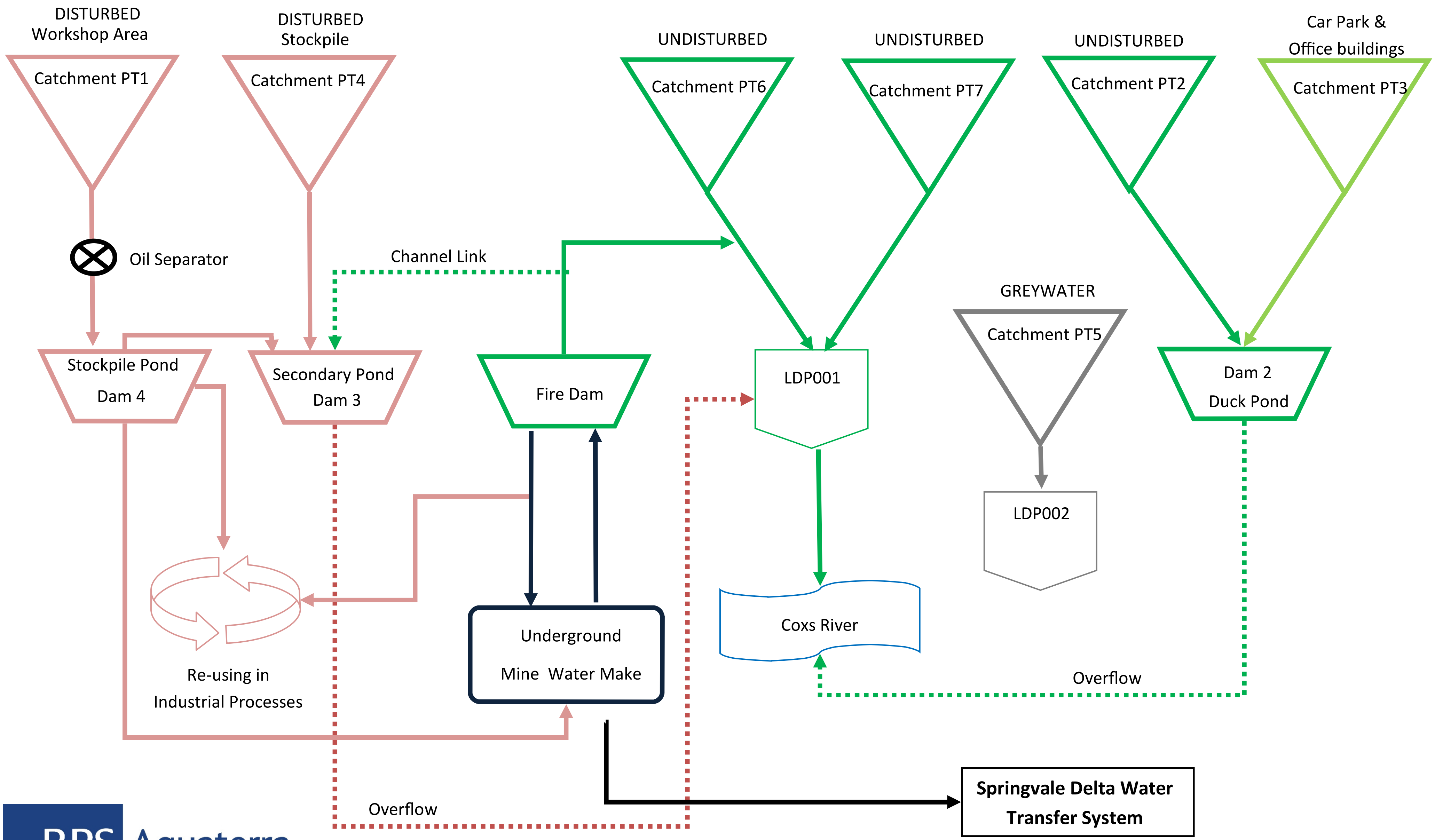
Municipal water supply (potable) is used in the Bathhouse and Administration Buildings to support the existing full-time workforce of 358 persons. It is intended that the increase in workforce, including contractors, to 450 FTE personnel will be met by current infrastructure.

Erosion and Sediment Control

As indicated in **Figure 3.1**, Pit Top Surface Water Infrastructure comprises Stockpile Pond / Primary Pond, Secondary Pond and Duck Pond. Details of these storages is summarised in **Table 3.3**.

It is noted that increase in footprint of the ROM coal stockpile associated with the modification will occur within catchment PT4, with runoff captured by Stockpile Pond, as is currently the case.

SPRINGVALE PIT TOP CATCHMENTS AND FLOW DIAGRAM



RPS Aquaterra

Figure 3-1

Table 3.3 : Pit Top Erosion and Sediment Control Infrastructure (adapted from Table 4.2 of RPS (2014a))

Asset Name	Main Function	Receives water from	Discharges to	Measured Surface Area (m^2)	Estimated Storage Volume (ML)
Stockpile / Primary Pond	Sediment Settlement Pond	Disturbed areas	Reused in industrial processes Secondary Pond	2,103m^2	7ML
Secondary Pond	Sediment Settlement Pond	Disturbed areas	Overflow to Springvale Creek via LDP001	2,575m^2	7ML
Duck Pond	Sediment Settlement Pond	Green area and roof and car park drainage	Springvale Creek via LDP001	1,846m^2	2ML

Sewerage

Springvale Mine has been recently (2016) connected to Lithgow City Council's reticulated sewer system. It is intended that the increase in workforce, including contractors, to 450 FTE personnel will be met by current infrastructure.

Mine Water Discharge

Mine water discharge is currently transmitted through the SDWTS to Springvale Coal's LDP009 for discharge to Sawyers Swamp Creek. Underground inflows to adjacent operation at Angus Place Colliery are also transmitted to Springvale Coal's LDP009. Sawyers Swamp Creek flows into Coxs River and then Lake Wallace.

Further detail on the site water balance and the regional water balance is presented in **Section 4.2** and **Section 4.4** respectively.

3.2.3 Surrounding Land Use

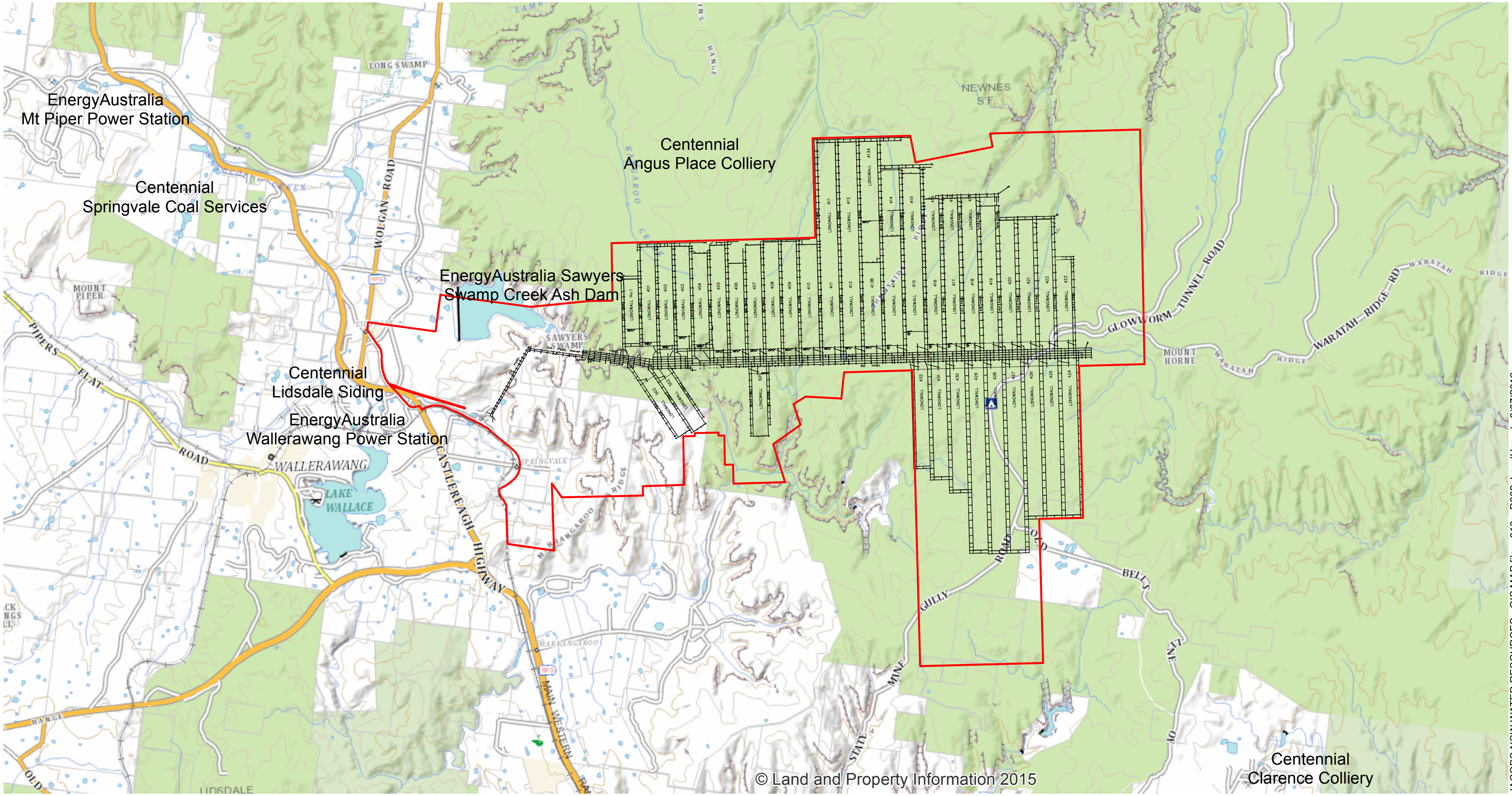
Longwall mining of the Lithgow Seam occurs approximately 400m below the Newnes Plateau. Land use on the Newnes Plateau is Newnes State Forest and to the northeast of the Newnes State Forest is the Wollemi National Park. The distance from LW419 to the boundary of the Wollemi National Park is 7.5km. Birds Rock Flora Reserve is located within the Newnes State Forest and is 4.5km northeast of LW419. The Ben Bullen State Forest lies to the west of the Upper Coxs River and is approximately 6.5km to the northwest of LW401 and is approximately 10.5km to the northwest of LW419. The Gardens of Stone National Park is located north of Ben Bullen State Forest and is approximately 17km to the northwest of LW419.

To the west of the previously mined longwalls at Springvale Mine is Sawyers Swamp Creek Ash Dam (SSCAD), located within the Sawyers Swamp Creek catchment. To the southwest of LW401 is the Springvale Mine portal, located off Castlereagh Highway and further southwest is Wallerawang Power Station. Wallerawang Power Station is approximately 4km southwest of LW401, of which Lake Wallace is the water supply reservoir.

The southern longwalls, LW424 to LW432 and LW501 to 503 also underlie the Newnes State Forest. To the southwest of LW432 and to the south of LW501 is Marrangaroo Creek.

Within the Coxs River catchment, Mount Piper Power Station is situated approximately 10km west-northwest of LW401, adjacent Wangcol Creek. Downstream of Lake Wallace, approximately 13km south-southwest of LW401, is Lake Lyell, which is a water supply reservoir for Mount Piper Power Station, and Wallerawang Power Station, when it was operational. Thompsons Creek Reservoir is an offline reservoir and is situated above Mount Piper Power Station, located approximately 12.5km west-southwest of LW401. It is noted that there is a water distribution network operated by EnergyAustralia between Lake Lyell and Lake Wallace and between Lake Lyell and Mount Piper Power Station/Thompsons Creek Reservoir.

Figure 3.2 presents the layout of land uses surrounding the PAA.



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Project Application Area

0 2000 4000m
1:100,000 @ A4

Project No. IA097101

Data sources
LPI Web Services 2016, Springvale Coal Pty Ltd

Figure 3-2 | Surrounding Land Uses

3.2.4 Rivers and Creeks

The PAA encompasses two adjacent catchments, the Wolgan River and the Upper Coxs River. The catchment divide between these catchments runs in a northwest to southeast direction through the PAA.

Table 3.4 presents catchment characteristics in the PAA.

Table 3.4 : Catchment Characteristics in the PAA (after Table 3.3 of RPS (2014a))

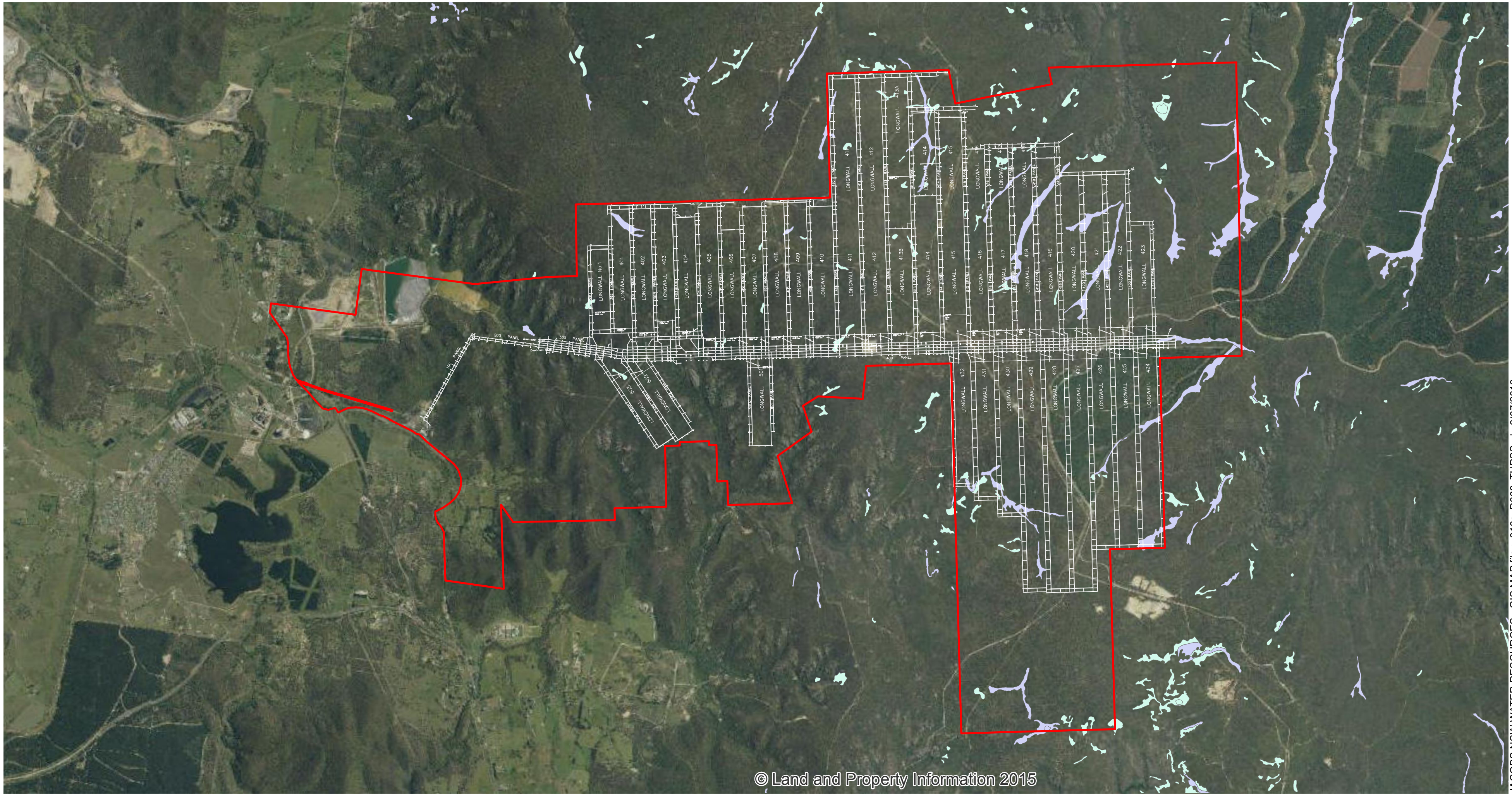
Main Catchment	Sub-Catchment and Strahler Order	Associated Watercourses	Sub-Catchment Area (ha)	% of Catchment Area within PAA (approx.)
Coxs River	Coxs River (5th and 6th)	Wangcol Creek (3rd), Springvale (2nd) and Sawyers Swamp Creek (3rd)	13,026	30
	Marrangaroo Creek (4th)	Unnamed watercourses south of PAA	5,495	30%
	Pipers Flat Creek (5th)	Unnamed watercourses south of PAA	5,948	0%
Wolgan River	Wolgan River Western Branch	Wolgan River (4th and 5th)	8,526	9%
	Wolgan River Eastern Branch	Carne Creek (5th and 6th)	8,597	30%
Colo River	Nine Mile Creek / Bungleboori Creek	Nine Mile Creek (3rd)	4,840	1%

3.2.5 Sensitive Environmental Receptors

Sensitive environmental include shrub swamps and hanging swamps (THPSS) listed under the *Environmental Protection and Biodiversity Conservation Act* 1999 (Cth). The shrub swamps are also listed under the TSC Act. These ecosystems are considered groundwater dependent.

Figure 3.3 presents the location of Newnes Plateau shrub swamps and hanging swamps at Springvale Mine.

It is highlighted there is no proposed discharge to the Newnes Plateau and potential impact to these ecosystems are due to subsidence and mining induced change to groundwater contribution to surface water flow. The influence of subsidence on geomorphological characteristics was presented in the EIS and is summarised in **Section 4.5** and the impact presented in **Section 5.2.3**. There is no expected change to subsidence impact on THPSS due to the modification. The impact of mining induced change to groundwater contribution to surface water flow is presented in the Groundwater Assessment accompanying this application for modification to consent.



JACOBS NSW WATER RESOURCES - GIS MAP file : 010c_D003_THPSS | 6/07/2016

Legend

- Project Application
- Shrub Swamp
- Hanging Swamp

0 2000 4000m
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Project No. IA097101

Figure 3-3 | Location of Newnes Plateau Shrub Swamps and Hanging Swamps

Data sources
LPI Web Services 2016, Springvale Coal Pty Ltd

3.2.6 Surface Water Users

Table 3.5 presents the identified surface water users in the Upper Nepean and Upstream Warragamba Water Source (Wywandy Management Zone) that are downstream of the project and may, potentially, be impacted.

Table 3.5 : Surface Water Users in the Upper Nepean and Upstream Warragamba Water Source (Wywandy Management Zone)

WAL No.	Licence Class and Entitlement (ML)	Works Approval No.	Lot/DP	Location	Comments
Downstream of the project (current)					
25607	Unregulated River (10ML)	10CA103248	8/2452472	Coxs River, 250m downstream of junction with Sawyers Swamp Creek.	3.5km downstream of Springvale LDP009
27428	Major Utility [Power Generation] (25,000ML[a])	10CA117220	3/1181412	Lake Wallace	7.4km downstream of Springvale LDP009
Downstream of the project (far field)					
27428	Major Utility [Power Generation] (25,000ML[a])	10CA117220	1181411	Lake Lyell	22.6km downstream of Springvale LDP009
27431	Major Utility[Urban Water] (620,000ML)	10CA117212	n/a	Lake Burragorang	~80 km downstream of Springvale LDP009

Note: a) Entitlement split across Lake Wallace, Lake Lyell and Thompsons Creek Reservoir

Table 3.6 presents the identified surface water users in the Hawkesbury and Lower Nepean Water Source (Colo River Management Zone) that are downstream of the project and may, potentially, be impacted by the project.

Table 3.6 : Surface Water Users in the Hawkesbury and Lower Nepean Water Source (Colo River Management Zone)

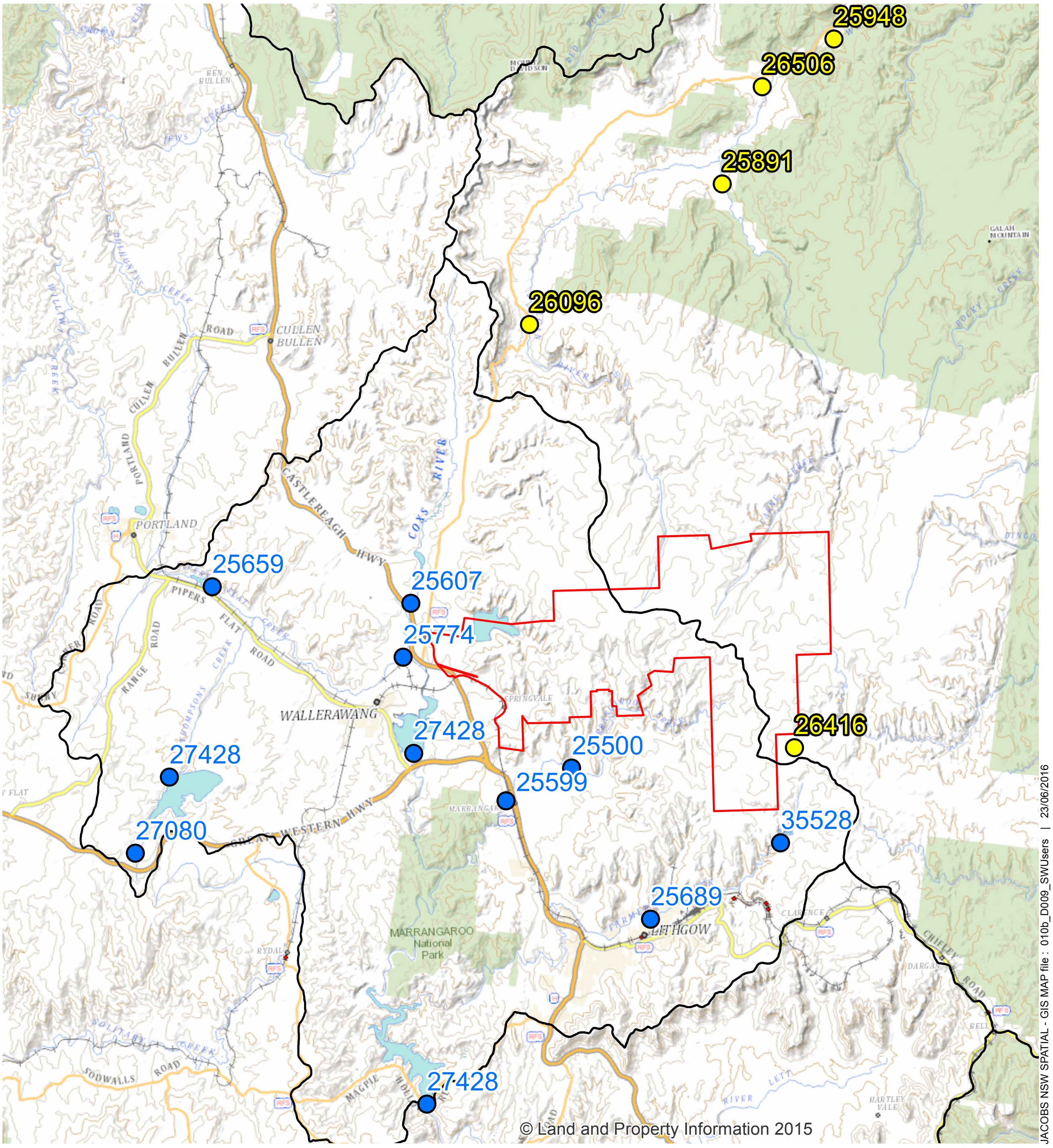
WAL No.	Licence Class and Entitlement (ML)	Works Approval No.	Lot/DP	Location	Comments
Downstream of the project (current)					
25891	Unregulated River (42ML)	10WA104809	26/751666	Carne Creek within the Wolgan Valley	15.8km downstream of LW418
26506	Unregulated River (60ML)	10WA104760	2/1127218	Wolgan River within the Wolgan Valley	19.4km downstream of LW418

Figure 3.4 presents the location of identified surface water users in the vicinity of the PAA. It is noted that most surface water users presented in **Figure 3.4** are not downstream of the project or are sufficiently far (15km) from the PAA to be deemed to not require consideration.

3.2.7 Surface Water / Groundwater Interaction

THPSS located on the Newnes Plateau are considered to be groundwater dependent although are not listed as high priority groundwater dependent ecosystems in the Schedule of the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources* 2011 (NSW). Some THPSS are considered to be losing water features and others are considered to be gaining. Further detail is presented in the Groundwater Assessment.

As identified in the Groundwater Assessment, the Coxs River is considered to be a losing watercourse, however, the rate of loss is minor, given the streambed of the Coxs River comprises exposed Permian Coal Measures (previously mined in parts, such as within Wangcol Creek) and interburden.



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- Project Application
- Wywandy Man. Zone
- Colo River Man. Zone
- Greater Metropolitan Region Unregulated River Water Sources 2011

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Project No. IA097101

Figure 3-4 | Surface Water Users in the vicinity of the PAA

Data sources
NSW LPI Web Services 2016, Springvale Coal Pty Ltd

3.3 Hydrological Investigation

3.3.1 Surface Monitoring Network

Surface water monitoring at Springvale Mine comprises monitoring of flow and quality in rivers and creeks as well as monitoring within shrub swamps (flow and quality). Further detail is presented in RPS (2014a).

Details of groundwater level monitoring within shrub swamps is presented in the Groundwater Assessment for the modification.

3.3.2 Surface Water Flows

DPIWater undertakes surface water flow monitoring at several locations within the Coxs River catchment. Of relevance to Springvale Mine is the gauging station upstream of Lake Wallace (DPIWater Gauge No. 212054). As noted in **Section 3.2.2**, mine water discharge to Sawyers Swamp Creek flows into the Coxs River and then Lake Wallace.

Figure 3.5 presents daily discharge of the Coxs River at DPIWater Gauge No. 212054. Also presented in **Figure 3.5** is the calibration time-series from the Regional Water Quality Impact Assessment Model (RWQIAM) (Jacobs, 2015a). The RWQIAM is discussed in detail in **Section 4.4**.

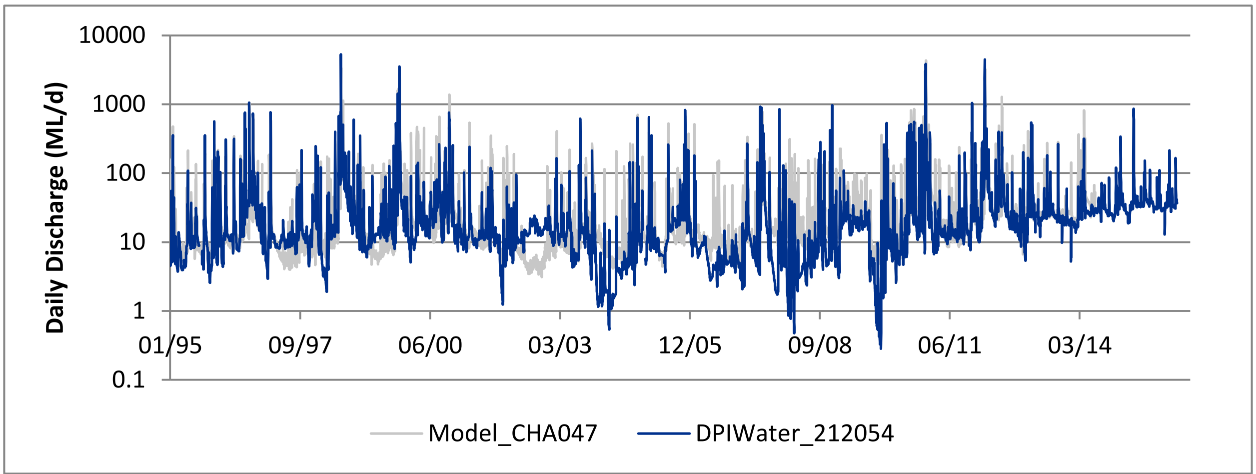

Figure 3.5 : Time-Series Flow at Lake Wallace (DPIWater Gauge No. 212054)

Further detail of observed flow in rivers and creeks and within swamps is presented in RPS (2014a).

3.3.3 Surface Water Quality

DPIWater also undertakes surface water quality monitoring upstream of Lake Wallace (DPIWater Gauge No. 212054).

Figure 3.6 presents daily water quality (salinity, mg/L; converted assuming translation from electrical conductivity (µS/cm) to salinity (mg/L) is 0.67) upstream of Lake Wallace. Output from the RWQIAM is also presented in **Figure 3.6**.

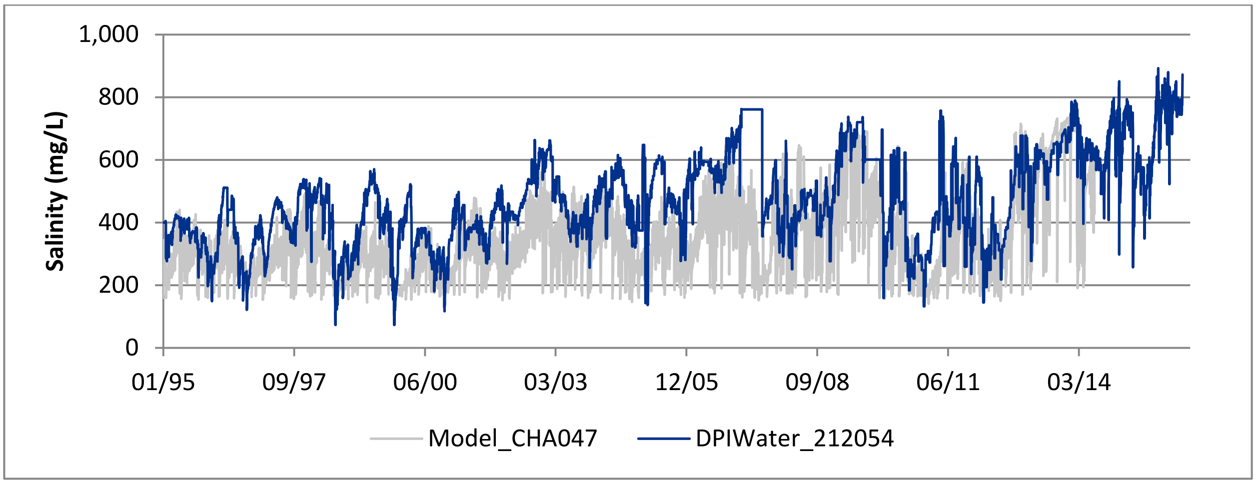

Figure 3.6 : Time-Series Quality at Lake Wallace (DPIWater Gauge No. 212054)

Further detail of observed water quality in rivers and creeks and within swamps is presented in RPS (2014a).

4. Hydrological Analysis

This chapter presents the expected change to the hydrological environment as a result of the modification.

4.1 Proposed Modification

The modification application seeks to allow for:

- an increase in the workforce from the approved 310 full time equivalent (FTE), including contractors, to 450 FTE personnel
- an increase in run-of-mine (ROM) coal production from the approved 4.5 million tonnes per annum (Mtpa) to 5.5 Mtpa
- an increase in the existing ROM coal stockpile at the pit top from the approved 85,000 tonnes capacity to 200,000 tonnes capacity and an increase in the coal stockpile footprint (by 0.3 ha) northeast of the existing area.

Modelling presented in the Groundwater Assessment indicates that the increase in mining rate does not lead to a significant difference in inflow to underground operations. Accordingly, there is negligible change to the Site Water Balance as a result of the proposed modification.

The modification will not lead to a change to impacts of subsidence from that presented in the EIS.

As will be presented below, the increase in the footprint of the ROM stockpile can be accommodated by existing erosion and sediment control infrastructure.

Due to negligible change to the Site Water Balance, there is also negligible change to the Regional Water Flow and Quality Model (RPS (2014b), Jacobs (2015a), Jacobs (2015b)), presented during the assessment process of the Springvale Mine Extension Project.

As indicated in **Section 3.2.2** above, the increase in demand to potable supply and sewerage in response to the increase in FTE workforce, including contractors, will be met by existing infrastructure.

4.2 Site Water Balance

4.2.1 Approach to Analysis

Site water balance modelling presented in this report was updated since the time of the EIS and incorporates the change in status at Angus Place Colliery, as well as the modification to the mining rate proposed at Springvale Mine. The full report by Springvale Coal’s water balance modelling consultant, GHD Pty Ltd, including appendices, is presented in **Appendix A**.

Objectives of the model were:

- quantify the water and salt budget on site with respect to existing operations
- present an assessment of the impact of the modification to predicted conditions.

4.2.2 Model Construction

The model was constructed in GoldSIM, which is an industry-standard software platform.

The model incorporates all of the surface water sources and sinks within the Springvale Mine operation.

The primary input to the site water balance is modelled inflow to underground operations.

4.2.3 Model Verification

As presented in **Appendix A**, the model was verified against available monitoring data including daily metered pumping rates and discharges to Springvale LDP001 and LDP009.

4.2.4 Model Results

As presented in the surface water assessment accompanying the EIS (RPS, 2014a), the site water balance is dominated by inflow to underground operations, including groundwater salinity.

Modelling indicates negligible change to predicted discharge and water quality from the site due to the proposed modification.

4.3 Erosion and Sediment Control

4.3.1 Approach to Analysis

As presented in the Section 4.4.2 of the Surface Water Assessment presented at the time of the EIS (RPS, 2014a), the 'Blue Book' was used to confirm the required capacity of erosion and sediment control structures at Pit Top.

4.3.2 Results of Analysis

Table 4.1 presents the required sediment pond capacity in accordance with the 'Blue Book' methodology after Table 4.12 of RPS (2014a).

Table 4.1 : Pit Top Catchments – Sediment Pond Size (after Table 4.12 of RPS (2014a))

Sub-catchment	Hydrologic Soil Type	Catchment Area (ha)	Draining To	Existing Storage Capacity (m^3)	Required Storage Capacity				
					Settling (m^3)	Storage (m^3)	Total Individual (m^3)	Total Combined (m^3)	Meets Requirement?
PTC2	Type C	6.26 ha	Duck Pond	2,000	276	276	553	1,996	Yes
PTC3	Type D	4.37 ha			962	481	1443		
PTC1	Type C	9.38 ha	Stockpile Pond and Secondary Pond	14,000	339	339	677	8,836	Yes
PTC4	Type F	9.75 ha			2,144	1,072	3,217		
PTC6	Type C	27.3 ha			2,471	2,471	4,942		
PTC5	Type D	0.33ha	STW Ponds	1,000	73	36	109	109	Yes

From **Table 4.1**, Stockpile / Primary Pond and Secondary Pond have a combined existing storage capacity of 14,000m^3. The calculated required capacity of Stockpile Pond and Secondary Pond is 8,836m^3. The ROM stockpile resides within the catchment of the Stockpile and Secondary Pond.

From **Table 4.1**, the size of Stockpile and Secondary Pond meets the requirements of the 'Blue Book' methodology and, accordingly, it is concluded that there is sufficient capacity within the existing infrastructure to accommodate the proposed increase in footprint of the ROM Stockpile.

4.4 Regional Water Flow and Quality Modelling

4.4.1 Approach to Analysis

During the environment impact assessment for the Springvale Mine Extension Project, the RWQIAM was developed in 2014 (RPS, 2014b) and then updated in 2015 (Jacobs 2015ab). The RWQIAM was used to predict the impact to flow and quality (salinity) of mine water discharge associated with the Angus Place and Springvale Mine Extension Projects. The update to the model in 2015 incorporated the change in status at Angus Place Colliery to Care and Maintenance.

As presented in the Groundwater Assessment accompanying this application to modify consent, the increase in mining rate at Springvale Mine does not lead to a significant difference in inflow to underground operations.

Accordingly, the model results presented in the RWQIAM (Jacobs, 2015ab) are applicable to use in support of the proposed modification to consent. i.e. there are no significant changes to model predictions as a result of the modification.

4.4.2 Model Calibration

As presented in RPS (2014b) and Jacobs (2015a), the RWQIAM was calibrated to flow and water quality (salinity) at available monitoring locations with the Coxs River catchment, through to Lake Burragorang.

4.4.3 Model Results

There were several scenarios presented in the RWQIAM incorporating various End-of-Pipe Targets for salinity which were then used to inform the Conditions of Consent for the project, such as Schedule 4 Condition 13 with respect to the Upper Coxs River Action and Monitoring Plan.

From Jacobs (2015a), for the prediction simulation without treatment:

- predicted change to salinity in Lake Burragorang due to the project was an increase from modelled median of 98mg/L in the null case to a modelled median of 103mg/L in the sequential implementation case under median rainfall conditions. This was equivalent to an increase of 5% and was considered to have a neutral impact to water quality since the predicted increase in salinity was small.

4.5 Geomorphology

4.5.1 Approach to Analysis

The potential for impact to geomorphology associated with the project includes:

- change to longitudinal gradient through shrub swamps due to differential settlement
- potential for scour within Sawyers Swamp Creek associated with mine water discharge.

4.5.2 Results of Analysis

Longitudinal Gradient through Shrub Swamps

There is no proposed change to predictions of subsidence presented in the EIS (RPS, 2014a). Accordingly, it is concluded that the modification to consent will not result in a change to the potential for erosion within shrub swamps from that presented in the EIS.

Potential for Scour within Sawyers Swamp Creek

Section 6.3 of the Surface Water Assessment presented at the time of the EIS (RPS, 2014a) presents an assessment of the potential for scour due to mine water discharge. RPS (2014a) found that the potential for scour was small since the average channel velocity during a typical large rainfall event was much higher than proposed channel velocities.

As presented in **Section 4.2**, there is no proposed change to the rate of mine water discharge associated with the modification. It is therefore concluded there is no change to the potential for scour within Sawyers Swamp Creek as a result of the modification.

4.6 Flood Modelling

4.6.1 Approach to Analysis

The potential for impact to flooding and drainage associated with the project consists:

- mine water discharge to Sawyers Swamp Creek, which then flows into the Coxs River.

4.6.2 Results of Analysis

Section 6.3 of the Surface Water Assessment (RPS, 2014a) states that mine water discharge will not result in significant impact to flooding and drainage within Sawyers Swamp Creek or the Coxs River, since predicted daily flow will remain in-bank, defined notionally to contain the 2 year Average Recurrence Interval flood event.

As presented in **Section 4.2**, there is no proposed change to the rate of mine water discharge to Sawyers Swamp Creek associated with the modification. Accordingly, it is concluded there will be no change to flooding and drainage as a result of the modification.

4.7 Results of Hydrological Analysis

4.7.1 Site Water Management

There is no proposed change to site water management associated with increase in mining rate.

The increase in demand for potable water will be met by existing infrastructure.

The increase in requirement for sewerage will be met by existing infrastructure, since the project is now connected to Lithgow City Council's sewerage network.

The increase in sediment retention due to the minor increase in the disturbed catchment containing the ROM Stockpile will be met by existing infrastructure.

4.7.2 Surrounding Land Use

There are no expected changes to surrounding land use due to the modification.

4.7.3 Rivers and Creeks

There is no direct extraction from surface watercourses associated with the project and there is no proposed extraction associated with the modification.

As presented in **Section 4.4**, the project results in mine water discharge to Sawyers Swamp Creek and the Coxs River. The proposed modification to consent, however, does not result in an increase in inflow to underground operations and therefore there is no expected change to predicted impact to rivers and creeks.

4.7.4 Sensitive Environmental Receptors

The change to the hydrology of shrub swamps and hanging swamps due to the project is presented in the Groundwater Assessment accompanying this application for modification to consent.

There is no expected change to subsidence due to the modification of the current project. Accordingly there is no expected change to longitudinal gradient within these ecosystems that could lead to increased erosion potential.

Similarly, there is no expected change to geomorphology or flooding within the Coxs River due to the modification.

4.7.5 Surface Water Users

The change to surface water flow, level and quality due to the modification to consent at relevant surface water users is presented in **Table 4.2**.

Table 4.2 : Predicted Change to Flow, Level and Quality for Surface Water Users

Surface Water User	Distance from Site	Predicted Change to Flow	Predicted Change to Level	Predicted Change to Quality
Coxs River (Upper Nepean and Upstream Warragamba Water Source (Wywandy Management Zone))				
WAL25607	3.5km downstream of Springvale LDP009	No change due to the modification. Increase in flow due to the project.	No change due to the modification. Increase in level (whilst remaining in-bank) due to the project.	No change in surface water quality due to the modification. Salinity of surface water quality of 1,200µS/cm due to the project.
WAL27428 (Lake Wallace)	7.4km downstream of Springvale LDP009	No change due to the modification. Lake Wallace already operating at full level due to closure of Wallerawang Power Station in April 2014.	No change due to the modification.	No change due to the model. Salinity of surface water quality of approximately 1,200µS/cm due to the project.
Coxs River (Upper Nepean and Upstream Warragamba Water Source) (far field)				
WAL27428 (Lake Lyell)	22.6km downstream of Springvale LDP009	No change due to the modification.	No change due to the modification.	No change due to the modification.
WAL27431 (Lake Burragorang)	~80 km downstream of Springvale LDP009	No change due to the modification.	No change due to the modification.	No change due to the modification. Increase from modelled median salinity of 98mg/L to 103mg/L under median rainfall conditions predicted for the project.
Wolgan River (Hawkesbury and Lower Nepean Water Source (Colo River Management Zone))				
WAL25891	15.8km downstream of LW418	No change due to the modification.	No change due to the modification.	No change due to the modification.
WAL26506	19.4km downstream of LW418	No change due to the modification.	No change due to the modification.	No change due to the modification.

From **Table 4.2**, there is no expected change to surface water users due to the modification.

With respect to the surface water users on the Wolgan River,WAL25891 and WAL26506, these are located sufficiently downstream that predicted changes to swamp hydrology on the Newnes Plateau presented in the EIS will have negligible consequence at those water supply works. As identified above, the proposed modification will not change predicted impacts presented in the EIS.

4.7.6 Surface Water / Groundwater Interaction

Table 4.3 presents the expected change to groundwater as a result of mine water discharge to the Coxs River.

Assessment of the impact of mining-induced change to groundwater contribution to shrub swamps is presented in the Groundwater Assessment for the modification.

Table 4.3 : NSW Aquifer Interference Policy (Level 1 Minimal Impact Considerations) (DPIWater, 2012) – Less Productive Porous and Fractured Rock Aquifers

Level 1 Minimal Impact Consideration	Predicted Change
Water table Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic 'post-water sharing plan' variations, 40 metres from any: • high priority groundwater dependent ecosystem or • high priority culturally significant site listed in the schedule of the relevant water sharing plan.	There are no high priority groundwater dependent ecosystems or high priority culturally significant sites downstream of the point of discharge to Sawyers Swamp Creek.
OR A maximum of a 2 metre water table decline cumulatively at any water supply work.	There is no direct extraction from surface water sources associated with the project that could lead to a decline in water table level of a water supply work. There is also no proposed extraction associated with the modification to consent and accordingly, the modification will not lead to a decline in water table level at any water supply work.
Water pressure A cumulative pressure head decline of not more than a 2 metre decline, at any water supply work.	As above, there is no direct extraction from surface water sources associated with the project and there is no proposed extraction associated with the modification. Accordingly, the modification will not lead to a decline in water pressure at any water supply work.
Water quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity.	Mine water discharge to the Coxs River comprises groundwater inflow to underground operations. Recharge to that deep groundwater system is via outcropping of coal seams in or immediately adjacent to the Coxs River.

5. Impact Assessment

This chapter presents and discusses the potential impacts to streamflow and quality as a result of the proposed modification to the project.

It is noted that the impact assessment is presented with respect to relevant Commonwealth and NSW legislation, guidelines and policy.

5.1 Commonwealth Legislation, Guidelines and Policy

5.1.1 Significant Impact Guidelines for Coal Seam Gas and Large Coal Mines 2013

Table 5.1 presents an assessment of the Proposal against the Significant Impact Guidelines for Coal Seam Gas and Large Coal Mines (DoE, 2013).

Table 5.1 : Impact Assessment against Significant Impact Guidelines (DoE, 2013)

Impact Guideline	Compliant	Comment
Hydrological Characteristics		
A significant impact on the hydrological characteristics of a water resource may occur where there are, as a result of the action: a) changes in the water quantity, including the timing of variations in water quantity	Yes	As established in the EIS, the Coxs River has had a long history of industrial activity. The proposed modification to consent does not change the predicted impact of the project.
b) changes in the integrity of hydrological or hydrogeological connections, including substantial structural damage (e.g. large scale subsidence)	Yes	The predicted impact of the project to the Newnes Plateau shrub swamps is presented in the EIS. Further detail on potential impact to shrub swamps is presented in the Groundwater Assessment, such as recent evidence that indicates the role of geological lineaments may be important in regard to the shrub swamps.
c) changes in the area or extent of a water resource	Yes	There is no change in the extent of any water resource as a result of the modification.
Water Quality		
A significant impact on a water resource may occur where, as a result of the action: a) there is a risk that the ability to achieve relevant local or regional water quality objectives would be materially compromised, and as a result the action: i. creates risks to human or animal health or to the condition of the natural environment as a result of the change in water quality	Yes	The project results in mine water discharge to the Coxs River catchment, which eventually discharges into Lake Burragorang. As presented during the environmental impact assessment, the RWQIAM indicates a small increase in salinity in Lake Burragorang as a result of the project.
ii. substantially reduces the amount of water available for human consumptive uses or for other uses, including environmental uses, which are dependent on water of the appropriate quality	Yes	The project comprises an increase in availability of water in the Coxs River catchment. The proposed modification to consent does not change the predicted impact of the project. The impact of the change to groundwater contribution to shrub swamps is presented in the Groundwater Assessment.

Impact Guideline	Compliant	Comment
iii. causes persistent organic chemicals, heavy metals, salt or other potentially harmful substances to accumulate in the environment	Yes	Water quality criteria established in the current Conditions of Consent, expressed in Springvale Coal's EPL, have been tailored to reduce the potential impact of metals and salinity on the environment.
iv. seriously affects the habitat or lifecycle of a native species dependent on a water resource, or	Yes	As established in the EIS, the Coxs River is an adapted ecosystem (perennial) from its long history as an industrialised catchment. The modification to consent does not result in a change to the rate of mine water discharge from that presented in the EIS.
v. causes the establishment of an invasive species (or the spread of an existing invasive species) that is harmful to the ecosystem function of the water resource, or	Yes	N/A
b) there is a significant worsening of local water quality (where current local water quality is superior to local or regional water quality objectives), or	Yes	As established in the Current Conditions of Consent, there is a requirement to achieve a reduction in salinity of mine water discharge to the Coxs River to ≤ 500µS/cm (90th percentile) by 30 June 2019. The target water quality (salinity) was derived through toxicity assessment by NSW OEH.
c) high quality water is released into an ecosystem which is adapted to a lower quality of water.	Yes	At this stage, the Upper Coxs River Action and Monitoring Plan has not been submitted. If there is mechanical treatment of mine water discharge to a higher water quality then it will be necessary to present that this will not lead to adverse impact.

5.1.2 Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000

Assessment of the impact of the modification against ANZECC (2000) is presented in **Section 5.2.3** in regard to the NSW Water Quality and River Objectives (OEH, 2006).

5.1.3 Australian Drinking Water Guidelines 2011

Assessment of the impact of the modification against NHMRC (2016) is presented in **Section 5.2.3** in regard to the NSW Water Quality and River Objectives (OEH, 2006) and *State Environmental Planning Policy (Sydney Drinking Water Catchment)* 2011 (NSW).

5.2 NSW Legislation, Guidelines and Policy

5.2.1 Water Management Act 2000

Water Management Plan for the Greater Metropolitan Unregulated River Water Sources 2011

Rules for granting access licences, managing access licences, water supply works approvals and access licence dealings are provided in the *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources* 2011 (NSW).

There is no direct surface water extraction from the *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources* 2011 (NSW).

Indirect take from the above water sharing plan due to mining-related reduction in groundwater contribution to surface water courses is presented in the Groundwater Assessment accompanying this application for modification to consent, including an assessment of compliance with relevant rules from the water sharing plan.

Impact to Surface Water Users

Table 5.2 presents an assessment of the impact of the predicted change to flow, level and quality due to the modification to the already approved impacts on relevant surface water users.

Table 5.2 : Impact Assessment of Changes to Flow, Level and Quality on Surface Water Users

Surface Water User	Distance from Site	Impact to Flow	Impact to Level	Impact to Quality
Coxs River (Upper Nepean and Upstream Warragamba Water Source (Wywandy Management Zone))				
WAL25607	3.5km downstream of Springvale LDP009	Negligible	Negligible	Negligible
WAL27428 (Lake Wallace)	7.4km downstream of Springvale LDP009	Negligible	Negligible	Negligible
Coxs River (Upper Nepean and Upstream Warragamba Water Source) (far field)				
WAL27428 (Lake Lyell)	22.6km downstream of Springvale LDP009	Negligible	Negligible	Negligible
WAL27431 (Lake Burragorang)	~80 km downstream of Springvale LDP009	Negligible	Negligible	Negligible
Wolgan River (Hawkesbury and Lower Nepean Water Source (Colo River Management Zone))				
WAL25891	15.8km downstream of LW418	Negligible	Negligible	Negligible
WAL26506	19.4km downstream of LW418	Negligible	Negligible	Negligible

5.2.2 Environmental Planning and Assessment Act 1979

State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011

Table 5.3 presents an assessment of the impact against the *State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011*.

As noted in **Section 2.3.2**, the assessment of the project presented during the environmental impact assessment did not use the NorBE tool, because it was not suitable.

Table 5.3 : Impact Assessment against Neutral or Beneficial Effect Test (WaterNSW, 2015)

Assessment Condition	Compliant	Impact Assessment
"A neutral or beneficial effect on water quality is satisfied if the development: (a) has no identifiable potential impact on water quality, or	N/A	N/A
(b) will contain any water quality impact on the development site and prevent it from reaching any watercourse, waterbody or drainage depression on the site, or	N/A	N/A
(c) will transfer any water quality impact outside the site where it is treated and disposed of to standards approved by the consent authority."	Yes	As specified in the conditions of consent, under the Upper Coxs River Action and Monitoring Plan (Schedule 4, Condition 13),

Assessment Condition	Compliant	Impact Assessment
		there is a requirement to meet a specified water quality (salinity) of ≤ 500µS/cm (90th percentile) by 30 June 2019. The modification to consent will not result in an increase in inflow to underground operations, and so there is no expected change in water quality of mine water discharge. Accordingly, there will be no change to already approved impact on water quality due to the modification.

5.2.3 NSW Water Quality and River Flow Objectives 2006

Table 5.4 presents an assessment of impact of the modification to consent against the NSW Water Quality Objectives.

Table 5.4 : Impact Assessment against NSW Water Quality Objectives (OEH, 2006)

Water Quality Objective	Compliant	Impact Assessment
Aquatic Ecosystems "Maintaining or improving the ecological condition of water bodies and their riparian zones over the long term."	Yes	No change due to the modification. For the project, as presented in the environmental impact assessment, predicted water quality (salinity) is within the range experienced historically in the Coxs River catchment. Current conditions of Consent include the Upper Coxs River Action and Monitoring Plan, which prescribe a reduction in salinity to 500µS/cm (90th percentile) by 30 June 2019. There is no proposed discharge to the Newnes Plateau associated with the modification. Also with respect to the Newnes Plateau, the modification will not lead to change in subsidence from that predicted in the EIS. Accordingly, there is no expected change to potential for erosion within these ecosystems because of differential settlement.
Visual Aesthetics "Aesthetic qualities of water"	Yes	No change due to the modification. As per Section 2.3.3, there is a turbidity and suspended sediment quality limit to mine water discharge to Sawyers Swamp Creek at Springvale LDP009
Drinking Water – Groundwater "Refers to quality of drinking water drawn from the raw surface or groundwater sources before any treatment."	Yes	No change due to the modification. As indicated in the Groundwater Assessment, there are no local users of groundwater with respect to water supply. For the Coxs River, mine water discharge meets the ADWG with the exception of salinity where 600 to 900mg/L is considered of fair quality.
Industrial Water Supplies "The high economic value of water taken from river and lakes for use by industry needs recognition in water quality planning and management. It has been identified as an important environmental value through community consultation."	Yes	No change due to the modification. As per the Water Sharing Plan for the Greater Metropolitan Unregulated River Water Sources 2011, water must not be taken from the Coxs River under a major utility [power generation] access licence until all available mine water is used from its storages.

Table 5.5 presents an assessment of impact of the modification to consent against the NSW River Flow Objectives.

Table 5.5 : Impact Assessment against NSW River Flow Objectives (OEH, 2006)

River Flow Objective	Compliant	Impact Assessment
Protect natural pools in dry times "Protect natural water levels in pools of creeks and rivers and wetlands during period of no flow"	Yes	No impact due to modification. There is no direct extraction of water from surface watercourses due to the project or proposed as part of the modification.
Protect natural low flows "Protect natural low flows"	No	No change due to the modification with respect to the Newnes Plateau. As presented in the EIS, the project does not discharge to the Newnes Plateau with respect to any THPSS, therefore meets this objective. With respect to the Coxs River, there is continuous discharge to Sawyers Swamp Creek. This was approved as part of SSD5594 and continuous discharge to Sawyers Swamp Creek will continue under the modified project.
Maintain wetland and floodplain inundation "Maintain or restore natural inundation patterns and distribution or floodwaters supporting natural wetland and floodplain ecosystems"	Yes	No change due to the modification, since there are no physical works such as hydraulic structures on the Newnes Plateau or within the Coxs River catchment.
Maintain natural flow variability "Maintain or mimic natural flow variability in all streams"	No	No change due to the modification, as continuous discharge of mine water to Sawyers Swamp Creek will continue, as currently approved. As presented in the EIS, Sawyers Swamp Creek is a heavily modified catchment, due to its previous and current land use, including open cut mining and ash disposal facilities. The Coxs River is also extensively modified due to water supply reservoirs at Lake Wallace and Lake Lyell.
Maintain groundwater ecosystems "Maintain groundwater within natural levels and variability, critical to surface flows and ecosystems"	Yes	No expected change to groundwater level or quality due to the modification. As presented in the EIS, there is no predicted change to groundwater level with respect to the Coxs River from mine dewatering. As presented in this assessment, mine water discharge to the Coxs River is not expected to have any change to groundwater. For the Newnes Plateau, the impact to THPSS due to mining-related change to groundwater contribution is presented in the Groundwater Assessment.

5.2.4 Managing Urban Stormwater 2004 & 2008

Section 4.3 presents an assessment of existing erosion and sediment control infrastructure with respect to the 'Blue Book' (Landcom, 2004 and DECCW, 2008).

From **Section 4.3**, there is sufficient capacity within existing erosion and sediment control infrastructure and therefore there is no expected impact to surface water quality (as either suspended and base sediment load to downstream watercourses) as a result of the modification.

5.2.5 NSW Aquifer Interference Policy 2012

Table 5.6 presents an assessment of aquifer interference due to surface water management associated with the modification to consent.

Table 5.6 : Impact Assessment against NSW Aquifer Interference Policy (Level 1 Minimal Impact Considerations) (DPIWater, 2012) – Less Productive Porous and Fractured Rock Aquifers

Level 1 Minimal Impact Consideration	Compliant	Impact Assessment
Water table Less than or equal to a 10% cumulative variation in the water table, allowing for typical climatic 'post-water sharing plan' variations, 40 metres from any: • high priority groundwater dependent ecosystem or • high priority culturally significant site listed in the schedule of the relevant water sharing plan.	Yes	Negligible
OR A maximum of a 2 metre water table decline cumulatively at any water supply work.	Yes	Negligible
Water pressure A cumulative pressure head decline of not more than a 2 metre decline, at any water supply work.	Yes	Negligible
Water quality Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 metres from the activity.	Yes	Negligible

6. Licensing, Management, Mitigation and Monitoring

This chapter presents licensing requirements from relevant water sources and presents management measures for the project, including changes due to the modification, as well as the approach to on-going monitoring.

6.1 Licensing

6.1.1 Commonwealth Legislation

6.1.1.1 Environment Protection and Biodiversity Conservation Act 1999

There are no licensing requirements under the *Environmental Protection and Biodiversity Conservation Act* 1999 (Cth) with respect to take from surface water sources.

Recommendations provided in the approval for the project are in the process of being implemented.

6.1.2 NSW Legislation

6.1.2.1 Water Management Act 2000

Licensable Take

There is no direct surface water extraction from the *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources* 2011 (NSW).

Indirect take from the above water sharing plan due to mining-related reduction in groundwater contribution to surface watercourses is presented in the Groundwater Assessment.

6.1.2.2 Protection of the Environment Operations Act 1997

There are no changes to mine water discharge limits in the current EPL (No. 3607, dated 26 February 2016) suggested associated with this modification to consent.

6.2 Management

Water management at Springvale Mine is governed by the Water Management Plan, as specified in Schedule 4, Condition 14, of the current Conditions of Consent (SSD 5594). The Water Management Plan presents the monitoring network, establishes trigger levels on expected impacts as well as presents the Trigger Action Response Plan.

There is also a tailored Water Management Plan required with respect to each Extraction Plan (Schedule 3, Condition 10 of the current Conditions of Consent).

Lastly, the current Conditions of Consent also specify a requirement to prepare an Upper Coxs River Action and Monitoring Plan (Schedule 4, Condition 13) to achieve a target salinity in the Coxs River of 500µS/cm (90^{th} percentile) by 30 June 2019.

6.3 Monitoring

The monitoring network at Springvale Mine comprises:

- flow and quality monitoring in rivers and creeks
- flow and quality monitoring within shrub swamps (flow and quality)

Further detail of the monitoring network at Springvale is presented in RPS (2014a) and the current Water Management Plan.

Compared to the currently approved project, due to the expected negligible change to flow, level and quality, there are no presented changes to surface water monitoring at Springvale Mine associated with the Modification.

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Appendix A. Site Water and Salt Balance Assessment

Springvale Coal Pty Ltd

Springvale Mine Modification 1 Project

Water and Salt Balance Assessment

July 2016

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Appendices

Appendix A – Operational conditions
Appendix B – Additional modelling results

Glossary

Baseflow	The component of streamflow that originates from groundwater.
Bore	A constructed connection between the surface and a source of underground water that enables the underground water to be transferred to the surface either naturally or through artificial means.
Catchment	The land area draining through the main stream and tributary streams to a particular location.
Clean catchment areas	Catchments in which there are no exposed or disturbed surfaces containing coal or mined carbonaceous material.
Clean water	Waters on the premises that have not come into physical contact with coal, or mined carbonaceous material.
Cut through	Underground mine access ways between the development headings. They occur at regular intervals along the development headings.
Depression storage	The volume of water that is contained in natural depressions in the land surface.
Dewatering	Transfer of water from the underground mine workings to the surface or other underground areas.
Dirty catchment areas	Catchments in which coal or mined carbonaceous materials are present or areas where the topsoil has been disturbed.
Dirty water	Water on the premises that has come into physical contact with coal, mined carbonaceous materials or otherwise contains elevated sediment load.
Discharge	Quantity of water per unit of time flowing in a stream, for example cubic meters per second or megalitres per day.
Electrical conductivity	A measure of concentration of dissolved salts in water.
Evapotranspiration	The loss of water from soil by evaporation and from plant surfaces by transpiration.
FBT Tank	A tank located at the 85.5 Cut Through area within the existing underground workings of Springvale Mine.
Goaf	That part of a mine from which the mineral has been partially or wholly removed; the waste left in old workings.
Hydrogeology	The area of geology that deals with the distribution and movement of groundwater in soils and rocks of the earth's crust.
Infiltration	Natural flow of surface water through ground surfaces as a result of rainfall events.
Licensed discharge point	A location where Springvale Mine discharges water in accordance with conditions stipulated within the site Environment Protection Licence.
Lithgow Seam	Deepest coal horizon of the Permian Age Illawarra Coal Measures, with an average depth of 380 m.
Longwall	Longwall mining is a form of underground coal mining where a block of coal is mined using a longwall shearer. The longwall mining method is supported by roadway development, mined using a continuous miner unit.
Oil/Water Separator	Device designed to separate oil from water.

Pan factor	Reduction factor applied to measured pan evaporation to simulate evaporation from natural water bodies and surface water storages.
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.
Potable water	Water of a quality suitable for drinking.
Recharge	Inflow of water from surrounding strata into underground workings through infiltration. This can be as a result of rainfall events or from surrounding aquifers.
Run of mine coal	Raw or unprocessed coal.
SILO	An enhanced climate data bank based on historical climate data from 1889 provided by the Bureau of Meteorology. Records are mainly based on observed data, with interpolation where there are data gaps.
Springvale Coal Services Site	Site currently used for stockpiling and processing of run of mine coal from Springvale Mine but approved as part of the Western Coal Services Project to increase coal throughput at the site and to provide the coal handling and transport logistics predominantly for both Angus Place Colliery and Springvale Mine.
Water Transfer Scheme	Predominantly subterranean pipeline network which transfers extracted groundwater using boreholes from Angus Place Colliery and Springvale Mine to licensed discharge point 009 at Springvale Mine for discharge into the Coxs River (formely known as Springvale-Delta Water Transfer Scheme).
Surface water	Water that is derived from precipitation or pumped from underground and may be stored in dams, rivers, creeks and drainage lines.

Abbreviations

AHD	Australian Height Datum
AWBM	Australian Water Balance Model
BOM	Bureau of Meteorology
BS	Baseflow storage
EPL	Environment Protection Licence
GHD	GHD Pty Ltd
ha	Hectare
km	Kilometre
L/day	Litre per day
L/day/person	Litre per day per person
L/s	Litre per second
L/t	Litre per tonne
LDP	Licensed discharge point
m	Metre
Mg/L	Milligram per litre
ML	Megalitre
ML/day	Megalitre per day
ML/year	Megalitre per year
mm	Millimetre
Mtpa	Million tonnes per annum
ROM	Run of mine
SDWTS	Springvale Delta Water Transfer Scheme
SILO	Scientific information for land owners
Springvale Coal	Springvale Coal Pty Limited
SS	Surface storage
t/day	Tonne per day
t/year	Tonne per year
µS/cm	Microsiemens per centimetre

1. Introduction

Springvale Mine is an underground coal mine located approximately 15 km north-west of Lithgow, as shown on Figure 1-1. The underground mine entry and surface facilities are accessed via the Castlereagh Highway in Wallerawang. Springvale Mine is owned by Centennial Springvale Pty Limited (as to 50%) and Springvale SK Kores Pty Limited (as to 50%) as participants in the Springvale unincorporated joint venture. Springvale Mine is operated by Springvale Coal Pty Limited (Springvale Coal), a wholly owned subsidiary of Centennial Coal Company Limited, for and on behalf of the Springvale joint venture participants.

Underground coal mining commenced at Springvale Mine in 1995 following the granting of development consent DA 11/92 on 27 July 1992. Currently Springvale Mine operates under development consent SSD-5594, granted on 21 September 2015 by the NSW Planning Assessment Commission as a delegate for the Minister for Panning. Development consent SSD-5594 allows for the extraction of up to 4.5 million tonnes per annum (Mtpa) of run of mine (ROM) coal using longwall mining methods until 31 December 2028.

Springvale Coal is seeking to modify development consent SSD-5594 pursuant to Section 96(2) of the *Environmental Planning and Assessment Act 1979*. GHD Pty Ltd (GHD) was commissioned by Springvale Coal to prepare a Water and Salt Balance Assessment for the Springvale Mine Modification 1 Project (the Project). The assessment forms part of a Statement of Environmental Effects for the Project.

1.1 Project Application Area

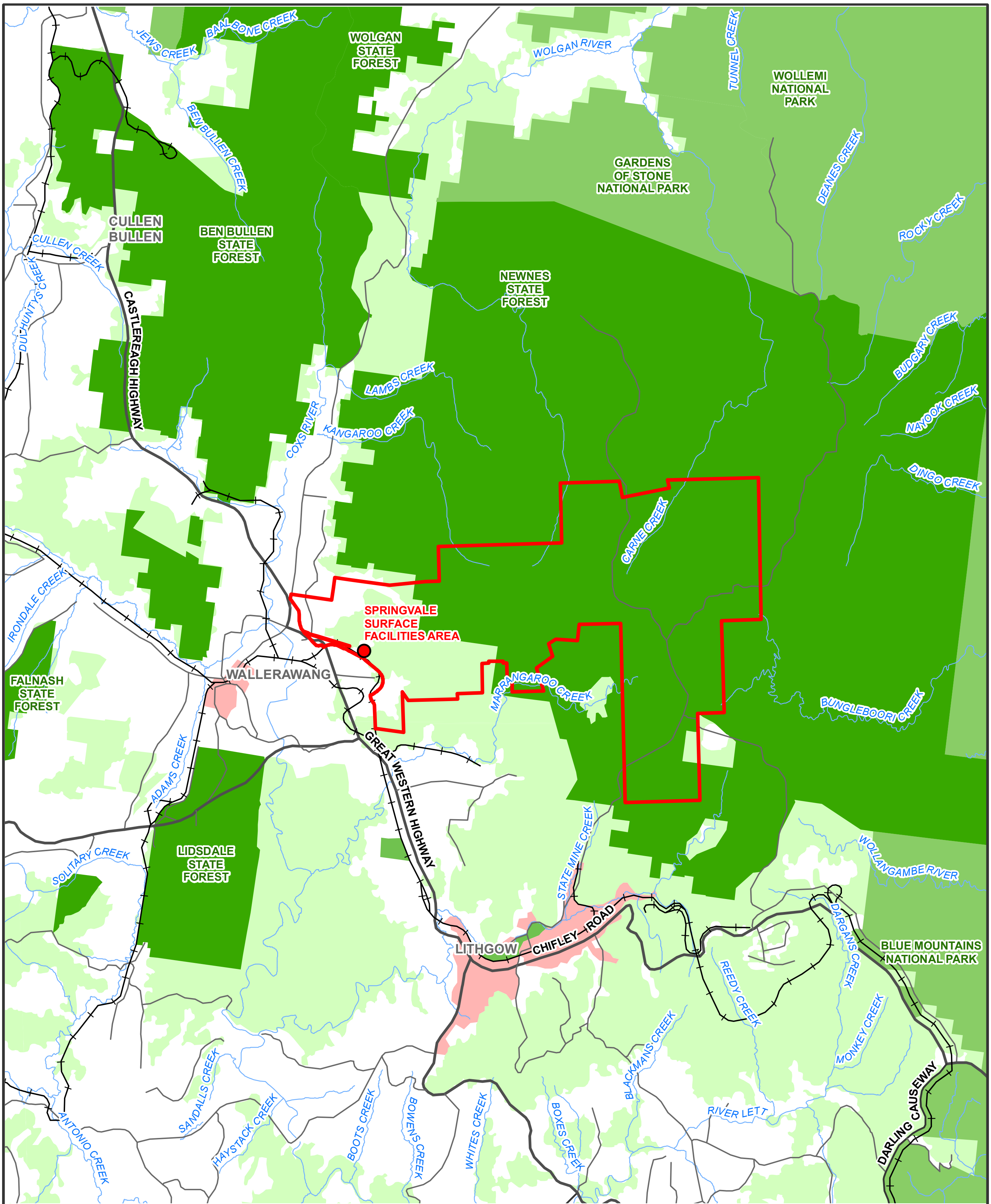
The Project Application Area approved in SSD-5594 is defined by the mining lease and exploration licence boundaries of Springvale Mine, identified on Figure 1-1. The assessment has given consideration to the overall water management system associated with Springvale Mine and includes water transfers associated with:

- Existing mining activities.
- Proposed mining activities.
- Surface operations.

1.2 Project description

The Project proposes to:

- Increase the workforce from 310 to 450 full time equivalent positions.
- Increase the approved ROM coal production rate from 4.5 Mtpa to 5.5 Mtpa.
- Increase the approved ROM coal stockpile from 85,000 tonnes to 200,000 tonnes, with an associated increase in the stockpile footprint area of approximately 0.3 ha.



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0 0.5 1 2 3 4

Kilometers

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

GHD

LEGEND

- Project Application Area
- Waterway
- Existing Rail
- Principal Road
- Secondary Road
- Minor Road
- Built Up Area
- Nature Conservation
- State Forest
- Forest Or Shrub

LOCATION	Lidsdale
SEAM	Lithgow
DRAWN	R.Towner
CHECKED	T. Davies
APPROVED	S. Callander
SCALE	refer to scalebar

Springvale Mine Modification 1 Project
Water and Salt Balance Assessment

Locality Plan

Centennial Springvale

DATE 19/04/2016 Figure 1-1

GIS Filename: G:\22\0105001\GIS\Maps\Deliverables\Western\Springvale\2218141\WaterBalanceAssessment\2218141_SV_WSBA_001_LocalityPlan_B.mxd

1.3 Overview of site operations

1.3.1 Site features

The surface site features and associated operations at Springvale Mine are provided on Figure 1-2 and include:

- Administration building and portable offices on the pit top site.
- Crusher and screening plant for handling coal and stockpile area.
- Various workshops, service buildings and material storage sheds.
- Visitor and employee car parking areas and a heliport.
- Personnel and materials drift for access to the underground workings.
- Coal conveyor drift and coal conveyor drive to transport coal from the underground workings to the surface.
- Mine dewatering infrastructure on the Newnes Plateau and at the pit top.
- Water management facilities including various surface storages and both clean and dirty water diversion drains.
- Licensed discharge points (LDPs).
- Ventilation system providing air to the underground mine workings via Ventilation Shaft No. 1 and No. 2 and underground mine adits. Air is exhausted via Ventilation Shaft No. 3 located on the Newnes Plateau.

1.3.2 Coal production

Coal is extracted and handled from Springvale Mine at a rate of 4.5 Mtpa of ROM coal, with coal transported from the underground workings to a temporary ROM coal stockpile area at the pit top. ROM coal is transferred from the reclaim conveyor to a crusher and screening plant. All crushed coal is transported off-site and no reject material is generated at the pit top. An overland conveyor system delivers coal directly to Mount Piper Power Station or to the Springvale Coal Services site for stockpiling and processing. The transfer of coal from the pit top at Springvale Mine to off-site locations is authorised under the Western Coal Services Project development consent SSD 12_5579.

1.3.3 Related operations

Angus Place Colliery

Angus Place Colliery is an underground coal mine located approximately 6 km north of Springvale Mine. Angus Place Colliery is seeking approval to extend its mining operations using longwall mining operations and extract up to 4 Mtpa of ROM coal as part of the Angus Place Mine Extension Project (Golder Associates, 2014). Angus Place Colliery moved to a care and maintenance phase in March 2015, during which mining operations have ceased but environmental management of the site, including dewatering of the underground workings, is ongoing.

1:4,000 for A4

0 12.5 25 50 75 100

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

LEGEND

- Licensed Discharge Point
- Pollution Control Structure
- Survey

LOCATION	Lidsdale
SEAM	Lithgow
DRAWN	R.Towner
CHECKED	T. Davies
APPROVED	S. Callander
SCALE	refer to scalebar

Springvale Mine Modification 1 Project
Water and Salt Balance Assessment

Site Features

Centennial Springvale

DATE 19/04/2016

Figure 1-2

GIS Filename: G:\22\0105001\GIS\Maps\Deliverables\Western\Springvale\2218141\WaterBalanceAssessment\2218141_SV_WSBA_002_SiteFeatures_B.mxd

Groundwater inflows into the underground workings at both Angus Place Colliery and Springvale Mine are transferred to the Springvale Delta Water Transfer Scheme (SDWTS), which is a predominantly subterranean pipeline network. Mine water from Springvale Mine is taken as priority, with the remaining capacity supplied by mine water from Angus Place Colliery. Section 2.5.9 provides more detail about the operation of the SDWTS.

1.4 Report objectives

The Water and Salt Balance Assessment has been developed to:

- Quantify the water and salt budget in relation to the surface water, process water usage and groundwater management systems for existing operations.
- Provide an assessment of the changes to water transfers, water discharges, frequency of discharges and wastewater volumes that may occur as a result of the proposed future operations.
- Document the most likely (average annual values) of the water and salt transfers within the Springvale Mine operations.
- Document the variability of the likely (annual values) of the water and salt transfers within the Springvale Mine operations.

The objective of the Water and Salt Balance Assessment is to provide a detailed assessment of the potential impacts of the Project on the water and salt balance of the site. The water and salt budget of the SDWTS is also considered in the Water and Salt Balance Assessment, including transfers from Angus Place Colliery into the SDWTS.

1.5 Scope of work

The scope of work for the Water and Salt Balance Assessment included:

- Review and collation of data relating to Springvale Mine.
- Establish an understanding of the water management system at the site.
- Develop a GoldSim water and salt balance model for the site that could assess the water management system under various rainfall patterns. The model was developed initially to represent the existing conditions and appropriately modified to represent conditions upon implementation of the Project.
- Compare the existing and proposed water and salt balances of Springvale Mine with consideration of implications of the Project.

2. Water management

2.1 Environment protection licence

Environment protection licences (EPLs) are issued by the NSW Environment Protection Authority under the *Protection of the Environment Operations Act 1997*. Licence conditions relate to pollution prevention and monitoring and can control the air, noise, water and waste impacts of an activity. Springvale Mine's EPL 3607 includes both volumetric and concentration limits for the discharge of water off-site. Springvale Mine's LDPs are indicated on Figure 2-1 and include:

- LDP001 – Discharge of surface water, mine water make and runoff into Springvale Creek through settling ponds (Primary and Secondary Ponds, refer Figure 1-2).
- LDP002 – Discharge of treated sewage effluent from Springvale Mine via a spray irrigation network to a designated utilisation area.
- LDP004 – Emergency discharge location into unnamed tributary of the Wolgan River on the Newnes Plateau. This is situated in the Hawkesbury/Nepean Catchment.
- LDP005 – Emergency discharge location into unnamed tributary of the Wolgan River on the Newnes Plateau. This is situated in the Hawkesbury/Nepean Catchment.
- LDP006 (not shown on Figure 2-1) – Discharge of runoff into Wangcol Creek through final filter lagoon located at Springvale Coal Services site (not considered within this assessment), which is part of the Western Coal Services Project.
- LDP007 (not shown on Figure 2-1) – Discharge of runoff from the overland conveyor system into Coxs River (not considered within this assessment), which is part of the Western Coal Services Project.
- LDP009 – SDWTS bypass point east of Kerosene Vale Ash Dam for discharge into the Coxs River.
- LDP010 – SDWTS emergency/maintenance discharge point upstream of the settling ponds, for discharge into the Coxs River.

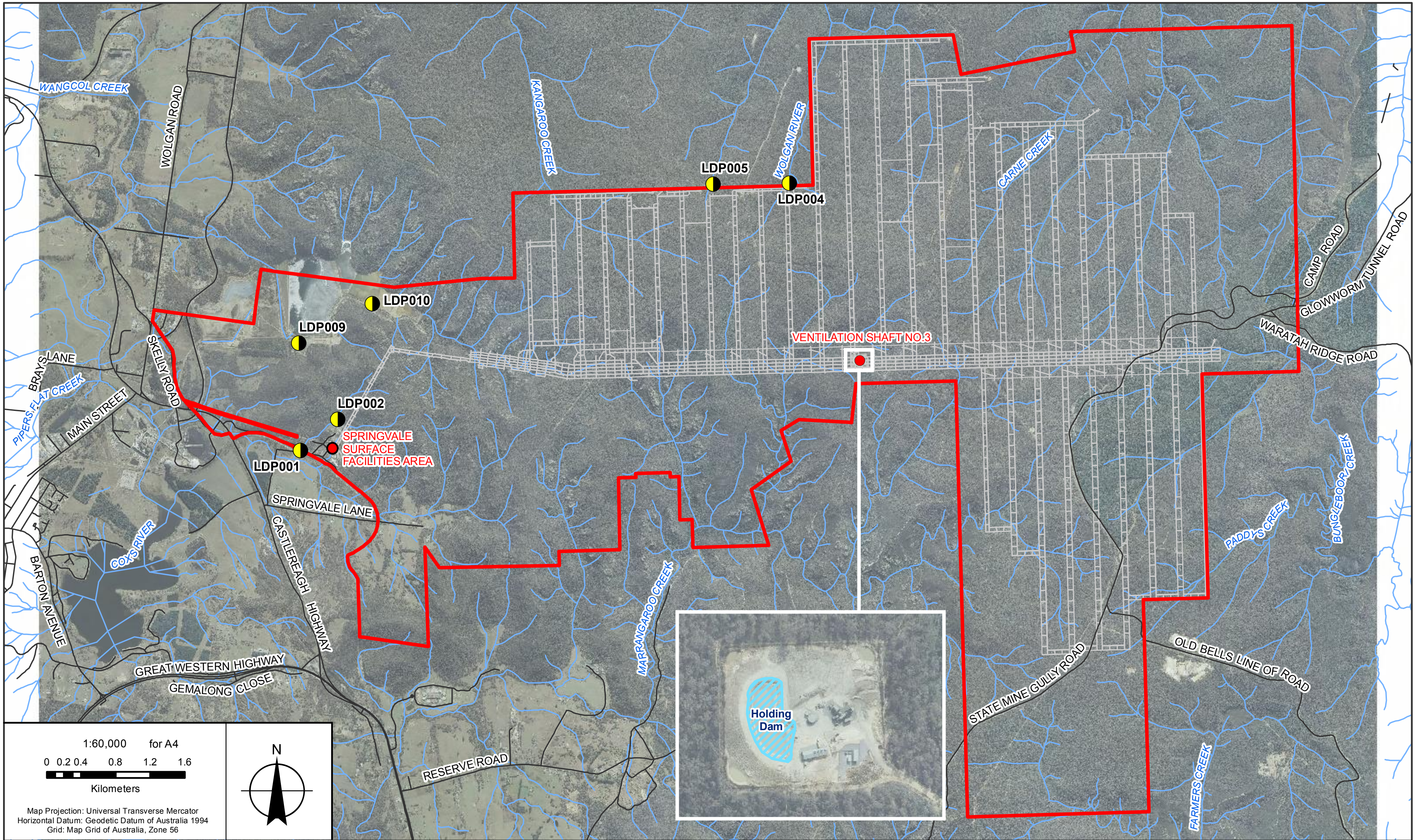
Springvale Mine was connected to the Lithgow City Council sewage system in 2016. As a result, discharges of treated sewage effluent through LDP002 have ceased.

The LDPs associated with the Western Coal Services Project, LDP006 and LDP007, are not considered as part of the Water and Salt Balance Assessment.

2.2 Site hydrology

The Project Application Area lies on the border of the Coxs River Catchment and the Wolgan River catchment. Both catchments are part of the Greater Hawkesbury/Nepean catchment, which ultimately contributes to the Hawkesbury River and Broken Bay.

The pit top area is located within the Coxs River catchment, which flows in a southerly direction. The Ventilation Shaft No. 3 site located on the Newnes Plateau is located within the Marrangaroo Creek catchment, which is a sub-catchment that contributes to the Coxs River. The underground workings are located below both the Coxs River catchment and the Wolgan River catchment. LDP001, LDP002, LDP009 and LDP010 are all located within the Coxs River catchment. LDP004 and LDP005 on the Newnes Plateau are located within the Wolgan River catchment.



LEGEND

- Licensed Discharge Point
- Project Application Area
- Road
- Existing and Proposed Workings
- Waterway

LOCATION	Lidsdale
SEAM	Lithgow
DRAWN	R.Towner
CHECKED	
APPROVED	
SCALE	refer to scalebar

Springvale Mine Modification 1 Project
Water and Salt Balance Assessment

Licensed Discharge Points

Centennial Springvale

DATE 19/04/2016

Figure 2-1

GIS Filename: G:\22\0105001\GIS\Maps\Deliverables\Western\Springvale\2218141\WaterBalanceAssessment\2218141_SV_WSBA_003_LicencedDischargePoints_B.mxd

Springvale Mine does not extract water from any natural watercourse, however it does discharge both mine water and runoff into Springvale Creek and the Coxs River through LDPs as listed in Section 2.1.

2.3 Existing operations

The water management system at Springvale Mine is comprised of surface, potable, waste and underground elements. The primary objective of water management at Springvale Mine is the separation of clean and dirty water and the effective management of water through collection, treatment and discharge.

A schematic of the overall water management system at Springvale Mine is provided in Figure 2-2. The water cycle at the mine is represented in Figure 2-3.

2.3.1 Surface water system

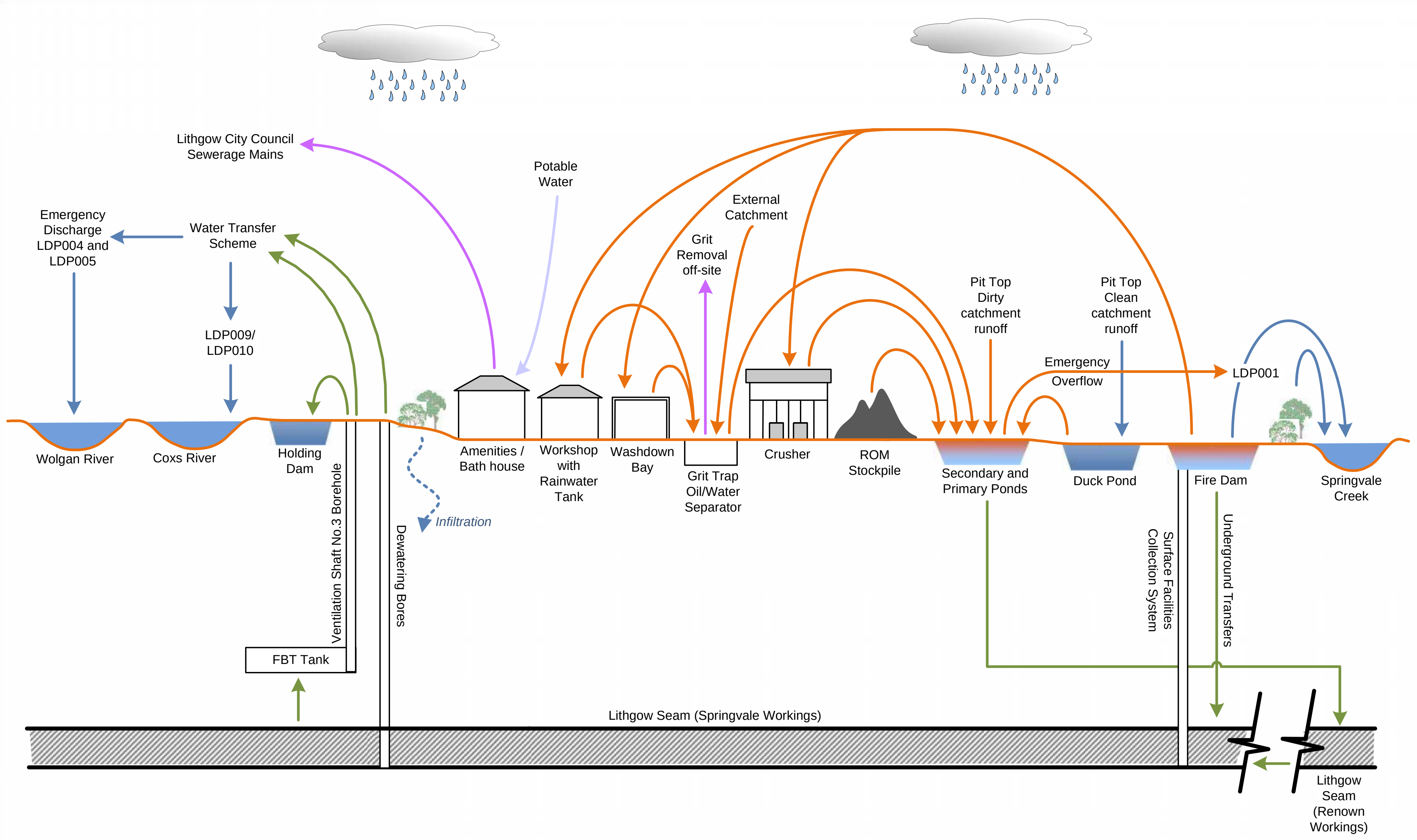
The surface water system consists of runoff contributing to surface water storages at Springvale Mine. The surface water storages present are the Primary and Secondary Ponds, Fire Dam and Duck Pond at the pit top and the Holding Dam on Newnes Plateau. The primary functions of the surface water system are as pollution control structures and to store water harvested from the site. Figure 2-4 and Figure 2-5 show the catchments contributing to the Springvale Mine pit top area. The clean and dirty water diversions in place at the pit top site are provided on Figure 2-6 and Figure 2-7.

The inputs to the surface water system under existing conditions consist of:

- Direct rainfall onto storages.
- Runoff from the contributing catchment as a result of rainfall.
- Transfer of groundwater from the underground workings to the Fire Dam at the pit top and the Holding Dam at the Ventilation Shaft No. 3 site.
- Transfer of groundwater from the Fire Service Pipeline to the crusher and the vehicle washdown and workshop.

The outputs from the surface water system under existing conditions consist of:

- Evaporation from water storages.
- Discharges through LDP001 into Springvale Creek consisting of overflows from the Fire Dam and emergency overflows from Secondary Pond in addition to clean catchment runoff.
- Emergency discharges through LDP004 and LDP005 into Wolgan River.
- Discharges through LDP009 and emergency discharges through LDP010 into Coxs River.
- Removal of water off-site from the Grit Trap via the Oil/Water Separator by a contractor.
- Transfer of process water from the Fire Dam to the Fire Service Pipeline.
- Water used for dust suppression.



Dirty Water
Clean Water
Underground Water
Potable Water
Waste Water

LOCATION	Springvale
SEAM	Lithgow
DRAWN	SM
CHECKED	TD
APPROVED	SC
SCALE	NTS

Springvale Mine Modification 1 Project
Water and Salt Balance Assessment

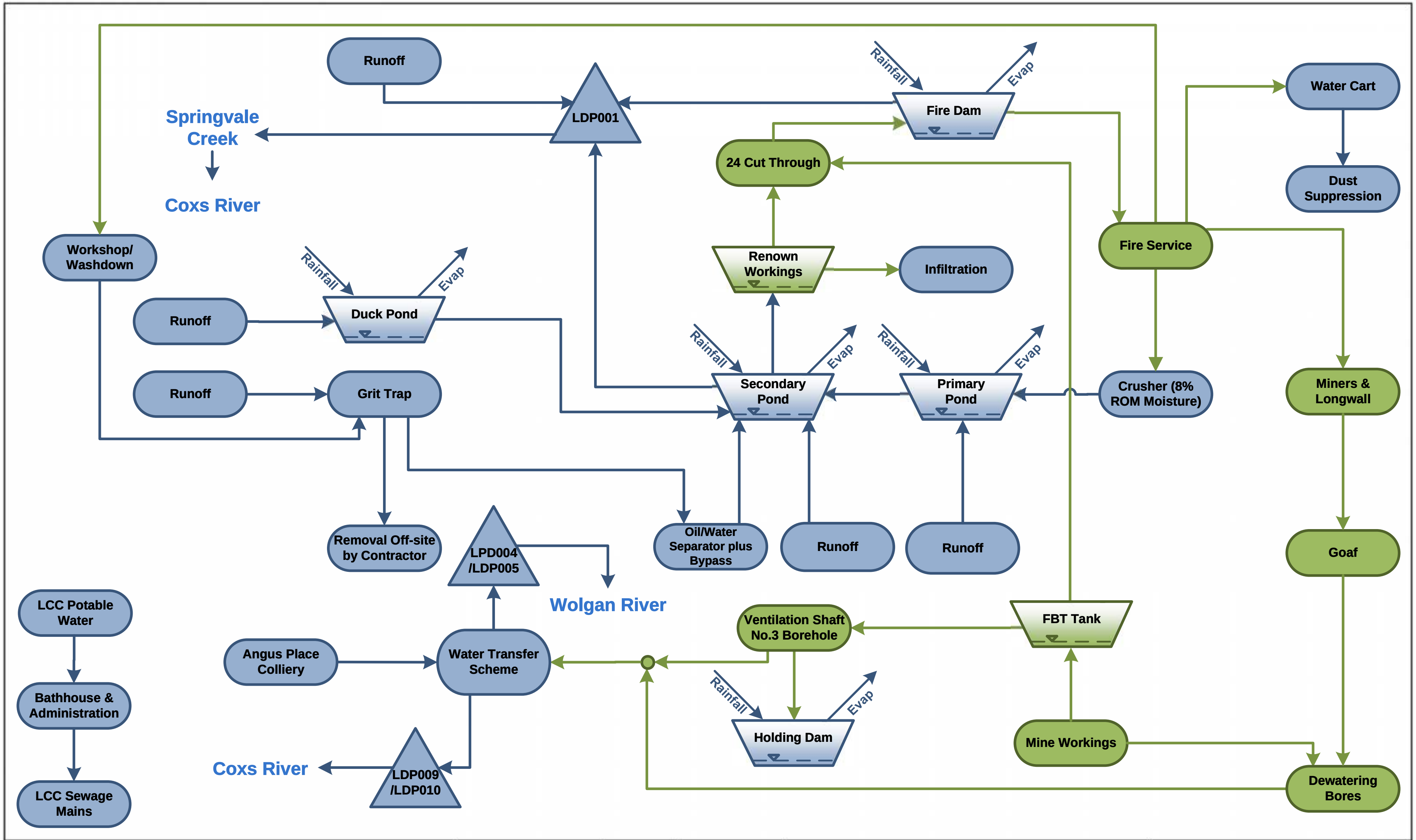
Overall Water Management Schematic

Centennial Springvale

DATE April 2016

Figure 2-2

G:\22\18141\Visio\2218141_SV_FIG2-2_Springvale Overall Water Management Schematic.vsd



LEGEND

Surface Water Transfer

Underground Water Transfer

Storage

LOCATION	Springvale
SEAM	Lithgow
DRAWN	SM
CHECKED	TD
APPROVED	SC
SCALE	NTS

Springvale Mine Modification 1 Project
Water and Salt Balance Assessment

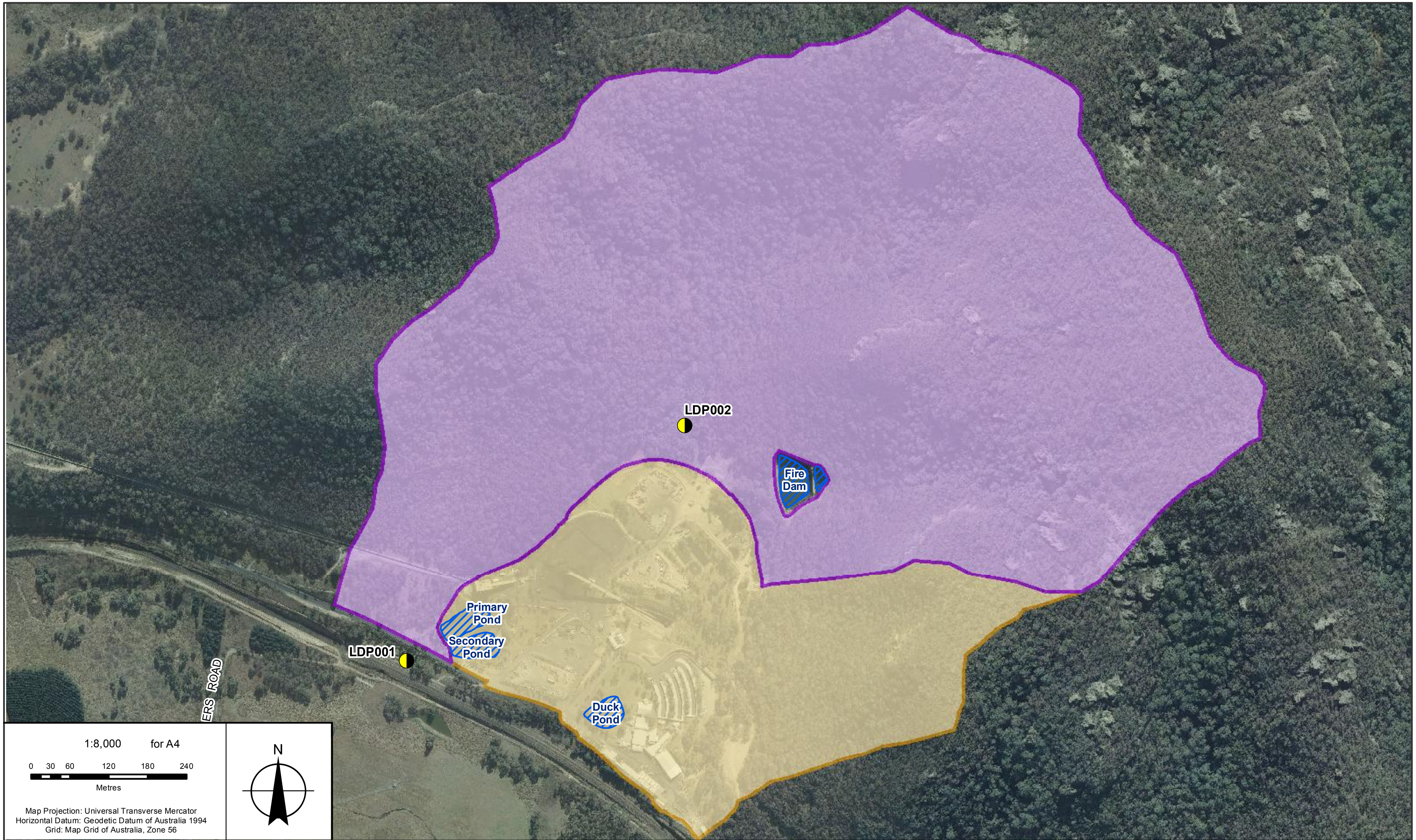
Water Cycle Schematic
Existing and Proposed Conditions

Centennial Springvale

DATE Apr 2016

Figure 2-3

G:\22\18141\Visio\2218141_SV_FIG2-3_Springvale_Existing and Proposed Water_Schematic.vsd



LEGEND
- Pit Top Catchment
- Clean Water Diversion Catchment
- Pollution Control Structure
- Licensed Discharge Point

LOCATION	Lidsdale
SEAM	Lithgow
DRAWN	R.Towner
CHECKED	T. Davies
APPROVED	S. Callander
SCALE	refer to scalebar

Springvale Mine Modification 1 Project
Water and Salt Balance Assessment

Pit Top Area
Overall Catchments

Centennial Springvale

DATE 19/04/2016 Figure 2-4

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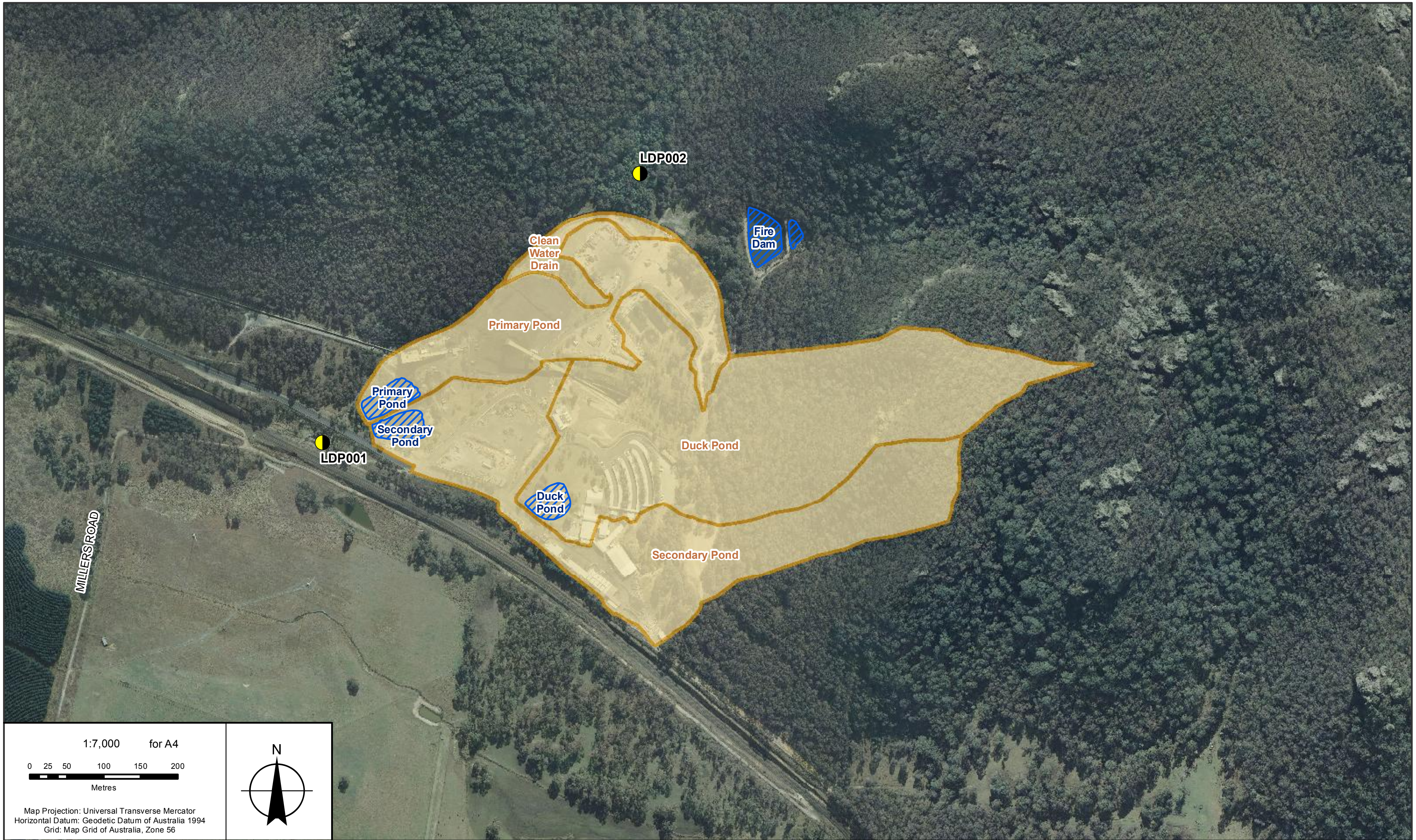


LEGEND

- Pit Top Catchment
- Pollution Control Structure
- Licensed Discharge Point

LOCATION	Lidsdale
SEAM	Lithgow
DRAWN	R.Towner
CHECKED	T. Davies
APPROVED	S. Callander
SCALE	refer to scalebar

Springvale Mine Modification 1 Project
Water and Salt Balance Assessment

Pit top area catchments
Existing conditions

Centennial Springvale

DATE 19/04/2016

Figure 2-5

GIS Filename: G:\22\0105001\GIS\Maps\Deliverables\Western\Springvale\2218141\WaterBalanceAssessment\2218141_SV_WSBA_005_SiteCatchments_B.mxd

GHD

LEGEND

- Pollution Control Structure
- Licensed Discharge Point
- Clean Water Diversion

LOCATION	Lidsdale
SEAM	Lithgow
DRAWN	R.Towner
CHECKED	T. Davies
APPROVED	S. Callander
SCALE	refer to scalebar

Springvale Mine Modification 1 Project
Water and Salt Balance Assessment

Pit Top Area
Clean Water Diversions
Existing Conditions

Centennial Springvale

DATE 19/04/2016

Figure 2-6

GIS Filename: G:\22\0105001\GIS\Maps\Deliverables\Western\Springvale\2218141\WaterBalanceAssessment\2218141_SV_WSBA_006_CleanWaterDiversions_B.mxd

LEGEND

- Dirty Water Diversion
- Pollution Control Structure
- Licensed Discharge Point

LOCATION	Lidsdale
SEAM	Lithgow
DRAWN	R.Towner
CHECKED	T. Davies
APPROVED	S. Callander
SCALE	refer to scalebar

Springvale Mine Modification 1 Project
Water and Salt Balance Assessment

Pit Top Area
Dirty Water Diversions
Existing Conditions

Centennial Springvale

DATE 19/04/2016

Figure 2-7

GIS Filename: G:\22\0105001\GIS\Maps\Deliverables\Western\Springvale\2218141\WaterBalanceAssessment\2218141_SV_WSBA_007_DirtyWaterDiversions_B.mxd

2.3.2 Potable and wastewater systems

The potable and wastewater systems are a component of the surface water system at Springvale Mine.

The inputs to the potable and wastewater system under existing conditions consist of:

- Potable water provided by Lithgow City Council to the administration and bathhouse buildings.
- Drinking water supplied by Lithgow Valley Springs/Neverfail Springwater.

The outputs from the potable and wastewater system under existing conditions consist of:

- Grey water and sewage from the administration and bathhouse buildings is directed to the Lithgow City Council sewage system from 2016. Previously, this water was directed to an on-site Sewage Treatment Plant, with wastewater passing through a set of effluent ponds and disposed of via an on-site irrigation system through LDP002. With the connection of Springvale Mine to the Lithgow City Council sewage system, the Sewage Treatment Plant and associated systems are expected to be decommissioned and discharges through LDP002 have ceased.

2.3.3 Underground water system

Mining at Springvale Mine intersects the Lithgow Seam and is predicted to produce groundwater inflows in the order of up to 164 L/s under existing conditions (CSIRO, 2015). The groundwater inflows are managed through the operation of several dewatering bores:

- Process water used at the pit top site is supplied by groundwater extracted from the Renown Workings via the pit top collection system borehole, which is directly transferred into the Fire Dam.
- The underground workings are dewatered using three dewatering bores on the Newnes Plateau: Bore 6, Bore 8 and the Ventilation Shaft No. 3 borehole. For Bore 6 and Bore 8, groundwater is then transferred directly to the SDWTS. For the Ventilation Shaft No. 3 borehole, groundwater is also transferred to the SDWTS, however may be temporarily stored underground within the FBT Tank. Water pumped via the Ventilation Shaft No. 3 borehole is also used to maintain the Holding Dam on the Newnes Plateau, which is used to supply fire-fighting activities when required.

The inputs to the underground water system under existing conditions consist of:

- Natural recharge of the active underground workings (Springvale Mine).
- Transfer of water from the Secondary Pond into the old underground workings (Renown Workings).
- Transfer of water from the Fire Dam to the Fire Services Pipeline.

The outputs from the underground water system under existing conditions consist of:

- Extraction of water from the Ventilation Shaft No. 3 borehole transferred to the Holding Dam or the SDWTS.
- Extraction of water from Bore 6 and Bore 8 transferred to the SDWTS.
- Extraction of water from the pit top collection system borehole transferred to the Fire Dam.
- Transfer of process water from the Fire Services Pipeline to the crusher and the vehicle washdown and workshop.

2.4 Future operations

2.4.1 Springvale Mine

The Project will incorporate several minor changes to the water management cycle at the site. The changes relate to the increase in workforce, ROM coal production rate and ROM coal stockpile area.

Groundwater inflows

The predicted increased volume of groundwater make will be discharged predominantly into the SDWTS via Bore 6 and Bore 8 in addition to the Ventilation Shaft No. 3 borehole. Process water for underground operations will continue to be sourced from the underground using the pit top collection system borehole and stored within the Fire Dam prior to use. Water will continue to be pumped into the Holding Dam at the Ventilation Shaft No. 3 site from the underground (using the Ventilation Shaft No. 3 borehole) for fire-fighting purposes on the Newnes Plateau.

ROM coal stockpile

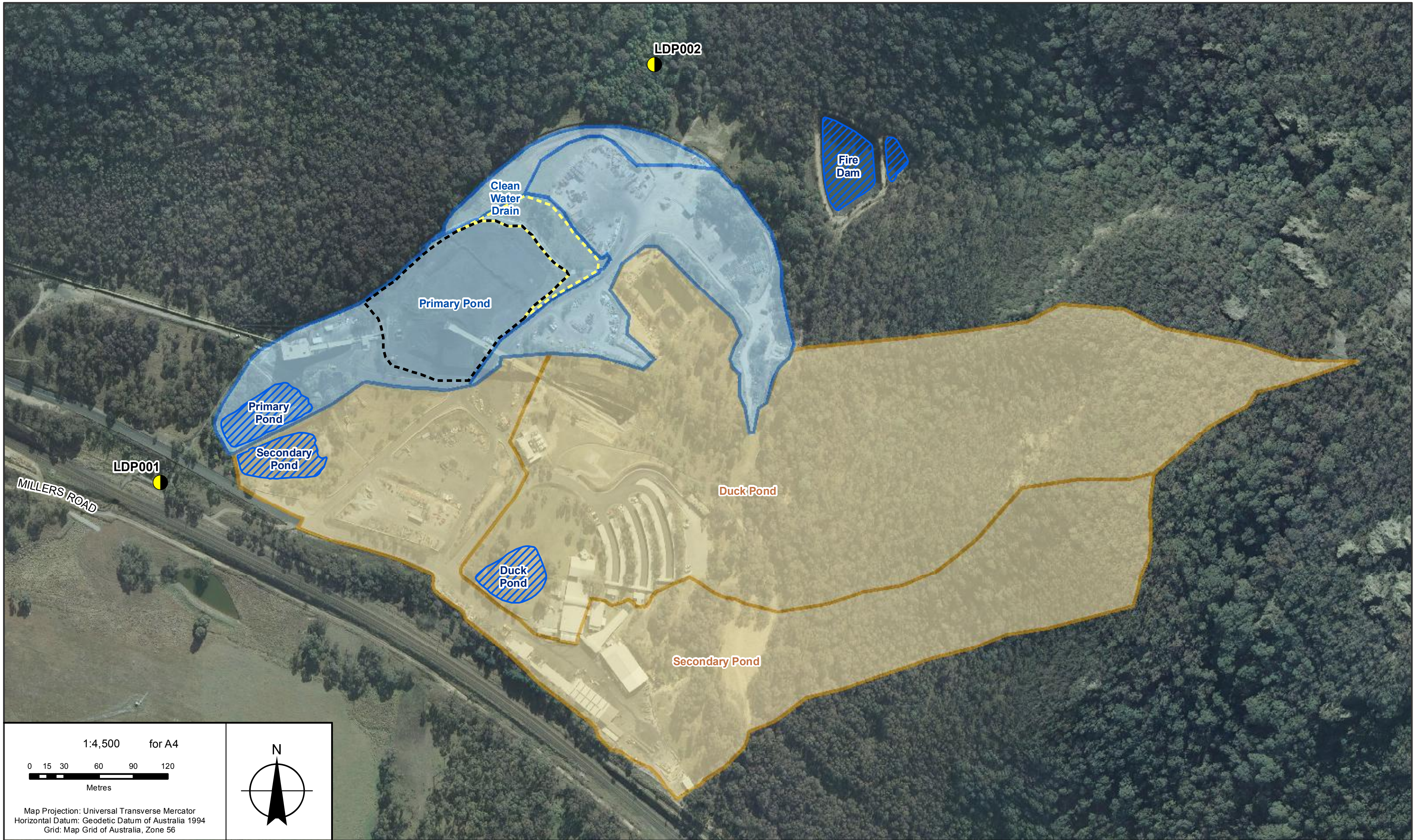
The Project proposes an increase in the ROM coal stockpile from 85,000 tonnes to 200,000 tonnes. The associated increase in the ROM coal stockpile area will increase the dirty water catchment of the site, with runoff from the extension area currently collected by a clean water drain and directed to LDP001 proposed to be directed to the Primary Pond.

Figure 2-8 presents the surface water catchments for Springvale Mine under proposed conditions. Figure 2-9 and Figure 2-10 present the clean and dirty water diversions at the pit top under proposed conditions.

2.4.2 Water Transfer Scheme

The SDWTS receives the majority of groundwater (not used to meet operational requirements or discharged through LDPs) from both Angus Place Colliery and Springvale Mine for transfer to Springvale Mine’s LDP009. Transfers from Springvale Mine take priority, with the remaining capacity of the SDWTS supplied by transfers from Angus Place Colliery. A schematic of the SDWTS including transfers from Springvale Mine and Angus Place Colliery is presented in Figure 2-11.

The hydrogeological model developed for Angus Place Colliery and Springvale Mine predicts increased groundwater inflows associated with the proposed longwalls at both Angus Place Colliery and Springvale Mine. The cumulative predicted groundwater make from both sites has been considered by the Water and Salt Balance Assessment.



LEGEND

- Pit Top Catchment
- Pollution Control Structure
- Proposed Catchment Modifications
- Licensed Discharge Point
- Existing ROM Area
- Proposed ROM Area

LOCATION	Lidsdale
SEAM	Lithgow
DRAWN	R.Towner
CHECKED	T. Davies
APPROVED	L. Hammersley
SCALE	refer to scalebar

Springvale Mine Modification 1 Project
Water and Salt Balance Assessment

Pit top area catchments
Proposed conditions

Centennial Springvale

DATE 19/04/2016 Figure 2-8

GIS Filename: G:\22\0105001\GIS\Maps\Deliverables\Western\Springvale\2218141\WaterBalanceAssessment\2218141_SV_WSBA_009_PropSiteCatchments_B.mxd

LEGEND

- Clean Water Diversion
- Pollution Control Structure
- Licensed Discharge Point

LOCATION	Lidsdale
SEAM	Lithgow
DRAWN	R.Towner
CHECKED	T. Davies
APPROVED	L. Hammersley
SCALE	refer to scalebar

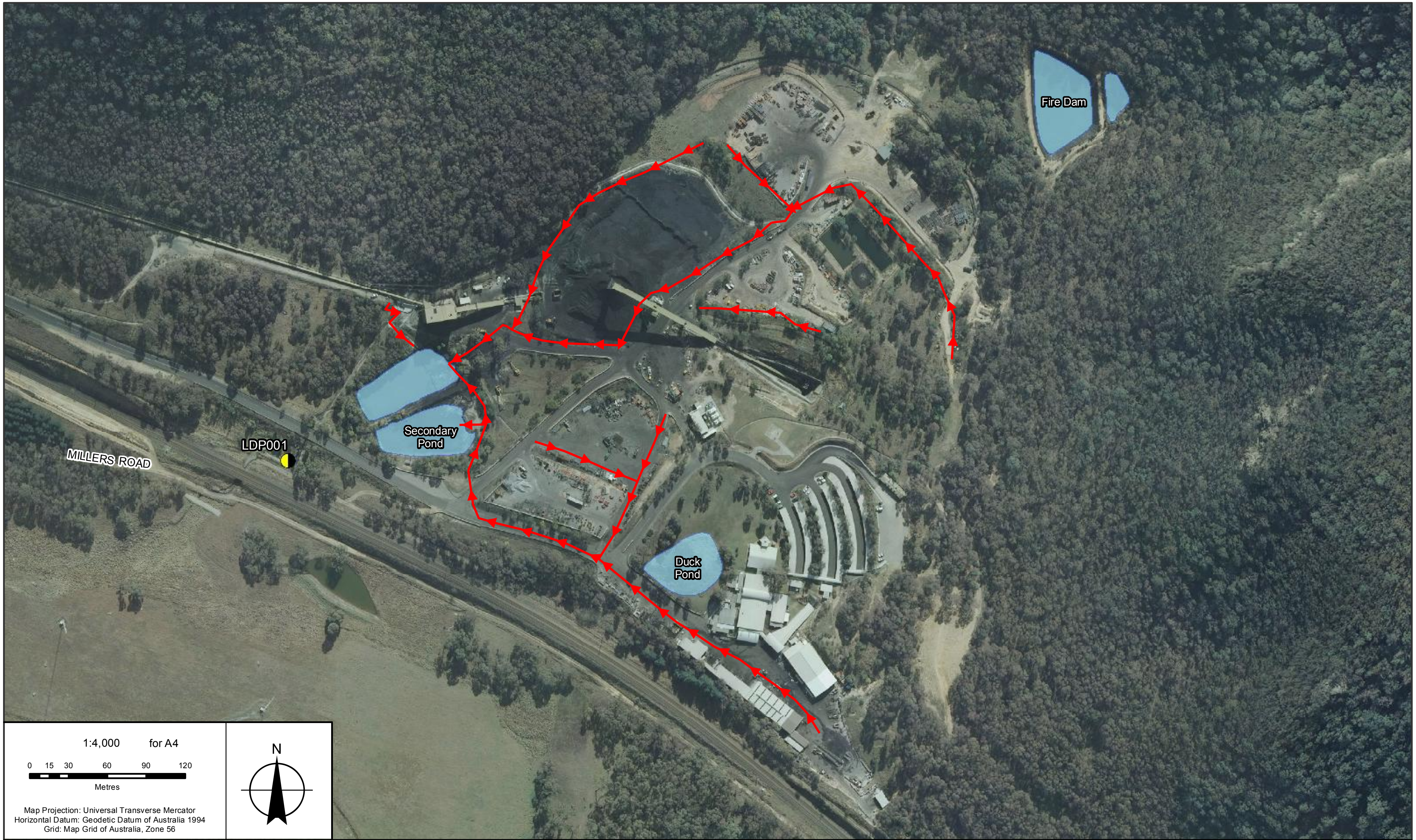
Springvale Mine Modification 1 Project
Water and Salt Balance Assessment

Pit Top Area
Clean Water Diversions
Proposed Conditions

Centennial Springvale

DATE 19/04/2016 Figure 2-9

GIS Filename: G:\22\0105001\GIS\Maps\Deliverables\Western\Springvale\2218141\WaterBalanceAssessment\2218141_SV_WSBA_010_PropCleanWaterDiversions_B.mxd



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0 15 30 60 90 120

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

GHD

LEGEND

Pollution Control Structure

Licensed Discharge Point

LOCATION	Lidsdale
SEAM	Lithgow
DRAWN	R.Towner
CHECKED	T. Davies
APPROVED	S. Callander
SCALE	refer to scalebar

Springvale Mine Modification 1 Project
Water and Salt Balance Assessment

Pit Top Area
Dirty Water Diversions
Proposed Conditions

Centennial Springvale

DATE 19/04/2016

Figure 2-10

GIS Filename: G:\22\0105001\GIS\Maps\Deliverables\Western\Springvale\2218141\WaterBalanceAssessment\2218141_SV_WSBA_011_PropDirtyWaterDiversions_B.mxd

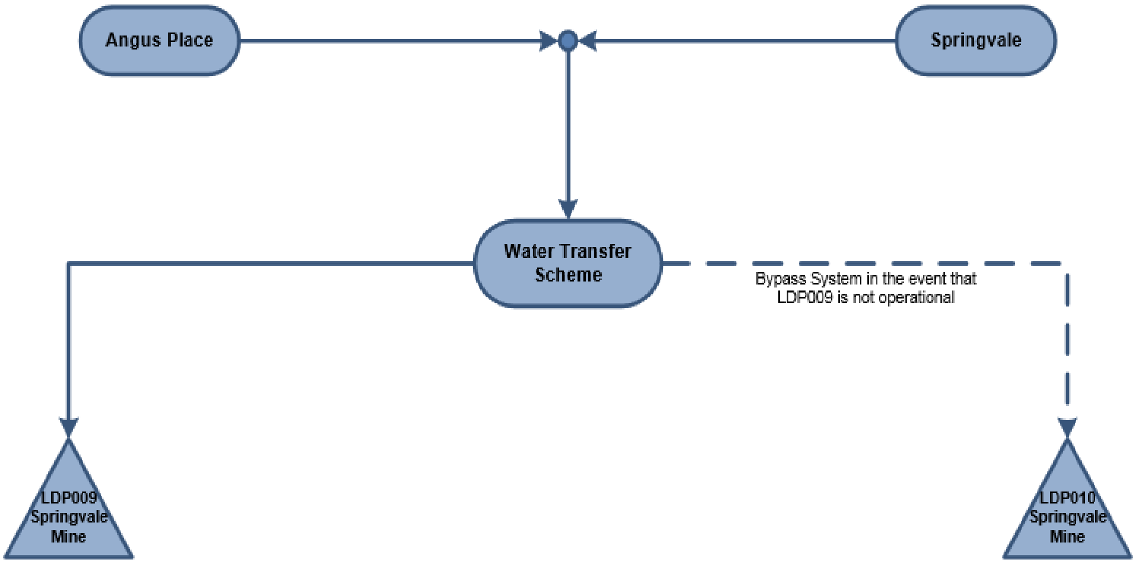


Figure 2-11 Water Transfer Scheme – Water management schematic

2.5 Water management features

2.5.1 Duck Pond

The Duck Pond captures water from the administration and bathhouse buildings area and carpark. The pond overflows to the Secondary Pond.

2.5.2 Primary Pond

The Primary Pond receives water from the crusher in addition to surface water runoff from the ROM coal stockpile and crusher area, conveyor equipment storage area and the facilities laydown pad. Under proposed conditions, the Primary Pond will receive additional surface water runoff from the increased ROM coal stockpile area. Overflows from the Primary Pond are directed to the Secondary Pond.

2.5.3 Secondary Pond

The Secondary Pond receives surface water runoff from the mining supplies storage area as well as overflows from the Primary Pond and Duck Pond and discharges from the Oil/Water Separator.

Water from the Secondary Pond is pumped into the Renown Colliery workings for percolation through the workings to remove sediment prior to transfer to the Pit Top Collection System for use as process water. Overflows from the Secondary Pond are directed to LDP001.

2.5.4 Fire Dam

The Fire Dam stores water transferred from the Renown Colliery workings and FBT Tank via the Pit Top Collection System and supplies process water to the Fire Service Pipeline. In the event that the Fire Dam exceeds its capacity to store mine water, overflows will occur via the northern clean water diversion contributing to LDP001.

2.5.5 Fire Service Pipeline

The Fire Service Pipeline is supplied process water from the Fire Dam. Water for underground mining operations, dust suppression, vehicle and plat washdown and the crusher are supplied by the Fire Service Pipeline.

2.5.6 Grit Trap

The Grit Trap receives surface water runoff from hardstand areas, oil storage areas and workshop as well as return flow from the vehicle and plant washdown. The removal of grit occurs offsite by a licensed contractor. Overflows are directed to the Secondary Pond via the Oil/Water Separator.

2.5.7 Holding Dam

The Holding Dam located at the Ventilation Shaft No. 3 facility receives pumped transfers from the FBT Tank.

2.5.8 FBT Tank

The FBT Tank receives groundwater transferred from the active underground workings. Pumped transfers from the FBT Tank occur to the SDWTS and the Holding Dam via the Ventilation Shaft No. 3 borehole and to the Fire Dam via the 24 Cut Through.

2.5.9 Water Transfer Scheme

The SDWTS receives excess water (groundwater not used to meet operational requirements or discharged through LDPs) from the Ventilation Shaft No. 3 borehole and dewatering bores at Springvale Mine as well as transfers of groundwater make from Angus Place Colliery. The capacity of the SDWTS is 30 ML/day. Transfers from Springvale Mine take priority, with the remaining capacity of the SDWTS supplied by transfers from Angus Place Colliery. All water transferred to the SDWTS is discharged to the Coxs River via LDP009, which is licensed to discharge up to 30 ML/day.

2.5.10 Sewage Treatment Plant

The Sewage Treatment Plant previously received wastewater from the administration and bathhouse buildings, with a continuous daily discharge applied to the irrigation area via LDP002. The Sewage Treatment Plant is expected to be decommissioned, following the connection of the site to the Lithgow City Council sewage system in 2016.

3. Modelling representation

3.1 Water balance

The modelling software used to represent the Springvale Mine water balance was GoldSim (Version 11.1). This software is a graphical object orientated system for simulating either static or dynamic systems. It is like a ‘visual spreadsheet’ that allows the visual creation and manipulation of data and equations representing system behaviour.

Simulation, in this context, is defined as a process of creating a model of an existing or proposed system (such as a mine water management system) in order to identify and understand the factors that control the system performance or predict (forecast) the future behaviour of the system under varying input conditions and operational decisions.

The model was created by representing the site water cycle as a series of elements, each containing pre-set rules and data, that were linked together to simulate the interaction of these elements within the water cycle. The water cycle was simulated over time in GoldSim and selected outputs from the modelled system were statistically summarised.

3.1.1 Hydrologic model

To estimate the runoff contributing to the water storages at Springvale Mine, the Australian Water Balance Model (AWBM) was incorporated into the wider water balance model. The AWBM was adopted as the most suitable model as it is widely used throughout Australia, has been verified through comparison with large amounts of recorded streamflow data and literature is available to assist in estimating input parameters based on recorded streamflow data (Boughton and Chiew, 2003). Another advantage of the AWBM is the consideration of soil moisture retention when determining runoff.

The AWBM is a catchment water balance model that calculates runoff from rainfall after allowing for relevant losses and storage. The model consists of three storage elements (with surface areas A_1, A_2 and A_3) representing elements such as infiltration into the soil. Rainfall initially enters these storages and once a storage element is full, any additional rainfall is considered to be excess rainfall. Of this excess rainfall, a proportion is routed to the groundwater/baseflow storage (BS) while the remainder is routed to the surface storage (SS). The discharge from the groundwater storage and surface storage is estimated as a proportion of the volume of the storages at the end of each day. The total daily runoff is equal to the combined volume of water discharged from these two storages.

The definition of AWBM parameters is provided in Table 3-1. Figure 3-1 provides a schematic representation of the AWBM.

Table 3-1 Description of Australian Water Balance Model parameters

Parameter	Description
A_1, A_2, A_3	The partial areas of the overall catchment contributing to storages 1, 2 and 3 respectively.
C_1, C_2, C_3	The capacity of storages 1, 2 and 3 respectively.
BFI	The proportion of excess rainfall flowing to the baseflow.
Excess	Excess from storages C_1, C_2 and C_3.
SS	Surface storage recharge.

Parameter	Description
BS	Baseflow storage recharge.
Kb	The proportion of the volume of the baseflow storage remaining in the storage at the end of each day. Not applicable for these catchments as there is no baseflow component.
Ks	The proportion of the surface flow storage remaining in the storage at the end of each day.

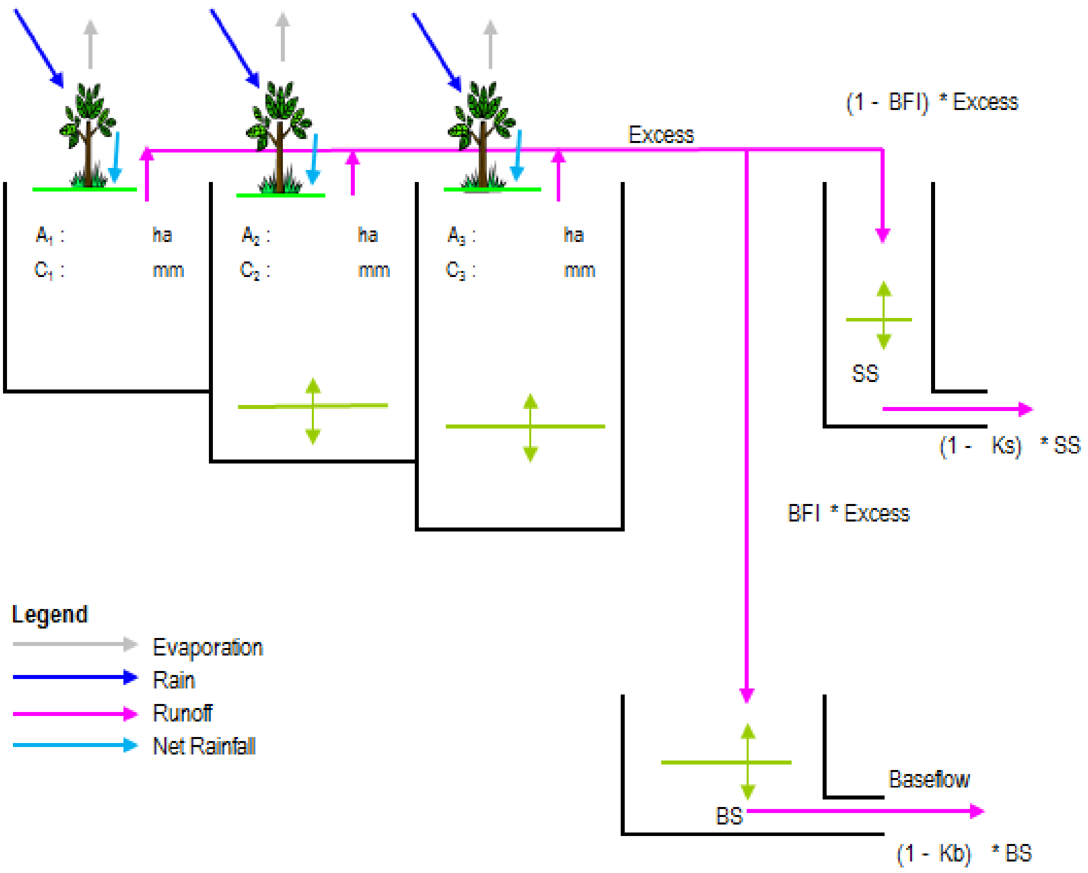


Figure 3-1 Australian Water Balance Model representation

3.1.2 Time steps and simulation timeline

The GoldSim model simulated the water cycle from current conditions in 2016 to 2035 using daily time steps. Daily time steps were used for the modelling as daily rainfall data was the shortest period of data available and changes in operational conditions are typically made on a daily (or shorter) basis.

3.1.3 Probabilistic modelling

To assess the impact of rainfall on the site, the water balance modelling was completed by applying 127 different rainfall patterns over the simulation timeline. To complete this, the simulation timeline was modelled for 127 'realisations', where each realisation represented a single model run from 2016 to 2035. The only variation between realisations was that each realisation modelled a different continuous historical rainfall pattern.

The 127 realisations were applied as the historical rainfall data extended from January 1889 to December 2015 (refer Section 4.4.1), which represents 127 years of complete rainfall data available. The 127 years of rainfall data provides 127 rainfall patterns as the seasonality in rainfall is maintained for each model run, e.g. the 1st January in the model was simulated with 1st January historical rainfall data. For each realisation, a continuous pattern of historical rainfall was applied over the simulation timeline. Where the end of the continuous historical rainfall record was reached in a realisation, the rainfall looped back to the start of the rainfall record.

The above repetition process provided 127 values for each simulated element in the model, for each day of the simulation timeline. Each extraction, discharge or transfer was then statistically assessed to provide estimates of the average, 10th percentile and 90th percentile annual totals for each year over the simulation timeline.

3.1.4 GoldSim representation

Existing operations

The water cycle for existing operations at Springvale Mine is represented in Figure 2-3. This was modelled in GoldSim with existing conditions based on site conditions in the year 2016.

To undertake the modelling, the following simplifications were incorporated:

- Transfer rates were modelled using daily time steps. In reality, transfer rates are determined during the day on an 'as needs basis' and may apply over periods smaller than a day.
- The rate of delivery of water to the administration and bathhouse buildings was input at constant rates. This was determined from average annual data obtained from Springvale Mine. In reality, the demand for water in the administration and bathhouse buildings varies daily.
- Operating rules/conditions were established within the model in accordance with advice from Springvale Mine.
- Rainfall and runoff are represented in daily time steps and therefore short duration, high intensity events are not accurately represented by the model. In reality, more overflows from the surface water storages may occur than represented by the water balance model.
- Several transfer rates were based on average pump rates and associated pumping data including:
  - Transfers from the Fire Dam to the Fire Service Pipeline.
  - Transfers from the Secondary Pond to the Renown Workings.
  - Transfers from the Renown Workings to the Fire Dam via the 24 Cut Through.
  - Dewatering of groundwater inflows into underground workings to the FBT Tank.

Proposed operations

<u>Springvale Mine</u>

The GoldSim water balance model developed for existing conditions was modified to represent the proposed conditions for the water cycle as a result of the Project. Amendments to the model to represent the proposed conditions were associated with:

- The management of the expected volume of mine water make due to extraction of the proposed workings.
- Increase in workforce from 310 to 450 full time equivalent positions.
- Increase in ROM coal production rate from 4.5 Mtpa to 5.5 Mtpa.

- Increase in the ROM coal stockpile area resulting in surface water runoff currently discharged to LDP001 being directed to the Primary Pond.

The predicted transfers for the water management system under proposed conditions are based on the predicted site conditions in 2021. This year was selected as it is when mine water make into the underground workings is predicted to peak and the water management system will be the most different compared to the existing conditions. The distribution of water over the Project life is also presented for critical elements of the Springvale Mine water management system.

Water Transfer Scheme

As the water budget of Angus Place Colliery, Springvale Mine and the SDWTS are interrelated, the transfer of mine water make into the SDWTS has been assessed collectively for Angus Place Colliery and Springvale Mine. The SDWTS was modelled from the present (2016) through to 2035. The critical point in time for the Project and the Angus Place Mine Extension Project (Golder Associates, 2014) in terms of water management is when the combined mine water make from both sites is greatest. Based on results by CSIRO (2015), the maximum mine water make from both sites is predicted to occur in 2030.

3.2 Salt balance

The salt balance was developed as an extension of the water balance model, with expected concentrations of salt applied to water inflows into the system. Transfers of the resulting salt loads were modelled throughout the site. The mass and concentration of salt within particular storages were established such that a mass balance was achieved after allowing for salt discharged via extraction and overflows.

Inflows of water into the system were assigned a specific concentration of salt depending on the source of water. Salt concentrations were based upon recorded water quality data and typical concentration values for similar sites, usually provided in units of µS/cm. A conversion factor of 0.67 was used to convert salinity data in µS/cm to mg/L as recommended by the Queensland Department of Natural Resources and Water (DNRW, 2007).

Salt transfers for both the existing and proposed scenarios were simulated in parallel with the water balance model. Extractions and overflows from each storage assumed instantaneous mixing.

Modifications for the proposed salt balance to represent proposed conditions were the same as the modifications for the water balance.

4. Data

4.1 Extent of water and salt balance model

The water and salt balance for the Project has been developed to assess the existing and proposed water management systems. The water and salt balance assessment includes the surface infrastructure and mining operations within the Project Application Area as well as the SDWTS, including transfers from Angus Place Colliery to the SDWTS.

4.2 Data sources

The sources of data for the water and salt balance are shown in Table 4-1.

Table 4-1 Data sources

Source	Data
Provided by Springvale Mine	Topographic information
	General operational data
	Water storage operation and management rules
	Surface storage capacities
	Maximum water transfer rates
	Potable water demand
	Crusher water demand
	Underground mining operations water demand
	Drainage infrastructure information
Derived from information provided by Springvale Mine	Areas of surface water storages
	Catchment areas
	Catchment types
	Site-specific salinity parameters
Provided by CSIRO (2015)	Groundwater inflows into underground workings of Angus Place Colliery and Springvale Mine
Queensland Department of Science, Information Technology and Innovation	Daily rainfall data
Bureau of Meteorology	Average monthly evaporation data
Queensland Department of Natural Resources and Water (DNRW, 2007)	Typical salinity parameters (where site-specific information was not available)

4.3 Site-specific data

4.3.1 General operational data

Operational data and site infrastructure information relating to water management at Springvale Mine was used to develop the water and salt balance model. This site-specific information was used as input to the model (i.e. modelling parameters) and is presented in Table 4-2. Water storage information is presented in Table 4-3.

Table 4-2 Model parameter data

Category	Parameter	Input
Mine operations	Hours of operation	Coal produced 24 hours per day, seven days per week
Administration and bathhouse buildings water	Potable water usage (administration building)	8,150 L/day
	Potable water usage (bathhouse)	79 L/day/person
Mining support operations	Dust suppression requirement	3.3 ML/year
	Capacity of SDWTS	30 ML/day
	Crusher water demand	42 L/t ROM coal
	Underground mining operations water demand	42 L/t ROM coal
Maximum pump rates	Fire Dam to Fire Service Pipeline	15 L/s
	Secondary Pond to Renown Workings	11 L/s
	Renown Workings to 24 Cut Through	8 L/s
	FBT Tank to 24 Cut Through	24 L/s
	FBT Tank to Ventilation Shaft No. 3 borehole	50 L/s
Salinity data	Electrical conductivity of rainfall	30 µS/cm
	Electrical conductivity of clean catchment runoff	70 µS/cm
	Electrical conductivity of coal-contact runoff	895 µS/cm
	Electrical conductivity of groundwater inflows into underground workings	1,135 µS/cm

Table 4-3 Surface water management structures

Storage	Capacity (ML)	Catchment area (ha)	Catchment type (%)	
			Pervious	Impervious
Duck Pond	2.0	4.9	89.6	10.4
Primary Pond	7.0	5.6 (existing) 5.9 (proposed)	0	100
Secondary Pond	7.0	2.8	25.7	74.3
Fire Dam	8.0	0.0	N/A	N/A
Grit Trap	N/A	6.0	78.6	21.4
Holding Dam	3.6	0.0	N/A	N/A
LDP001	N/A	86.3	100	0

Several activities associated with mining operations at the pit top draw water from the Fire Dam via off-take points on the Fire Service Pipeline. These include the crusher, underground workings, vehicle washdown, workshop and the water cart (when in use). The flow to each of these activities was modelled as an estimated proportion of the metered flow through the Fire Service Pipeline as follows:

- 40% to underground workings.
- 40% to crusher.
- Water cart as required (September to November 1 fill/day, December to February 2 fills/day, March to April 1 fill/day, May to August 0 fills/day).
- Remainder to vehicle washdown and workshop.

4.3.2 Groundwater inflows

Springvale Mine

Mine water make is a critical component of the water and salt balance at Springvale Mine. The groundwater inflows into the active underground workings provided by CSIRO (2015) and incorporated into the water and salt balance are provided in Figure 4-1.

As shown in Figure 4-1, current groundwater inflows into the mine are estimated at approximately 14 ML/day. Inflows into the mine are expected to peak in 2021 at approximately 19 ML/day.

For both existing and proposed conditions, the transfer of mine water make dewatered from the underground workings to the FBT Tank was assumed to be 74 L/s, with 50 L/s transferred to the Ventilation Shaft No. 3 Borehole and 24 L/s transferred to the 24 Cut Through, based on metered pump data from May 2012 to August 2013. It was assumed that the remaining mine water make was transferred to the SDWTS via the dewatering bores.

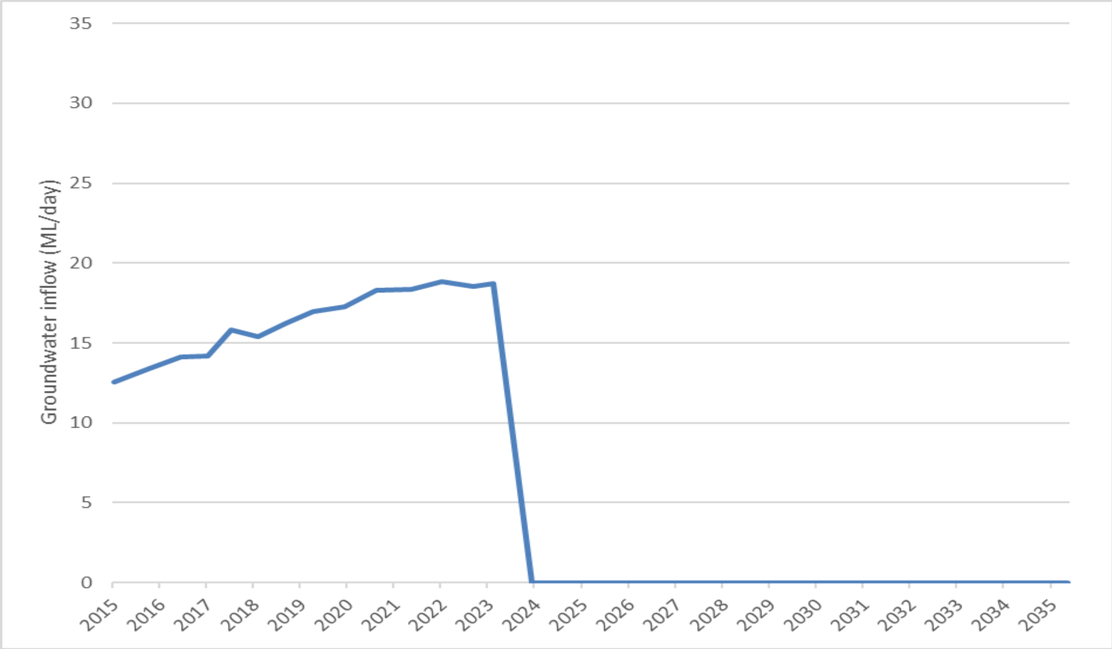


Figure 4-1 Predicted groundwater inflows into Springvale Mine underground workings (CSIRO, 2015)

Water Transfer Scheme

As detailed in Section 2.5.9, the water budgets of Angus Place Colliery, Springvale Mine and the SDWTS are interrelated through the capacity of the transfer scheme. The critical point in time for proposed conditions in terms of water management is when the combined groundwater inflow for both sites is the greatest. The combined groundwater inflow for both sites provided by CSIRO (2015) and incorporated into the water and salt balance is presented in Figure 4-2. The combined inflow into the underground workings of both Springvale Mine and Angus Place Colliery are predicted to peak in 2023 at approximately 25 ML/day, while overall peak is in 2030 at approximately 36 ML/day from Angus Place Colliery alone.

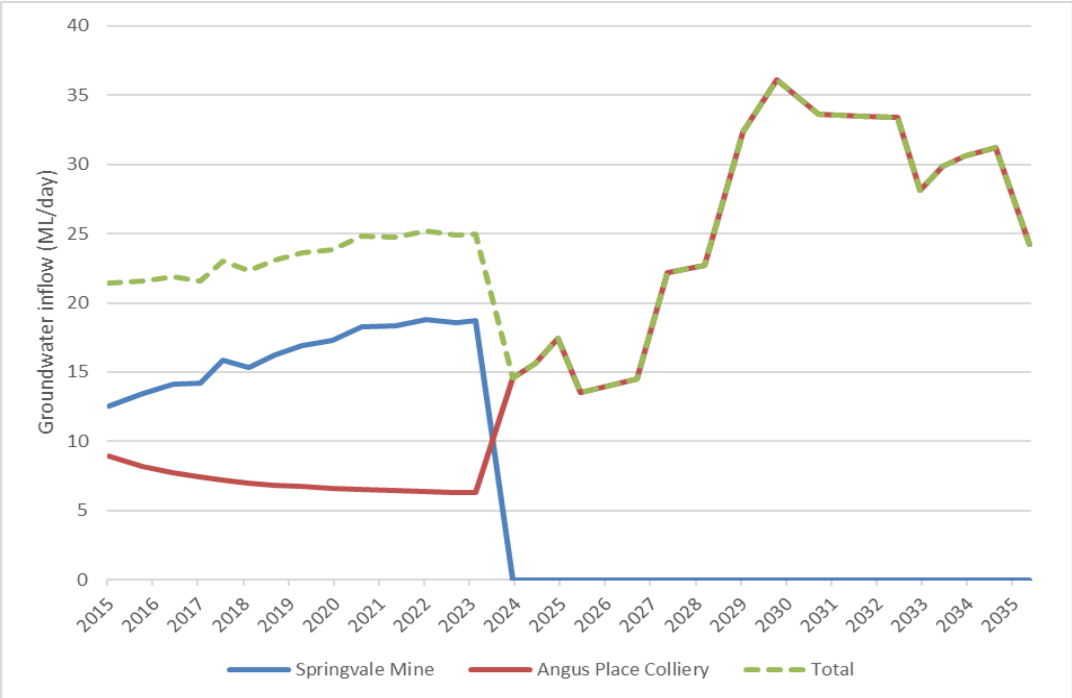


Figure 4-2 Combined predicted groundwater inflows into Angus Place Colliery and Springvale Mine (CSIRO, 2015)

4.4 Environmental data

4.4.1 Rainfall

For the purposes of the Water and Salt Balance Assessment, daily rainfall data was obtained from the Scientific Information for Land Owners (SILO) database operated by the Queensland Department of Science, Information Technology and Innovation. SILO patched point data is based on historical data from a particular Bureau of Meteorology (BOM) station with missing data ‘patched in’ with interpolations from nearby stations. For this assessment SILO data was obtained for BOM Lithgow (Birdwood St) Station (station number 63224) which is located approximately 9 km south-east of the Springvale Mine pit top.

Rainfall station selection process

A number of BOM stations were considered in the process of selecting a rainfall record for use within the water and salt balance model. A total of 13 BOM stations were identified within a 13 km radius of the pit top at Springvale Mine. Table 4-4 presents a summary of the stations identified, as well as other factors including distance from the pit top, elevation of the station and the length and completeness of the record.

The majority of the meteorological stations considered were determined to be inappropriate due to the short length of record, which would not be able to adequately represent the long-term wet and dry conditions of the site. Other sites were eliminated from consideration due to significantly varying elevations compared with the pit top at 910 m AHD and the potential for orographic influences on the rainfall record.

After consideration of the data presented in Table 4-4, the Lithgow (Birdwood St) station was determined to be the most appropriate station to obtain data for the water and salt balance model. This choice is justified due to a number of factors, including its location relatively close to the Project Application Area, similar elevation to the pit top and relatively long and complete record.

Annual rainfall

The period of data used in this assessment extended from January 1889 through to December 2015 and is provided in Figure 4-3.

The statistics for the rainfall data set for Lithgow (Birdwood St) station are:

- Minimum annual rainfall – 447 mm in 1944.
- Average annual rainfall – 862 mm.
- Median annual rainfall – 853 mm.
- Maximum annual rainfall – 1,683 mm in 1950.

Table 4-4 Rainfall station summary

Station	Station number	Distance from site (km)	Elevation (m AHD)	Length of record (years)	Completeness of record (%)
Lidsdale (Maddox Lane)	63132	3.3	890	56	100
Wallerawang Power Station	63176	3.7	875	18	25
Marrangaroo (Glenroy)	63051	5.4	921	24	65
Wallerawang (Thompsons Creek)	63133	6.7	914	12	95
Lidsdale State Forest	63046	7.4	975	40	99
Lithgow (Cooerwull)	63226	8.4	905	97	70
Rydal	63196	9.1	Unknown	22	88
Angus Place (Wolgan Gap)	63131	9.63	945	23	88
Lithgow (Birdwood St)	63224	10.5	950	92	78
Methven	63052	10.7	Unknown	63	94
Portland (Jamieson St)	63071	12.0	925	64	66
South Bowenfels	63144	12.8	920	21	98
Lithgow (Newnes State Forest)	63062	12.83	1,050	60	95

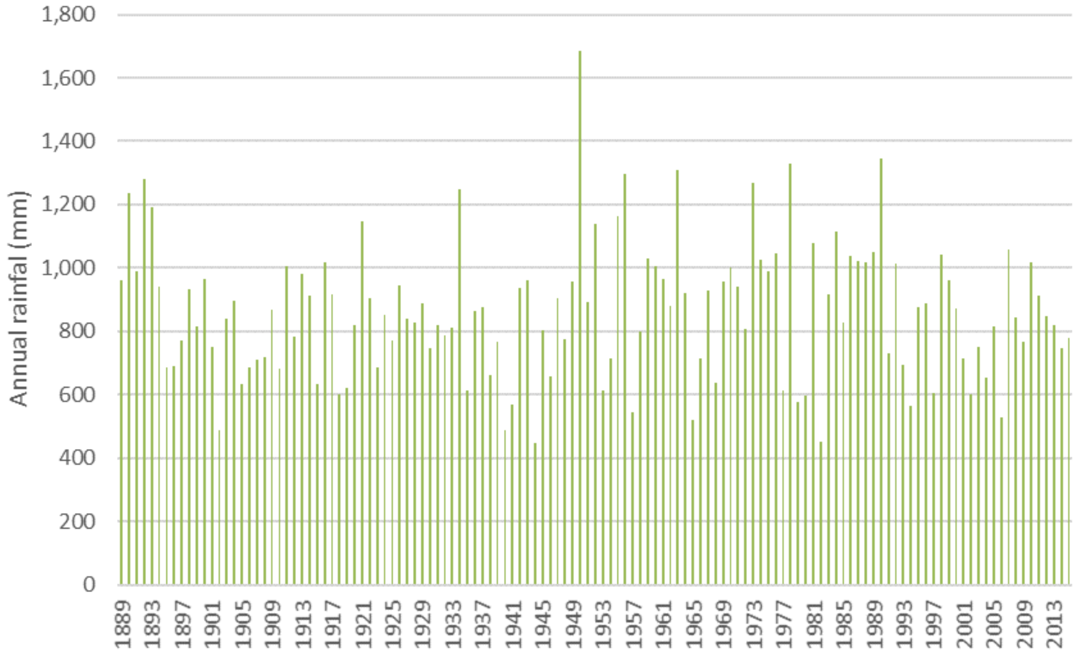


Figure 4-3 Annual rainfall recorded at Lithgow (Birdwood St) station

Monthly rainfall

The monthly rainfall statistics were also determined for the period of record from the Lithgow (Birdwood St) station and are provided in Figure 4-4. The average monthly rainfall was observed to vary from a low of approximately 57 mm in September to a high of approximately 93 mm in January. Figure 4-4 shows a significant variation in the maximum recorded monthly rainfall with the maximum monthly value being approximately 374 mm in August and the lowest monthly value being approximately 196 mm in September. The minimum monthly rainfalls are less than 10 mm for all months.

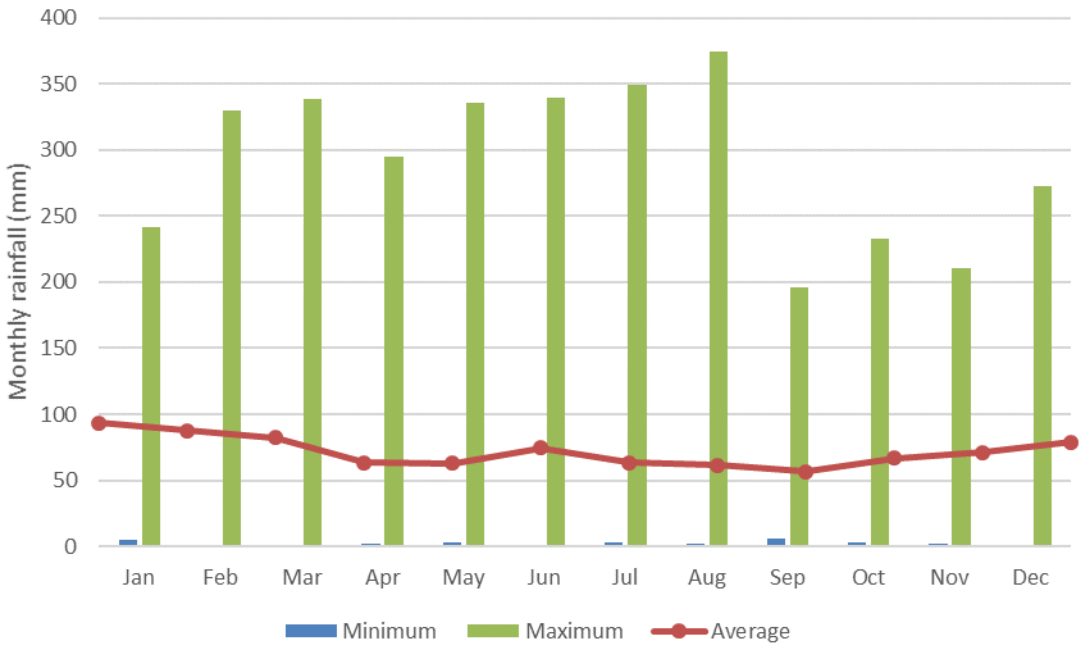


Figure 4-4 Monthly rainfall statistics for Lithgow (Birdwood St) station

Daily rainfall

An analysis of the rainfall data was undertaken to enable an understanding of the likely rainfall patterns at the site. For various intervals of daily rainfall, the average number of days per year which have rainfall within each interval are presented in Figure 4-5, with non-rainfall days (less than 0.1 mm) excluded. The figure also presents the cumulative days per year as a percentage against the same rainfall intervals. The average number of non-rainfall days (less than 0.1 mm) per year is approximately 231, which is approximately 63% of days in a year.

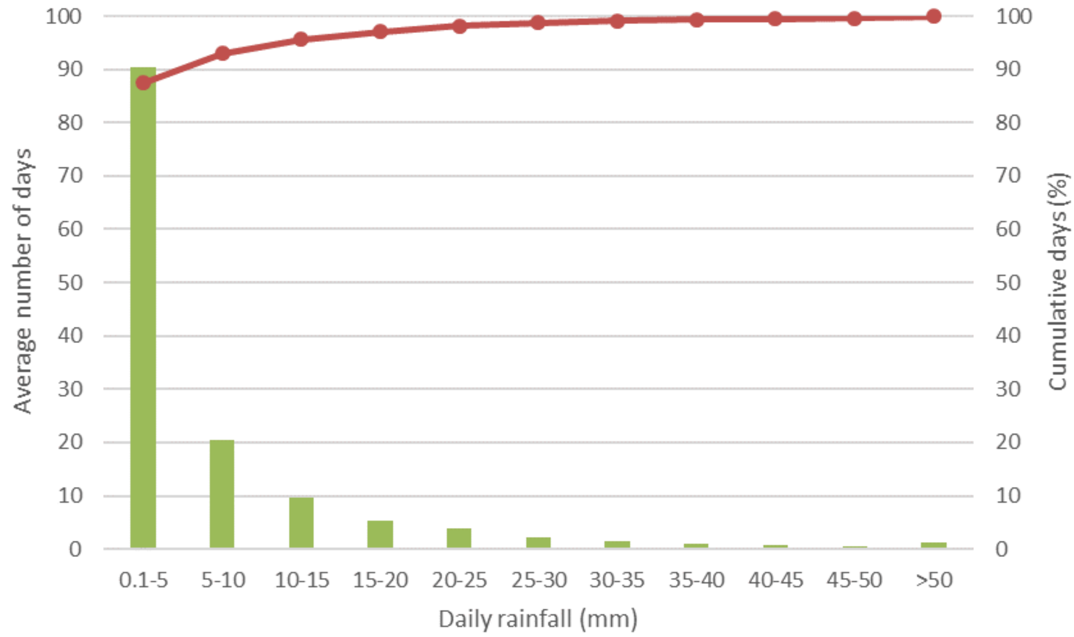


Figure 4-5 Number of rain days of various magnitudes for Lithgow (Birdwood St) station

Comparison of BOM and SILO data

A comparison of average monthly rainfall recorded by the BOM for the Lithgow (Birdwood St) station and the corresponding SILO patched point data is presented in Figure 4-6. The figure indicates that the interpolated SILO data reasonably represents the rainfall recorded by the BOM at the Lithgow (Birdwood St) station. The localised dataset was found to vary slightly, however indicates similar trends.

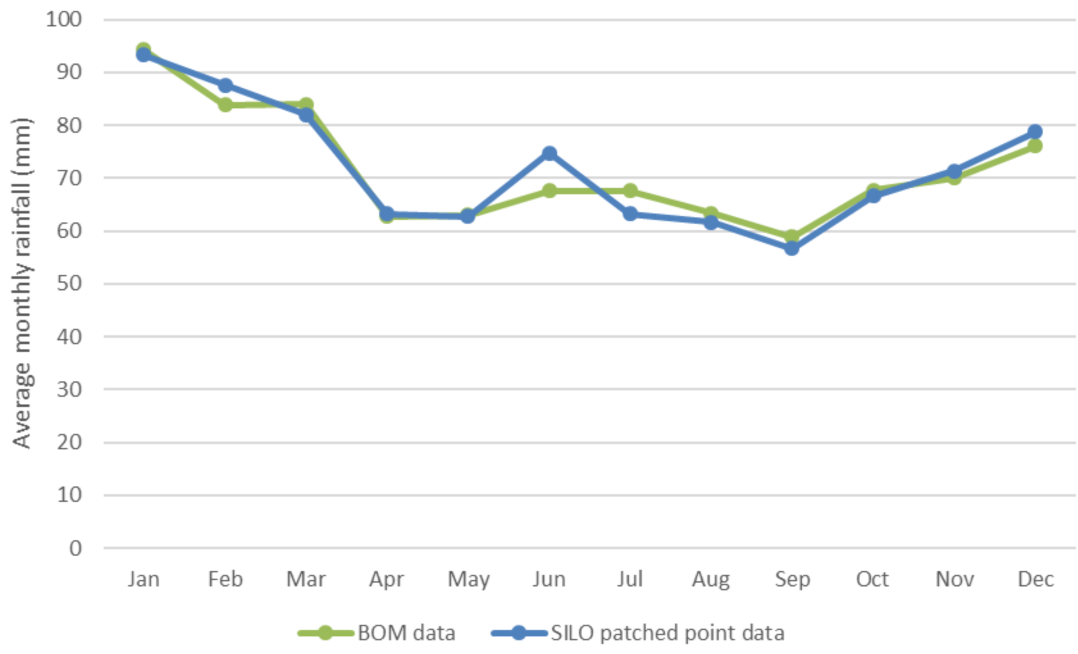


Figure 4-6 Comparison of BOM and SILO data for Lithgow (Birdwood St) station

4.4.2 Evaporation

Information provided at the closest BOM station which records evaporation, Bathurst Agricultural Station (station number 63005), was reviewed and average monthly evaporation rates were determined for input into the water and salt balance. The average daily evaporation rates adopted for the water and salt balance are presented in Figure 4-7.

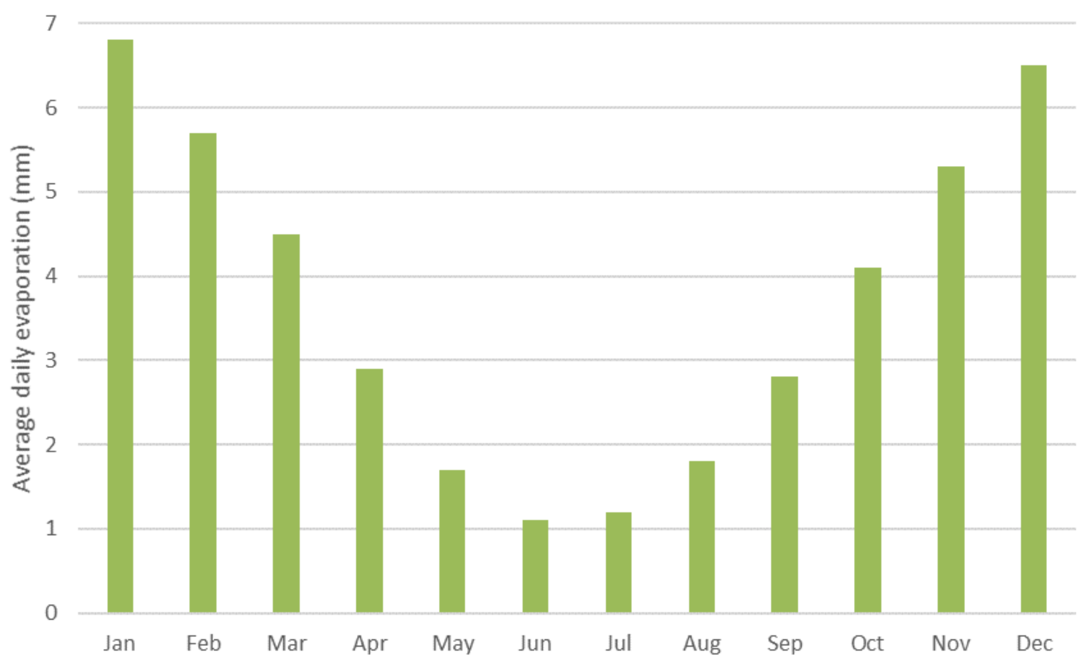


Figure 4-7 Average daily evaporation from Bathurst Agricultural station

A pan factor of 0.9 was adopted to the daily evaporation rates to simulate the evaporation of water from surface water storages. Evapotranspiration factors were applied in the hydrologic model to simulate evapotranspiration losses from catchments.

4.5 Hydrological model data

The relevant site catchments were divided into two areas representing bushland/vegetation and impervious areas. The two areas were modelled with a different set of AWBM parameters. The AWBM parameters adopted for the water and salt balance model are presented in Table 4-5. The runoff for each relevant catchment was then calculated by scaling the runoff depth to reflect the sub catchment impervious and pervious areas.

The parameters for bushland/vegetated areas were determined based on available literature where historical streamflow data had been used to provide recommendations on parameter selection. The nearest location for which AWBM model parameters had been determined by Boughton and Chiew (2003) was Coxs River, located approximately 2 km north-west of the Springvale Mine pit top. The recommended parameters relating to baseflow were adjusted to reflect the ephemeral nature of drainage lines adjacent to the sites.

The impervious areas were modelled without infiltration into the soil and without surface storage or baseflow storage. Only one storage was assigned a non-zero capacity. This storage represents depression storage of 7 mm for impervious areas. The baseflow parameters were adjusted to reflect no baseflow as the relevant site catchments are not typically large enough to generate baseflow.

The runoff parameters adopted were considered reasonable given the lack of site-specific flow gauging data and significant variability in catchment runoff characteristics that can occur.

Table 4-5 Australian Water Balance Model parameters adopted

Parameter	Bushland/vegetation areas	Impervious areas
A_1, A_2, A_3	0.134, 0.433, 0.433	1.0, 0.0, 0.0
C_1, C_2, C_3	8.1, 82.3, 164.6	7.0, 0., 0.
BFI	0.0	0.0
Excess	Calculated	Calculated
SS	(1-BFI) x Excess	(1-BFI) x Excess
BS	BFI x Excess	BFI x Excess
Kb	NA	NA
Ks	0.5	0.0

5. Modelling results

5.1 Model verification

Outputs of the model were compared to available monitored data supplied by Springvale Mine to provide an indication of the validity of the representation of existing conditions in the water and salt balance model. Daily metered pumping rates and recorded discharges through LDP001 were compared to modelled transfers in order to assist in the calibration of the water balance model.

Discharges through LDP001 and transfers to the SDWTS and the Fire Service Pipeline were found to be comparable to recorded data across the site. It is considered likely that slight discrepancies between the modelled and recorded transfers are a result of the adoption of constant transfer rates contributing to the FBT Tank and Fire Service Pipeline, as provided by Springvale Mine based on pump capacities and site observations. In reality, these transfer rates would vary based on operational requirements.

Salt outputs from the salt balance model were comparable to recorded water quality monitoring data across the site, including data for clean water catchments and mine water transfers.

It is recommended that LDP001 and LDP009 discharges and underground transfers continue to be recorded and the model verified further when additional data is available as the Project progresses.

5.2 Interpretation of results

5.2.1 Water balance

The water management system for Springvale Mine was modelled from 2016 through 2035. This timeline was simulated using a historical time series of daily rainfall data extending over 127 years. A total of 127 simulations were applied to this timeline with each simulation modelling a different rainfall pattern (refer Section 3.1.2). As a result, for each year in the timeline 127 annual totals were available for each transfer element within the water management system, thereby representing a wide range of possible rainfall conditions.

The results presented in Section 5.3 show the average annual water transfer volumes (along with 10th percentile and 90th percentile values) for the water management elements at Springvale Mine for both existing and proposed conditions. The purpose of displaying the three results for each element is to show an average annual volume as well as an indication of the possible range of volumes.

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 percentile and 90th percentile values have been used (rather than absolute minimum and maximum values) to remove the impact of skewing by infrequent to extreme wet and dry conditions.

5.2.2 Salt balance

Similar to the water balance, the salt modelling provided 127 possible annual totals of salt transfers for each transfer element. The results presented in Section 5.3 show the average annual salt transfer volumes (along with 10th percentile and 90th percentile values) for the water management elements at Springvale Mine for both existing and proposed conditions. In addition to the salt transfer quantities, the average electrical conductivity of each transfer is also presented.

5.3 Springvale Mine water management system results

5.3.1 Water balance results

The predicted values for existing and proposed conditions for each of the water transfers associated with Springvale Mine are provided in Figure 5-1 and Figure 5-2 respectively. As discussed in Section 5.2.1, the results present the average annual transfers between the water management elements of the site as well as an indication of the range of values expected due to possible variations in rainfall.

The results presented for the proposed conditions are based on the predicted site conditions in 2021. This year was selected as it is when mine water make into the underground workings at Springvale Mine are predicted to peak and the water management system will be the most different compared to the existing conditions.

It should be noted that mine water make into the underground workings are predicted to vary over time, in accordance with projected mine water make shown in Figure 4-1.

A summary of the average inputs and outputs of the Springvale Mine water management system for the existing (2016) and proposed (2021) conditions is presented in Table 5-1.

Table 5-1 Summary of average predicted water inputs and outputs

	Existing conditions (2016) (ML/year)	Proposed conditions (2021) (ML/year)
INPUTS		
Direct rainfall onto storages and catchment runoff	172.4	172.6
External potable water and bottled water supply	13.3	16.0
Groundwater inflows into underground workings	5,121.0	6,728.1
TOTAL INPUTS	**5,307**	**6,917**
OUTPUTS		
Evaporation	13.0	13.1
Dust suppression	3.6	3.6
Discharge through LDP001	641.1	589.2
Discharge through LDP002	0.0	0.0
Discharge through LDP004/LDP005	0.0	0.0
Transfer to SDWTS	4,551.4	6,202.0
Removal of grit off-site	0.1	0.1
Inflow into Renown Workings	83.9	92.7

	Existing conditions (2016) (ML/year)	Proposed conditions (2021) (ML/year)
Sewage to Lithgow City Council system	13.3	16.0
TOTAL OUTPUTS	**5,306**	**6,917**
CHANGE IN STORAGE		
Surface water storages	0.3	0.0
Underground storages	0.0	0.0
TOTAL CHANGE IN STORAGE	**0**	**0**
BALANCE		
Inputs – outputs – change in storage	1	0

As seen in Table 5-1, the largest source of water into the Springvale Mine water management system is the inflow of groundwater into the underground workings. Under existing conditions in 2016, the predicted groundwater make is 5,121 ML. The greatest change to the system is the predicted increase in groundwater make, which is estimated to increase by approximately 1,607 ML to a total of 6,728 ML in 2021.

For the proposed scenario in 2021, the results indicate a slight increase in rainfall and runoff collected by surface water storages. This is due to the increase in the ROM coal stockpile area, with runoff discharged to LDP001 under existing conditions directed to the Primary Pond under proposed conditions. Slightly more runoff is generated under proposed conditions due to the impervious nature of the ROM coal stockpile area.

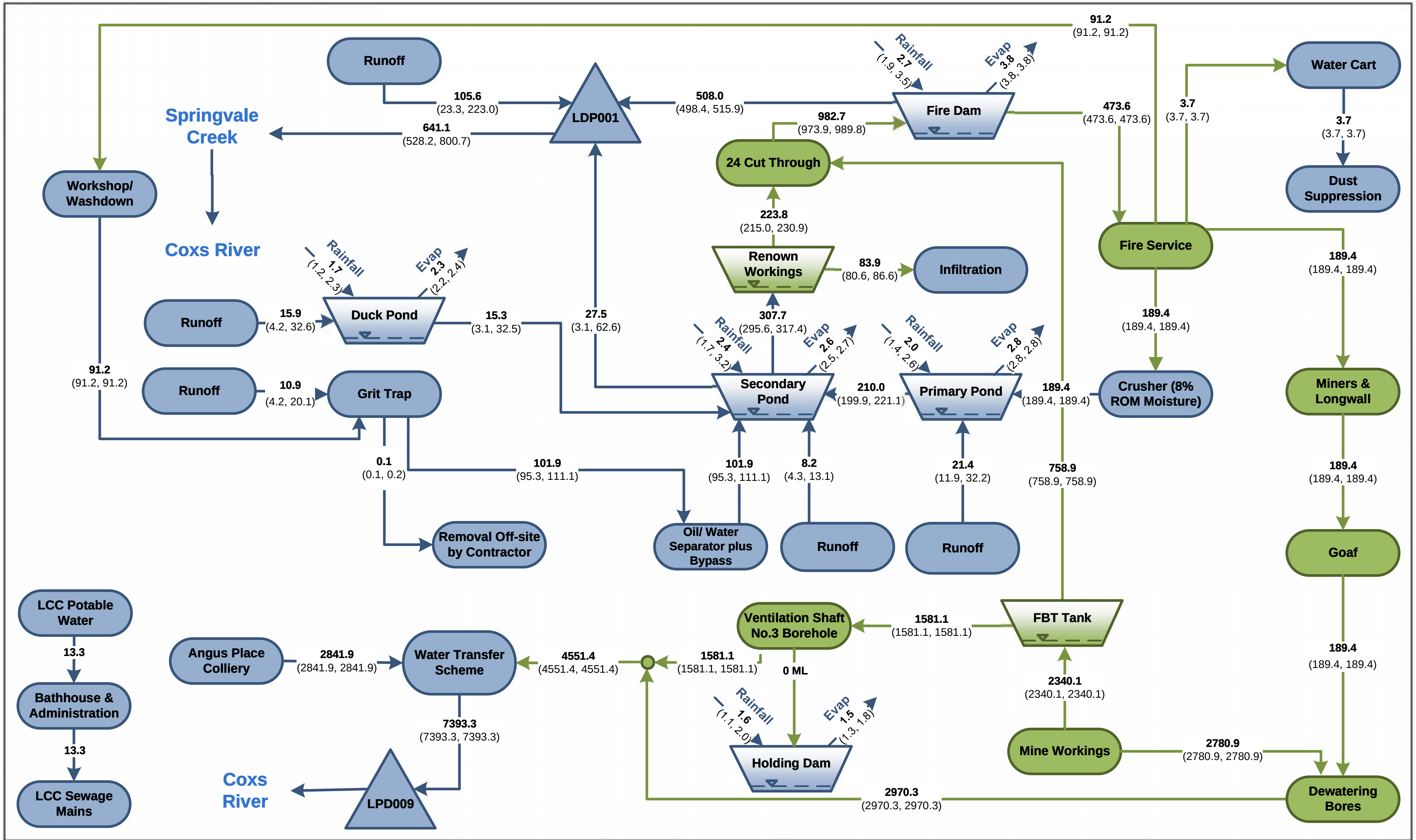
Under existing conditions at Springvale Mine in 2016, the predicted average annual discharges from Springvale Mine in 2016 are 4,551 ML (average 12.4 ML/day) to the SDWTS for discharge through LDP009 and 641 ML (average 1.8 ML/day) through LDP001.

For the proposed conditions, through LDP001 are predicted to decrease by approximately 52 ML (average 0.1 ML/day) under proposed conditions, due to the increased demand for process water that is predicted to occur with the increase in ROM coal rate. Transfers to the SDWTS are predicted to increase by 1,651 ML to a total of 6,202 ML (average 17.0 ML/day), due to the increase in groundwater make at Springvale Mine under proposed conditions.

For the potable water management systems, under existing conditions approximately 13.3 ML/year is expected to be sourced from the Lithgow City Council potable water system, with all wastewater disposed of through the Lithgow City Council sewage system. An increase in site personnel under proposed conditions is expected to result in a slight increase in potable water supply and sewage.

The majority of in situ moisture associated with the extracted coal is expected to be lost from the system through evaporation and infiltration in the stockpiles, with the remainder transported off-site associated with product coal. Therefore, the in situ moisture associated with extracted coal does not impact significantly on other elements of the water management system.

The results of the water balance indicate that Springvale Mine has a surplus of water under both existing and proposed conditions. As mine water is used to supply water to mining associated activities, extended periods of low rainfall are not likely to affect the availability of water to supply mining operations.



LEGEND

Surface Water Transfer

Underground Water Transfer

Storage

XXML (XX-XX) — Mean ML/y; 10th, 90th Percentile ML/y

LOCATION	Springvale
SEAM	Lithgow
DRAWN	SM
CHECKED	TD
APPROVED	LH
SCALE	NTS

Springvale Mine Modification 1 Project
Water and Salt Balance Assessment

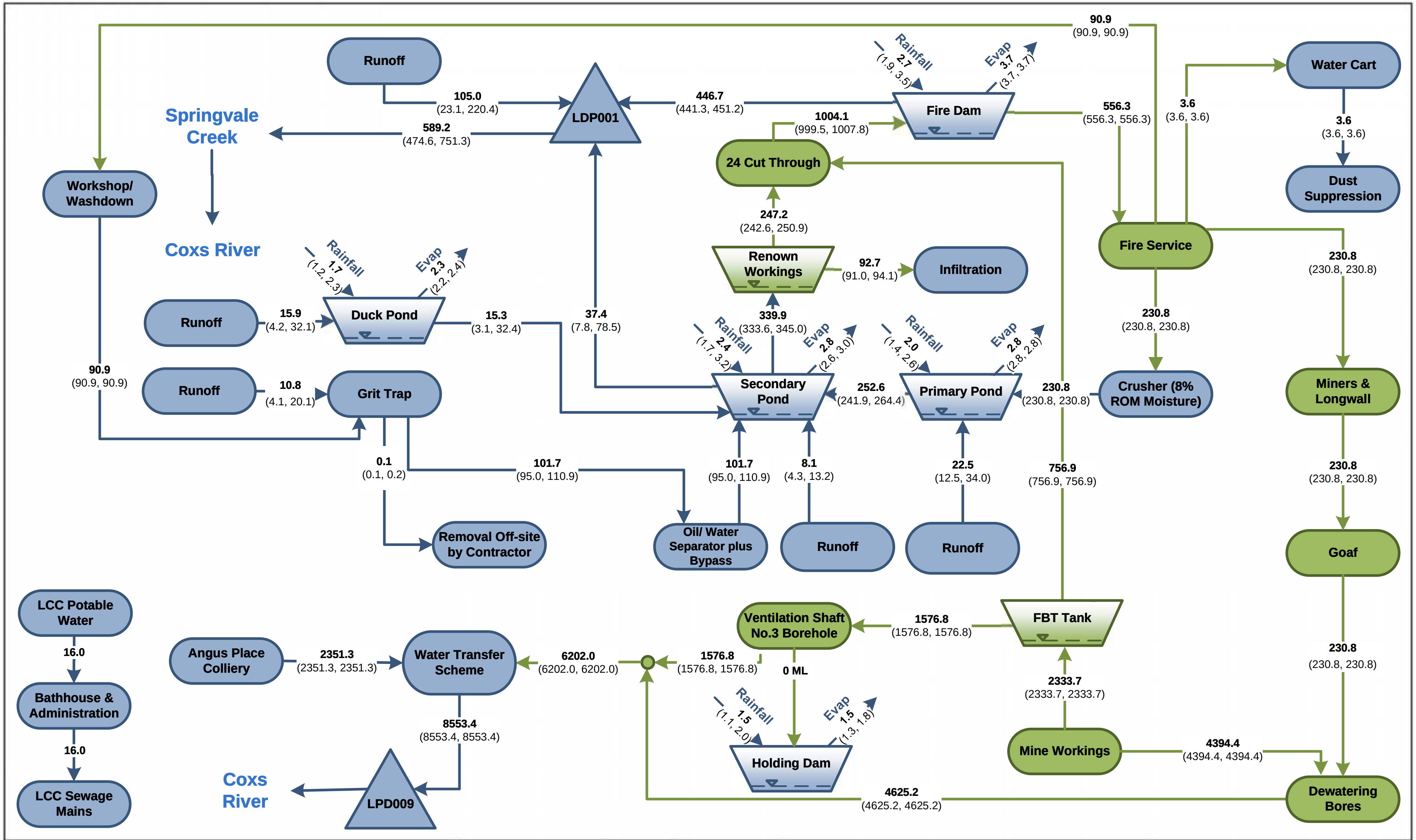
Annual water transfers
Existing conditions (2016)

Centennial Springvale

DATE Apr 2016

Figure 5-1

G:\22\18141\Visio\2218141_SV_FIG5-X_Springvale Water Transfer Schematic.vsd



LEGEND

Surface Water Transfer

Underground Water Transfer

Storage

XXML (XX-XX) Mean ML/y 10th, 90th Percentile ML/y

LOCATION	Springvale
SEAM	Lithgow
DRAWN	SM
CHECKED	TD
APPROVED	LH
SCALE	NTS

Springvale Mine Modification 1 Project
Water and Salt Balance Assessment

Annual water transfers
Proposed conditions (2021)

Centennial Springvale

DATE Apr 2016

Figure 5-2

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Predicted LDP001 Discharges

Figure 5-3 presents the time series of predicted annual discharges through LDP001.

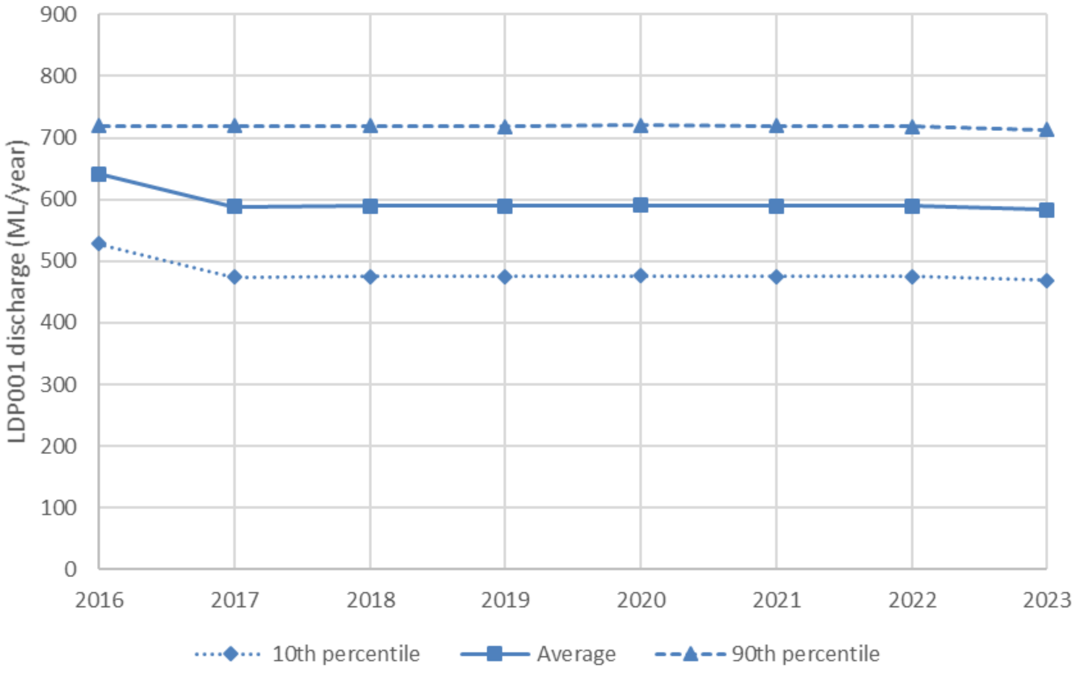


Figure 5-3 Predicted annual LDP001 discharges

The average annual discharge under existing conditions was predicted to be approximately 641 ML/year (average 1.8 ML/day) and is expected to decrease to approximately 590 ML/year (average 1.6 ML/day) as a result of the Project. This is due to the increased demand for process water as a result of the increased ROM coal production rate.

The time series of predicted daily LDP001 discharges is presented in Appendix B. A seasonal pattern can be seen in the daily time series of discharges, corresponding to the pattern found in the rainfall and evaporation data, as discussed in Section 4.4.

The percentiles of the range of daily flow rates predicted to pass through LDP001 under existing and proposed conditions are presented in Figure 5-4. For clarity, the results are shown on a single graph with logarithmic y-axis scale and the 10 ML/day volumetric limit imposed on LDP001 by EPL 3607.

The results indicate that the EPL discharge limit of 10 ML/day is not exceeded for over 99% of days for both existing and proposed conditions. Discharges through LDP001 of approximately 1.4 ML/day under existing conditions and 1.2 ML/day under proposed conditions, consisting predominantly of mine water make, were modelled for over 80% of days. Discharges over this volume are attributable to the variation in runoff from catchments contributing to LDP001 and the Secondary Pond due to the wide range of possible rainfall conditions modelled.

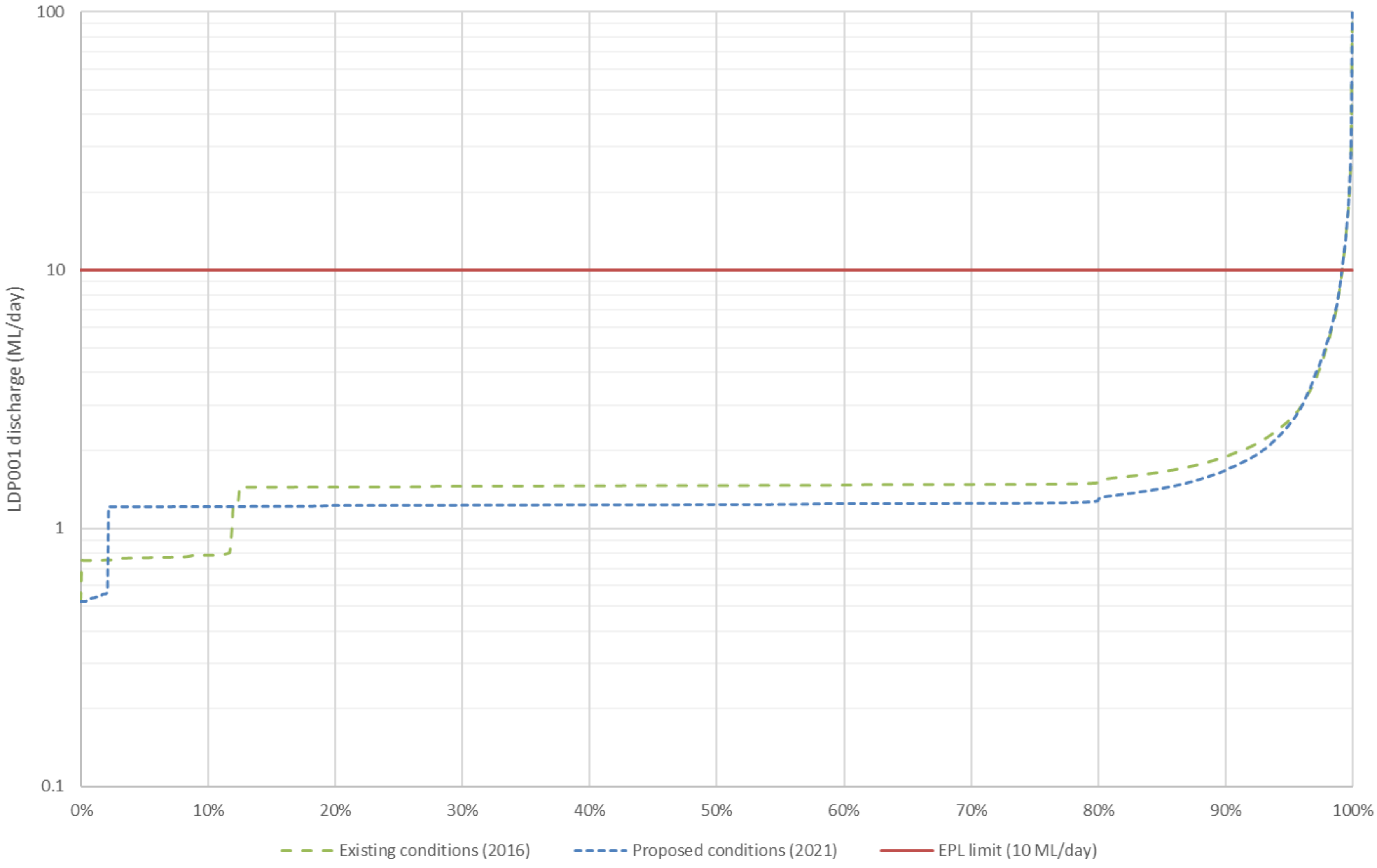


Figure 5-4 LDP001 daily flow percentiles

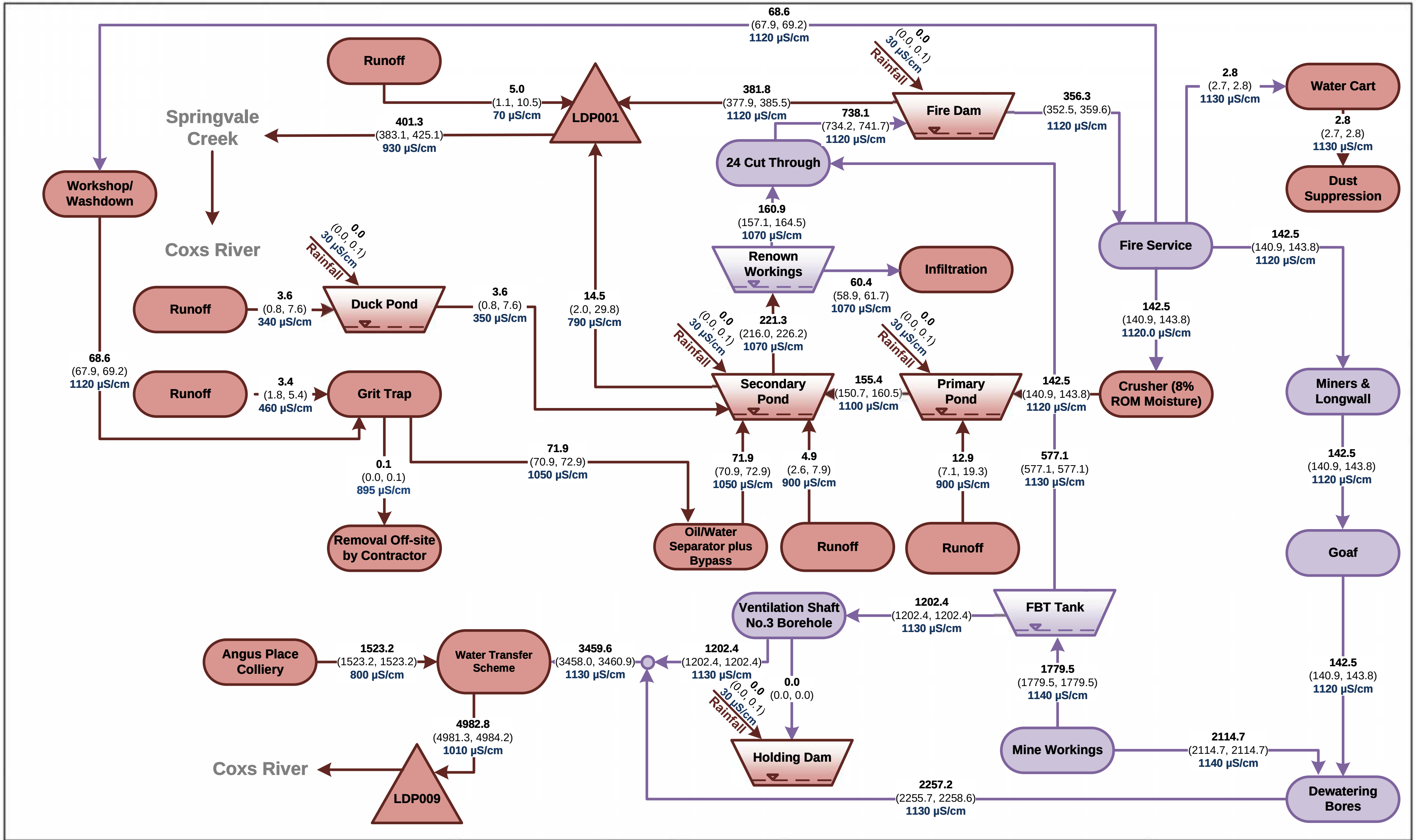
5.3.2 Salt balance results

The predicted values for existing and proposed conditions for each of the salt transfers associated with Springvale Mine are provided in Figure 5-5 and Figure 5-6 respectively. As discussed in Section 5.2.2, the results present the average annual transfers between the water management elements of the site as well as an indication of the range of values expected due to possible variations in rainfall. In addition to the salt transfer quantities, the predicted average salt concentration is also displayed on the figures.

A summary of the average inputs and outputs of the Springvale Mine water management system for the existing (2016) and proposed (2021) conditions is presented in Table 5-2.

Table 5-2 Summary of average predicted salt inputs and outputs

	Existing conditions (2016) (t/year)	Proposed conditions (2021) (t/year)
INPUTS		
Direct rainfall onto storages and catchment runoff	29.8	30.2
Groundwater inflows into underground workings	3,894.2	5,116.3
TOTAL INPUTS	**3,924**	**5,147**
OUTPUTS		
Dust suppression	2.7	2.7
Discharge through LDP001	401.3	362.1
Discharge through LDP002	0.0	0.0
Discharge through LDP004/LDP005	0.0	0.0
Transfer to SDWTS	3,459.6	4,714.6
Removal of grit off-site	0.1	0.1
Infiltration into Renown Workings	60.4	67.3
TOTAL OUTPUTS	**3,624**	**5,147**
CHANGE IN STORAGE		
Surface water storages	-0.1	-0.3
Underground storages	0.0	0.0
TOTAL CHANGE IN STORAGE	**0**	**0**
BALANCE		
Inputs – outputs – change in storage	0	0



GHD

LEGEND

→	Surface Salt Transfer	XX	Mean (t/y)
→	Underground Salt Transfer	(XX-XX)	10th, 90th Percentile (t/y)
	Storage	XXµS/cm	Mean Salinity

LOCATION	Springvale
SEAM	Lithgow
DRAWN	SM
CHECKED	TD
APPROVED	LH
SCALE	NTS

Springvale Mine Modification 1 Project
Water and Salt Balance Assessment

Annual salt transfers
Existing conditions (2016)

Centennial Springvale

DATE Apr 2016

Figure 5-5

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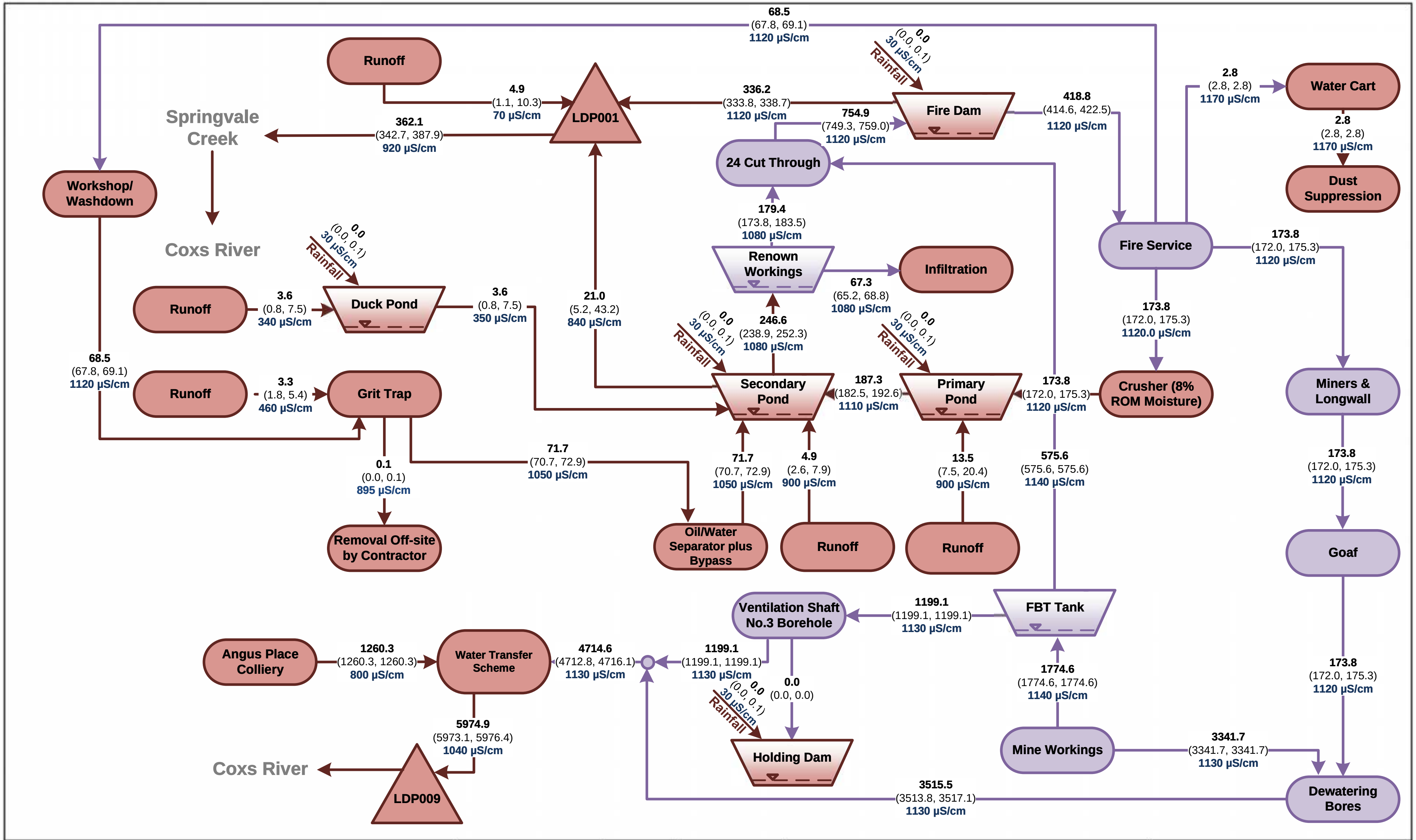

LEGEND

Surface Salt Transfer

Underground Salt Transfer

Storage

XX Mean (t/y)

(XX-XX) 10th, 90th Percentile (t/y)

XXµS/cm Mean Salinity

LOCATION	Springvale
SEAM	Lithgow
DRAWN	SM
CHECKED	TD
APPROVED	LH
SCALE	NTS

Springvale Mine Modification 1 Project
Water and Salt Balance Assessment

Annual salt transfers
Proposed conditions (2021)

Centennial Springvale

DATE Apr 2016

Figure 5-6

G:\22\18141\Visio\2218141_SV_FIG5-X_Springvale Salt Transfer Schematic.vsd

As seen in Table 5-2, the largest source of salt into the Springvale Mine water management system is the inflow of groundwater into the underground workings. The predicted annual salt mass associated with mine water make under existing conditions in 2016 is 3,894 tonnes. The greatest change to the system under proposed conditions in 2021 is the increase in salt associated with groundwater make, which is estimated to increase by approximately 1,222 tonnes of salt to 5,116 tonnes.

Under existing conditions, the predicted average annual mass of salt discharged from Springvale Mine in 2016 is 3,460 tonnes (average 9.5 t/day) at a concentration of 1,130 µS/cm to the SDWTS and 401 tonnes (average 1.1 t/day) at a concentration of 930 µS/cm through LDP001.

For the proposed conditions at Springvale Mine in 2021, the predicted annual salt mass discharged from LDP001 is 362 tonnes (average 1.0 t/day), representing a decrease of 39 tonnes of salt from existing conditions. Salt transfers to the SDWTS are predicted to increase to 4,715 tonnes (average 12.9 t/day) at a concentration if 1,130 µS/cm.

Predicted LDP001 discharges

Figure 5-7 presents the time series of the predicted electrical conductivity of discharges through LDP001.

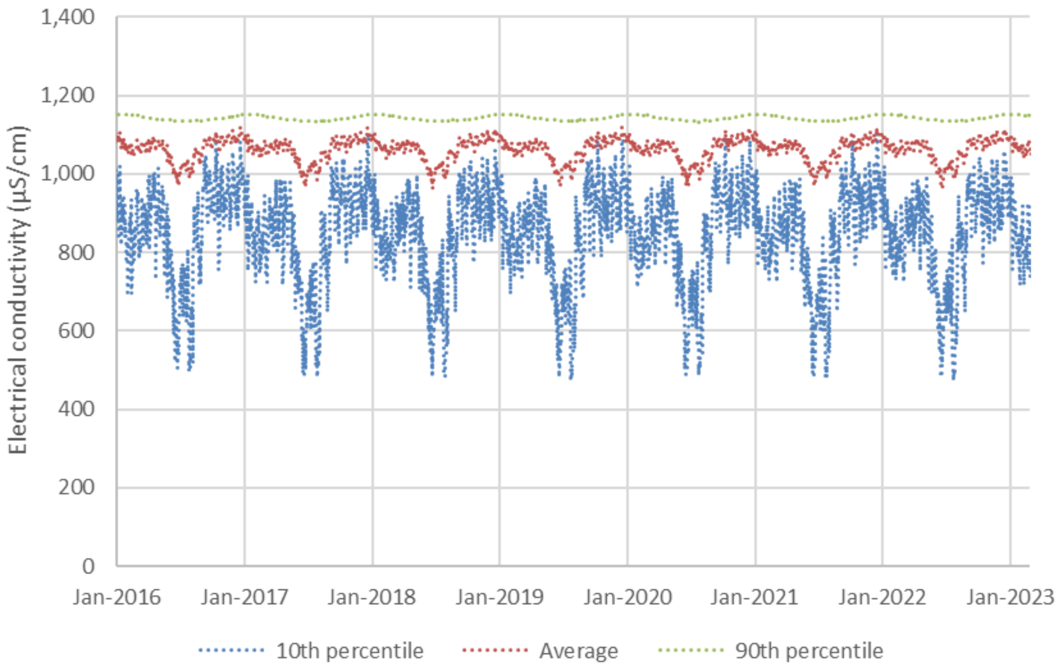

Figure 5-7 Predicted annual electrical conductivity of LDP001 discharges

The average electrical conductivity of discharges under existing conditions was predicted to be approximately 1,020 µS/cm. The bulk of water passing through LDP001 is expected to be comprised of mine water make passed through the Fire Dam. Discharges of salt are diluted with runoff from the upstream catchment and overflows from the Secondary Pond under high rainfall conditions. A seasonal pattern in salinity is also present in Figure 5-7, corresponding to the pattern found in rainfall and evaporation data, as discussed in Section 4.4.

5.4 Water Transfer Scheme results

The total transfer rate of water to the SDWTS from both Angus Place Colliery and Springvale Mine is dependent on the management of mine water make at both sites. From the SDWTS, water is discharged through LDP009 at Springvale Mine into the Coxs River. Figure 5-8 presents the predicted average annual transfers from Angus Place Colliery and Springvale Mine to the SDWTS and combined total. It should be noted that the values presented in Figure 5-8 have been annualised for each calendar year. Predicted instantaneous transfer rates vary from the annual totals in the results presented. The predicted instantaneous transfer rates are provided in Appendix B.

The critical point in time for the Project and the Angus Place Mine Extension Project (Golder Associates, 2014) in terms of water management is when the combined mine water make from both sites is greatest. Based on the results by CSIRO (2015), the maximum total mine water make is predicted to occur in 2030, as presented in Section 2.5.9.

5.4.1 Springvale Mine contribution

Approximately 983 ML/year under existing conditions and 1,004 ML/year under proposed conditions is transferred to the Fire Dam via the 24 Cut Through for use as process water. The remaining mine water make is transferred to the SDWTS, predicted to be an average of 4,551 ML (average 12.4 ML/day) under existing conditions in 2016 and nil transfer under proposed conditions in 2030.

5.4.2 Angus Place Colliery contribution

The remaining capacity of the SDWTS is supplied by mine water make from Angus Place Colliery. An average of approximately 2,842 ML (7.8 ML/day) of mine water make is predicted to be transferred from Angus Place Colliery to the SDWTS in 2016 under existing conditions. Under proposed conditions in 2030 the transfer of mine water make from Angus Place Colliery to the SDWTS is expected to be approximately 12,591 ML (average 34.5 ML/day).

5.4.3 Total transfers to Water Transfer Scheme

A summary of the modelled average annual transfers from Angus Place Colliery and Springvale Mine to the SDWTS, as well as the total transfers to the SDWTS, under existing and proposed conditions is presented in Table 5-3.

Table 5-3 Summary of average annual transfers to SDWTS

Component	Existing conditions (2016)	Proposed conditions (2030)
Transfer from Springvale Mine	4,551 ML	0 ML
Transfer from Angus Place Colliery	2,842 ML	12,591 ML
Total transfer to SDWTS	7,393 ML	12,591 ML*

* As predicted dewatering is predicted to exceed 30 ML/day, the maximum transfer of water to the SDWTS will be subject to a modification. This will occur as part of recommencement of mining at Angus Place Colliery.

Under existing conditions in 2016, the total transfer from both Angus Place Colliery and Springvale Mine to the SDWTS is predicted to be approximately 7,393 ML (average 20.2 ML/day).

Figure 5-8 Predicted average annual transfers to the SDWTS

Under proposed conditions, the predicted transfer from Angus Place Colliery reaches a maximum of 12,591 ML in 2030. The daily transfers are likely to exceed the capacity of the SDWTS of 30 ML/day during this period. This dewatering limit will require a modification to increase the capacity of the SDWTS. The modification will be undertaken as part of recommencement of mining at Angus Place Colliery.

5.4.4 Predicted salt transfers

Figure 5-9 presents the predicted average electrical conductivity of transfers from Angus Place Colliery and Springvale Mine to the SDWTS and combined total transfer.

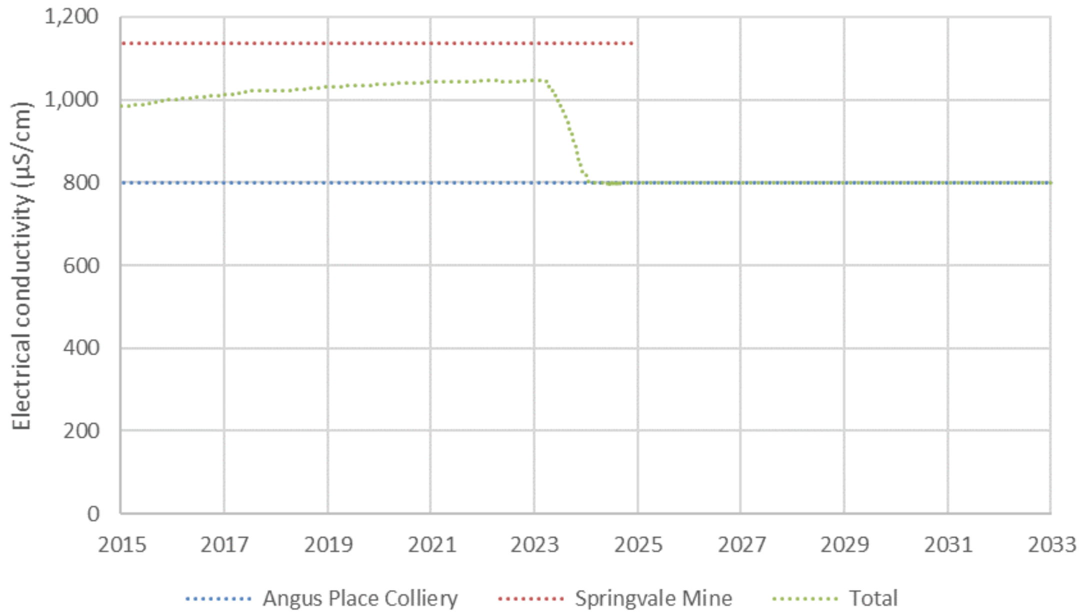

Figure 5-9 Predicted average annual electrical conductivity of transfers to the SDWTS

An average electrical conductivity of approximately 1,130 µS/cm is expected for mine water make transferred from Springvale Mine and approximately 800 µS/cm for transfers from Angus Place Colliery to the SDWTS. The electrical conductivity of total transfers to the SDWTS varies over time with the contribution of mine water make from each site to the SDWTS.

5.5 Qualifications on predictions

GHD has developed the water and salt balance model for the Project based on information provided by Springvale Mine and external data sources. Where data was not available, GHD has made assumptions as appropriate.

Data used to develop the model are categorised as follows:

- Relatively reliable data:
  - SILO rainfall data.
  - BOM evaporation data.
  - Surface catchment areas based on topographic maps.
  - Annual potable water demands.
  - Metered pumping data for water transfers.
- Less reliable data:
  - Storage capacities for storages that have not been surveyed.

– Site infiltration rates for impervious and natural catchments.
– Estimates of future rates of mine water make.

The consequences of the items listed within the ‘less reliable data’ category is there is likely to be a risk that the model predictions are somewhat inaccurate. It is envisaged at this time that the model predictions above should be considered to have an accuracy of ±50%. The accuracy is expected to improve when more site data is gathered during the life of the Project. This additional data will allow refinement of the model input and hence increase the reliability of the model predictions.

It should also be noted that the adoption of historical rainfall and evaporation data within the detailed water and salt balance model does not include the potential impacts of climate change.

It should also be noted that the water and salt balance model is sensitive to the coal moisture modelling parameters for the in situ coal, ROM coal and product coal. The modelling parameters used in the model were based on the information provided by Springvale Mine and are the best available predictions at the time this assessment was undertaken. The outcomes of this assessment are reliant on this information. If more suitable predictions for the key modelling assumptions become available, GHD recommend a modelling update be undertaken.

6. Summary

6.1 Springvale Mine water management system

The Water and Salt Balance Assessment considers the overall water management system associated with Springvale Mine and the impacts of the Project in assessing future conditions. The assessment has been undertaken to quantify the existing and proposed water and salt budgets such that potential impacts of the Project may be assessed.

The water and salt balance for the existing conditions was developed based on information provided by Springvale Mine regarding current operations and water management, as well as meteorological data and groundwater inflows predicted from hydrogeological modelling (CSIRO; 2015).

The existing conditions model was then amended to incorporate modifications corresponding to the Project. The full duration of the Project was modelled with 127 different rainfall patterns to assess the possible impacts of the Project on the water and salt balances at Springvale Mine. The 127 rainfall patterns each comprised the historic time series of 127 years of daily rainfall data, with each pattern using a different starting year within the time series.

For existing conditions in 2016, the largest source of water and salt were associated with groundwater inflows into the underground workings. On average, groundwater inflows account for approximately 96% (5,121 ML) of all water and 99% (3,894 tonnes) of all salt inflows into the Springvale Mine water management system, followed by direct rainfall and runoff to surface storages and potable water.

Under existing conditions, water predicted to be transferred to the SDWTS represents on average 86% (4,551 ML) of all water and 95% (3,460 tonnes) of all salt outputs from the site. The second largest annual water and salt output from the system on average is discharges through LDP001 representing 12% (641 ML) of water and 11% (401 tonnes) of salt. The remaining outflows from the Springvale Mine water management system are attributed to various elements, such as evaporation from storages, dust suppression and infiltration.

The proposed conditions at Springvale Mine were based on site conditions in 2021, when mine water make into the underground workings is predicted to peak. Amendments to the model to represent the proposed conditions were associated with the management of the expected increase in volume of mine water make due to extraction of the approved workings.

For proposed conditions in 2021, the largest source of water and salt will continue to be associated with groundwater inflows into the active underground workings. On average, modelled groundwater inflows account for approximately 97% (6,728 ML) of all water and 99% (5,116 tonnes) of all salt inflows into the Springvale Mine water management system, followed by direct rainfall and runoff to surface storages and potable water.

Water predicted to be transferred to the SDWTS represents on average 90% (6,202 ML) of all water and 92% (4,715 tonnes) of all salt outputs from the site under proposed conditions. The second largest modelled annual water and salt output from the system on average is discharges through LDP001 representing 9% (589 ML) of water and 7% (362 tonnes) of salt outflows from the Springvale Mine water management system.

6.2 Water Transfer Scheme

As the water budget of Angus Place Colliery, Springvale Mine and the SDWTS are interrelated, the transfer of mine water into the SDWTS has been assessed collectively for the Project and the Angus Place Mine Extension Project (Golder Associates, 2014). All transfers to the SDWTS are discharged via LDP009 at Springvale Mine into the Coxs River.

Under existing conditions in 2016, an average of 4,551 ML from Springvale Mine and an average of 2,842 ML from Angus Place Colliery were predicted to be transferred to the SDWTS. The total modelled transfer to the SDWTS from both sites was an average of 7,393 ML (average 20.0 ML/day).

Under proposed conditions, the predicted transfer from Angus Place Colliery reaches a maximum of 12,591 ML in 2030. The daily transfers are likely to exceed the capacity of the SDWTS of 30 ML/day during this period. This dewatering limit will require a modification to increase the capacity of the SDWTS. The modification will be undertaken as part of recommencement of mining at Angus Place Colliery.

7. References

Boughton and Chiew, 2003, *Calibration of the AWBM for Ungauged Catchments*

CSIRO, 2015, *Alternative Mine Schedule – Angus Place and Springvale Colliery Operations Groundwater Assessment.*

Department of Natural Resources and Water, 2007, *Measuring Salinity*, Kristie Watling, DNRW, Queensland Government.

Department of Science, Information Technology, Innovation and the Arts, 2013, *SILO Data Drill*, Queensland Government (site accessed: http://www.longpaddock.qld.gov.au/silo/; 21 February 2016.

Golder Associates, 2014, *Angus Place Mine Extension Project – Environmental Impact Statement*.

Appendices

Appendix A – Operational conditions

Table A-1 Operational conditions for water transfers

Feature	Operational conditions
Administration building	Inflows from: • Potable water from Lithgow City Council (demands every day). Outflows to: • Wastewater to the Lithgow City Council sewage system. • Runoff discharges to the Duck Pond.
Bathhouse building	Inflows from: • Potable water from Lithgow City Council (demands only on production days). Outflows to: • Wastewater to Lithgow City Council sewage system. • Runoff discharges to the Duck Pond.
Duck Pond	Inflows from: • Runoff from car park, administration building and bathhouse building. Outflows to: • Overflows to Secondary Pond.
Primary Pond	Inflows from: • Transfers from the crusher. • Runoff from contributing dirty water catchment. Outputs: • Overflows to Secondary Pond.
Secondary Pond	Inflows from: • Overflows from the Primary Pond and the Duck Pond. • Runoff from contributing dirty water catchment. • Overflows from Oil/Water Separator. Outflows to: • Pumped transfers to Renown Workings when volume in pond is greater than 46% (approximate depth of 2.5 m). • Overflows to LDP001.
Fire Dam	Inflows from: • Pumped transfers from Renown Workings and active underground workings via 24 Cut Through. Outflows to: • Pumped transfers to the Fire Service Pipeline for use at pit top and underground operations. • Overflows to LDP001.

Feature	Operational conditions
LDP001	Inflows from: • Overflows from the Fire Dam. • Overflows from the Secondary Pond. • Runoff from the natural upstream catchment.
Fire Service Pipeline	Inflows from: • Pumped transfers from the Fire Dam. Outflows to: • Pumped transfers to crusher. • Pumped transfers to continuous miners and longwall equipment. • Dust suppression. • Pumped transfers to vehicle washdown.
Vehicle washdown	Inflows from: • Transfers from the Fire Service Pipeline. Outflows to: • Discharges to the Grit Trap.
Grit Trap	Inflows from: • Transfers from the vehicle washdown. • Runoff from the external catchment. Outflows to: • Removal of grit by contractor. • Pumped transfers to the Oil/Water Separator.
Oil/Water Separator	Inflows from: • Pumped transfers from the Grit Trap. Outflows to: • Transfers to the Secondary Pond.
Holding Dam	Inflows from: • Pumped transfers from the FBT Tank.
Underground workings	Inflows from: • Groundwater inflows. • Pumped transfer from Fire Service Pipeline for continuous miners and longwall equipment. Outflows to: • Pumped transfers to the FBT Tank. • Pumped transfers to dewatering bores (Bore 6 and Bore 8).

Feature	Operational conditions
FBT Tank	Inflows from: • Receives groundwater from underground workings. Outflows to: • Pumped transfers to the SDWTS via Ventilation Shaft No. 3 borehole. • Pumped transfers to the Holding Dam via Ventilation Shaft No. 3 borehole when volume in dam is less than 20% of capacity and will continue until volume is greater than or equal to 25% of capacity. • Pumped transfers to the Fire Dam via the 24 Cut Through.
Water Transfer Scheme	Inflows from: • Pumped transfers from Ventilation Shaft No. 3 borehole. • Pumped transfers from dewatering bores. • Pumped transfers from Angus Place Colliery. Outflows to: • Discharge through LDP009.

Appendix B – Additional modelling results

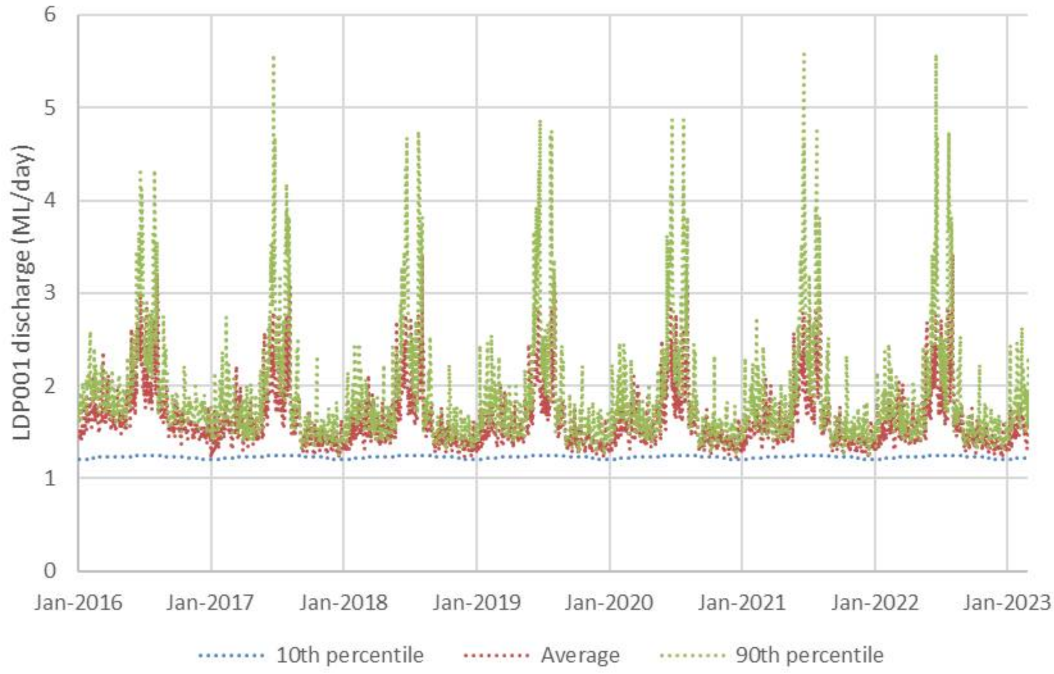

Figure B-1 Predicted daily LDP001 discharges

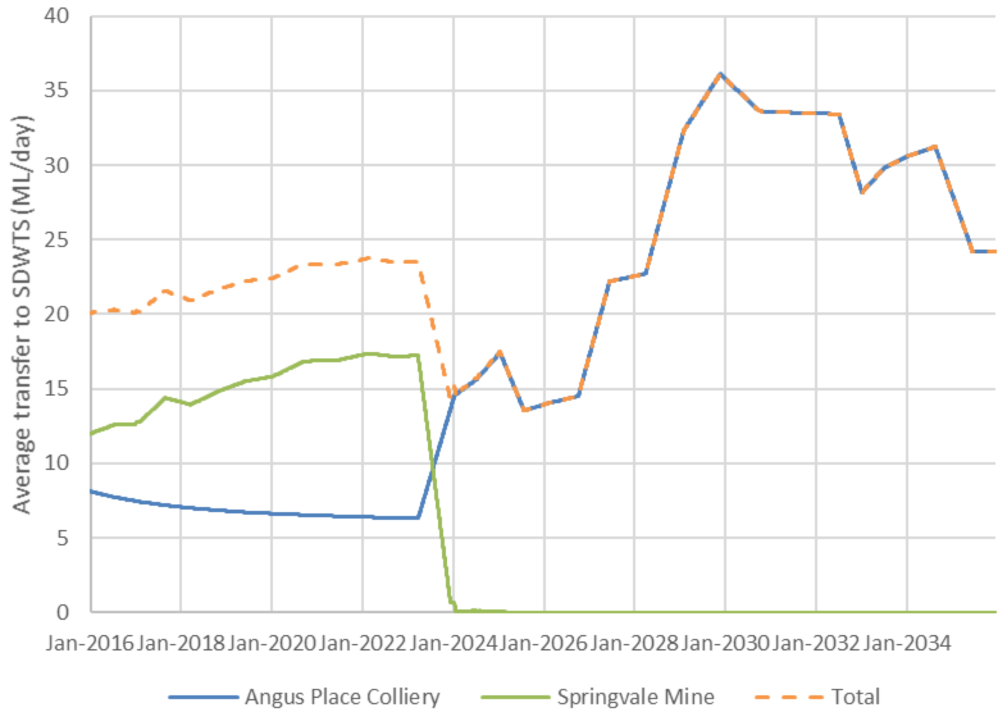

Figure B-2 Predicted average daily transfers to the SDWTS

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

GHD otherwise disclaims responsibility to any person other than Springvale Coal Pty Ltd 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(s) 4 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 Pty Ltd 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.

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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	T Davies T Tinkler	L Hammersley		S Gray		19/04/2016
1	T Davies T Tinkler	L Hammersley	L Hammersley	S Gray		19/05/2016
2	T Davies T Tinkler	L Hammersley	L Hammersley	S Gray		1/7/2016

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Appendix B. Landscape Information Sheets

Summary

Landscape

Low hills and rises on Permian Berry Siltstone and Permian Illawarra Coal Measures (shale, sandstone, conglomerate and limestone) in the Lithgow Valley, Blue Mountains Plateau, Hartley Valley and Wolgan Valley. Local relief 20-50 m; altitude 533-1128 m; slopes 10-25%; rock outcrop 2-10%. Extensively cleared open woodland.

Soils

Yellow Kurosols and Kandosols (Yellow Podzolic Soils and Yellow Earths).

Vegetation

Extensively cleared open-woodland. Small isolated remnants of the original vegetation contain Eucalyptus rossii (scribbly gum), Eucalyptus pauciflora ssp. pauciflora (snow gum), Eucalyptus mannifera ssp. mannifera (brittle gum), E. dives (broad-leaved peppermint), and E. macrorhyncha ssp. macrorhyncha (red stringybark) as the most common tree species. Grass understoreys are characteristic with common species including Poa labillardieri (tussock grass), Agrosits avenacea (blown grass), Danthonia spp. (wallaby grass) and Themeda australis (kangaroo grass). Shrubs of Acacia spp. (wattle), Hibbertia spp. (guinea flower) and Leptospermum spp. (tea-tree) are also present. Over parts of the Lisdale State Forest, native vegetation has been cleared and reseeded with Pinus radiata (radiata pine).

Land use

Grazing of sheep and beef cattle on freehold land is the most widespread land use. Smaller areas are devoted to State Forests, coalmining, power stations, shale quarries and residential urban use (Lithgow, Wallerawang, Cullen Bullen).

Land degradation

Moderate gully erosion is evident along some drainage depressions. Minor sheet erosion is common where ground cover has been disturbed by clearing. Extensive severe sheet and rill erosion have occurred on isolated steeper slopes, e.g. west of Wallerawang sewage works.

Land capability

Rural land capability	IV (V, VII)	**Urban Capability**	C (E)
Grazing limitation	low	**Urban limitation**	low to moderate
Cultivation limitation	moderate	**Soil regolith stability**	R3 (R2, R4)

Constraints

Steep slopes	not observed	**Mass movement hazard**	not observed
Seasonal waterlogging	not observed	**Permanent waterlogging**	not observed
Flood hazard	not observed	**Foundation hazard**	localised
Salinity hazard	not observed	**Low fertility**	widespread

Erosion hazard

Sheet	localised	**Gully**	localised

Streambank	not observed	**Wind**	not observed

Summary

Landscape Hillcrests within plateau on Hawkesbury Sandstone and Narrabeen Grose Sandstone (sandstone-quartz, sandstone-lithic, claystone and shale) in the Newnes Plateau, and lue Mountains Plateau. Local relief 5-20 m; altitude 562-1185 m; slopes 0-10%; rock outcrop not recorded. Partially cleared open forest.

Soils Tenosols (Lithosols, Structured Sands, Earthy Sands) and Yellow Kandosols (Yellow Earths).

Vegetation Partially cleared low open forests and woodland, replaced in some areas by pine plantations. Indigenous vegetation includes Eucalyptus sieberi (black ash), E. oreades (Blue Mountains ash), E. dives (broad-leaved peppermint), E. radiata ssp. radiata (narrow-leaved peppermint), E. rossii (scribbly gum), E. oblonga ssp. oblonga (narrow-leaved stringybark), E. pauciflora ssp. pauciflora (snow gum), E. mannifera ssp. mannifera (brittle gum), E. piperita ssp. piperita (Sydney peppermint), and hard-leaved E. sclerophylla (scribbly gum). Shrubby understorey species include Acacia buxifolia (box-leaf wattle), A. terminalis (sunshine wattle), Acacia dorothea (Dorothy's wattle), Boronia microphylla (small-leaved boronia), Daviesia latifolia (broad-leaf bitter pea), Monotoca elliptica (prickly broom heath), Persoonia levis (broad-leaf geebung), P. linearis (narrow-leaf geebung), P. laurina (laurel geebung), Leptospermum squarrosum (pink tea-tree), Hakea dactyloides (broad-leaved hakea), Banksia spinulosa (hairpin banksia), Brachyloma daphnoides (daphne heath), Leucopogon muticus (blunt beard-heath), Telopea speciosissima (waratah), Lomatia silaifolia (crinkle bush), Lomandra glauca ssp. glauca (pale mat-rush), Isopogon anemonifolia (broad-leaf drumstick), Phyllota spp. (phyllota) and Lomandra spp. (mat-rush) (Alden et al. 1980, Benson and Keith 1990).

Land use Mostly National Parks (Blue Mountains National Park, Wollemi National Park, Newnes State Forest) and State Forests, including some pine plantations. Sand is mined near Paddy's Creek. Future quarrying of the deeply weathered friable sandstone deposits has been proposed. The potential underground extraction of coal has also been examined over parts of this landscape, e.g. near Birds Rock.

Land degradation Minor sheet erosion and track erosion are present. The landscape is particularly susceptible to erosion following bushfire or logging.

Land capability

Rural land capability	VI	**Urban Capability**	B (C)
Grazing limitation	low	**Urban limitation**	low to moderate
Cultivation limitation	moderate	**Soil regolith stability**	R2 (R3)

Constraints

Steep slopes	not observed	**Mass movement hazard**	not observed
Seasonal waterlogging	not observed	**Permanent waterlogging**	not observed
Flood hazard	not observed	**Foundation hazard**	not observed
Salinity hazard	not observed	**Low fertility**	widespread

Erosion hazard

Sheet	widespread	**Gully**	not observed
Streambank	not observed	**Wind**	localised

Summary

Landscape Swamps and drainage depressions on Narrabeen Group Sandstone (sandstone, claystone and conglomerate) in the Newnes Plateau, Blue Mountains Plateau and Wanganderry Tablelands. Local relief 0-30 m; altitude 645-1146 m; slopes 0-5%; rock outcrop not recorded. Uncleared heathland.

Soils Stratic Rudosols (Alluvial Soils) and Hydrosols (Humic Gleys).

Vegetation Uncleared closed-heath and closed-sedgeland with open woodland on swamp margins. The original closed-heathland in better drained areas and closed-sedgeland communities in more waterlogged areas remain largely undisturbed. Leptospermum spp. (tea-trees) are the most common closed-heathland species in addition to Epacris microphylla (coral heath), Hakea teretifolia (dagger hakea), Epacris paludosa (swamp heath), Baeckea linifolia (swamp baeckea), Baeckea utilis (mountain heath-myrtle), Boronia deanei (Dean's boronia), Lepyrodia scariosa (scale rush), Patersonia fragilis (short purple flag) and Grevillea spp. (red spider flower). In more waterlogged areas closed-sedgeland includes Gymnoschoenus sphaerocephalus (button grass), Gleichenia dicarpa (pouched coral fern), and Gahnia spp. (saw-sedge). Swamp margins contain open-woodland including Eucalyptus mannifera ssp. mannifera (brittle gum), Eucalyptus dalrympleana ssp. dalrympleana (mountain gum), Pinus radiata (radiata pine), Hydrocotyle spp. (pennywort), Helichrysum diosmifolium (pill flower), Danthonia spp. (wallaby grass), Dampiera stricta (blue dampiera) and Viola spp. (violet) (Benson and Keith 1990).

Land use Largely undeveloped and contained within Newnes State Forest and Blue Mountains National Park.

Land degradation Dense sedge and swamp vegetation largely restricts erosion and promotes the retention of any sediments delivered to the swamp from adjacent hillslopes. Minor sheet erosion occurs on the less protected swamp margins.

Land capability

Rural land capability	VIII	**Urban Capability**	E
Grazing limitation	extreme	**Urban limitation**	severe
Cultivation limitation	extreme	**Soil regolith stability**	R1 (R2)

Constraints

Steep slopes	not observed	**Mass movement hazard**	not observed
Seasonal waterlogging	widespread	**Permanent waterlogging**	widespread
Flood hazard	widespread	**Foundation hazard**	widespread
Salinity hazard	not observed	**Low fertility**	widespread

Erosion hazard

Sheet	not observed	**Gully**	not observed
Streambank	not observed	**Wind**	not observed

Ecology Due Diligence Assessment

APPENDIX – K

Newcastle Office
Ground Floor, 241 Denison Street, Broadmeadow, NSW Australia 2292
PO Box 428, Hamilton, NSW Australia 2303

Our Ref: 125644: JS: AB
Date: 19 January 2015

Attn: Natalie Conroy
Springvale Coal Pty Ltd
Mudgee Road
Lidsdale, NSW 2790

Via: Email

Dear Natalie,

RE: DUE DILIGENCE SURVEY FOR STOCKPILE EXPANSION, SPRINGVALE

RPS Australia East (RPS) was commissioned by Springvale Coal to undertake a Due Diligence ecological survey for a proposed expansion of the coal stockpile. The expansion would require vegetation removal within the area proposed for the expansion to the north of the current stockpile location, hereafter referred to as the 'site'. The clearing activities would require the removal of all vegetation within the site to allow for coal stockpile reserves to be placed therein.

Legislation

This due diligence assumes that relevant approvals under the *Environmental Protection and Assessment Act 1979* (EP&A Act) exist for clearance works and any associated activities required for stockpile expansion. The assessment has considered protected entities listed under the *Threatened Species Conservation Act 1995* (TSC Act) and Matters of National Environmental Significance (MNES) as listed under the Commonwealth *Environment and Biodiversity Conservation Act 1999* (EPBC Act) Consideration has also been afforded to the requirements of the proposal in relation to the *Native Vegetation Act 2003* (NV Act).

Methodology

Initial desktop studies were conducted through the online NSW Wildlife Atlas database and the Protected Matters search tool to identify threatened flora, fauna and ecological communities with the potential to occur within the site (see **Attachment 1** and **2** for the results). The site was subsequently traversed on foot by a qualified RPS ecologist to determine ecological attributes of the area including targeted surveys for threatened flora species, ground-truthing of ecological communities and location of fauna habitat features including hollow-bearing trees and wombat burrows. A Trimble GPS unit with sub-metre accuracy was used to record any feature locations within the site.

Results

The location of the survey area for the proposed stockpile expansion is supplied in **Figure 1**.

The site was determined to be highly modified and predominantly comprised of exotic grass and herb species, including common weeds such as *Phalaris aquatica* (Phalaris), *Conyza bonariensis*

(Flax-leaf Fleabane), *Echium plantagineum* (Paterson's Curse) and *Holcus lanatus* (Yorkshire Fog). Some native grasses also persisted including; *Austrostipa verticillata* (Slender Bamboo Grass), *Rytidosperma carphoides* (Short Wallaby Grass) and *Panicum* sp. No canopy layer existed on the site, with a sparse shrub layer of *Acacia dealbata* (Silver Wattle) and thickets of *Rubus fruticosis* (Blackberry) were present. As a result, the site was not considered to be commensurate with any native vegetation communities. In addition, no threatened flora species were identified.

The site was also devoid of any important habitat features such as hollow-bearing trees or wombat burrows.

Impact Assessment

Although some adjoining areas contain threatened flora species and Endangered Ecological Communities (refer to **Figure 1**) the site was found to be highly modified and devoid of any significant ecological attributes. As a result of the highly modified nature of the site and lack of important fauna habitat features on the site, no potential impacts to any protected entities under the TSC Act or the EPBC Act are expected. Therefore, an impact assessment is not considered necessary under either legislation.

Conclusion

A due diligence ecological survey of the area proposed for coal stockpile expansion at Springvale Colliery determined that no native vegetation communities were present, and no threatened flora or fauna species were identified. No important habitat features were identified. As a result, an impact assessment under either the TSC Act or EPBC Act is not considered necessary.

Recommendations

The following recommendations have been outlined to limit potential impacts of the proposed clearing works upon surrounding ecological communities and associated flora and fauna species:

- Areas of vegetation removal should be clearly demarcated to ensure clearing works are limited to areas within the site;
- Appropriate sedimentation and erosion barriers should be installed along the interface between the site and surrounds to prevent indirect impacts to adjacent areas; and
- Washdown procedures should be employed for all equipment used during clearing operations to prevent the spread of weed species into surrounding vegetation.

We trust this information is sufficient for your purposes, however, should you require any further details or clarification, please do not hesitate to contact the writer by telephone.

Yours sincerely
RPS

Arne Bishop
Senior Ecologist

TITLE:	PROPOSED STOCKPILE EXPANSION	LOCATION:	SPRINGVALE COLLIERY
DATUM:	GDA 94	DATE:	16/12/2014
PROJECTION:	MGA ZONE 56	PURPOSE:	DUE DILIGENCE
LAYOUT REF:	"J:\JOBS\Centennial\All Jobs\125644 Springvale Pipeline\10 - Drafting\MapInfo Workspaces\Eco"	VERSION (PLAN BY):	JS AB (A A4)

CLIENT: CENTENNIAL SPRINGVALE
JOB REF: 125644

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RPS

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Attachment 1 – NSW Wildlife Atlas (Accessed December 2014)

Family Name	Scientific Name	Common Name	TSC Act Status	EPBC Act Status	No of Records within 10km
Fauna					
Myobatrachidae	Mixophyes balbus	Stuttering Frog	E	V	1
Hylidae	Litoria littlejohni	Littlejohn's Tree Frog	V	V	1
Scincidae	Eulamprus leuraensis	Blue Mountains Water skink	E	E	9
Anatidae	Oxyura australis	Blue-billed Duck	V		3
Accipitridae	Hieraaetus morphnoides	Little Eagle	V		5
Cacatuidae	Callocephalon fimbriatum	Gang-gang Cockatoo	V		84
Cacatuidae	Calyptorhynchus lathami	Glossy Black-Cockatoo	V		5
Strigidae	Ninox connivens	Barking Owl	V		6
Strigidae	Ninox strenua	Powerful Owl	V		23
Tytonidae	Tyto tenebricosa	Sooty Owl	V		2
Climacteridae	Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	V		45
Acanthizidae	Chthonicola sagittata	Speckled Warbler	V		3
Meliphagidae	Grantiella picta	Painted Honeyeater	V		1
Meliphagidae	Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V		2
Pomatostomidae	Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	V		2
Neosittidae	Daphoenositta chrysoptera	Varied Sittella	V		10
Petroicidae	Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	V		7
Petroicidae	Petroica boodang	Scarlet Robin	V		114
Petroicidae	Petroica phoenicea	Flame Robin	V		143
Estrildidae	Stagonopleura guttata	Diamond Firetail	V		1
Dasyuridae	Dasyurus maculatus	Spotted-tailed Quoll	V	E	3
Phascolarctidae	Phascolarctos cinereus	Koala	V	V	4
Burramyidae	Cercartetus nanus	Eastern Pygmy-possum	V		11
Petauridae	Petaurus norfolcensis	Squirrel Glider	V		4
Emballonuridae	Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V		2
Vespertilionidae	Chalinolobus dwyeri	Large-eared Pied Bat	V	V	8
Vespertilionidae	Falsistrellus tasmaniensis	Eastern False Pipistrelle	V		7
Vespertilionidae	Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V		9
Vespertilionidae	Scoteanax rueppellii	Greater Broad-nosed Bat	V		5
Muridae	Pseudomys novaehollandiae	New Holland Mouse		V	1
Lycaenidae	Paralucia spinifera	Bathurst Copper Butterfly	E	V	64
Petaluridae	Petalura gigantea	Giant Dragonfly	E		8
Ericaceae	Leucopogon fletcheri subsp. fletcheri		E		7
Flora					
Fabaceae (Faboideae)	Dillwynia tenuifolia		V		1
Lamiaceae	Prostanthera cryptandroides subsp. cryptandroides	Wollemi Mint-bush	V	V	1
Myrtaceae	Eucalyptus aggregata	Black Gum	V		23
Myrtaceae	Eucalyptus cannonii	Capertee Stringybark	V		25
Myrtaceae	Eucalyptus pulverulenta	Silver-leafed Gum	V	V	1
Orchidaceae	Genoplesium superbum	Superb Midge Orchid	E		2
Proteaceae	Persoonia hindii		E		60
Rutaceae	Boronia deanei	Deane's Boronia	V	V	6
Santalaceae	Thesium australe	Austral Toadflax	V	V	1
Scrophulariaceae	Derwentia blakelyi		V		116

V – Vulnerable
E – Endangered

Newcastle Office
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PO Box 428, Hamilton, NSW Australia 2303

Attachment 2 - EPBC Protected Matters Search

Australian Government
Department of the Environment

EPBC Act Protected Matters Report

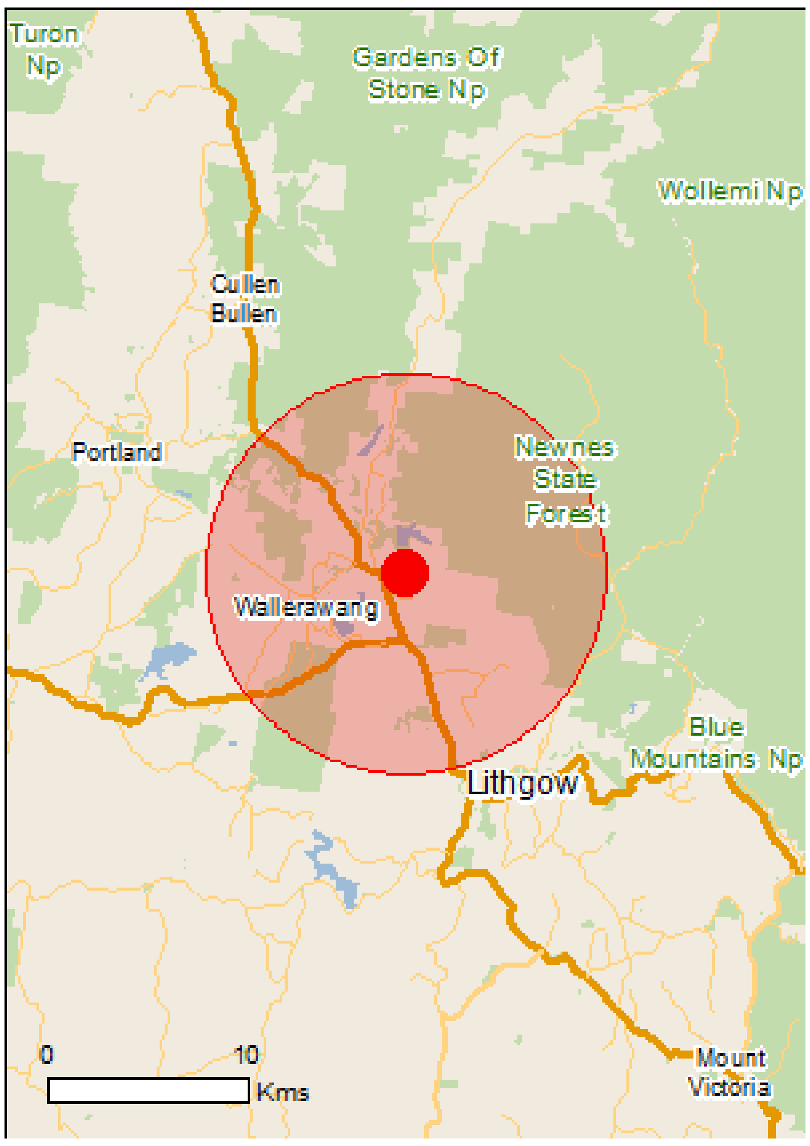
This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 19/12/14 16:01:25

- Summary
- Details
  - Matters of NES
  - Other Matters Protected by the EPBC Act
  - Extra Information
- Caveat
- Acknowledgements



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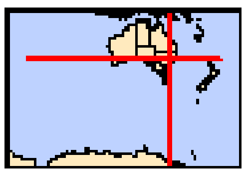

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Areas:	None
Listed Threatened Ecological Communities:	3
Listed Threatened Species:	32
Listed Migratory Species:	11

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate.

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	4
Commonwealth Heritage Places:	None
Listed Marine Species:	13
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Commonwealth Reserves Marine	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

Place on the RNE:	16
State and Territory Reserves:	3
Regional Forest Agreements:	None
Invasive Species:	33
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Temperate Highland Peat Swamps on Sandstone	Endangered	Community may occur within area
Upland Basalt Eucalypt Forests of the Sydney Basin Bioregion	Endangered	Community may occur within area
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Anthochaera phrygia		
Regent Honeyeater [82338]	Endangered	Species or species habitat known to occur within area
Lathamus discolor		
Swift Parrot [744]	Endangered	Species or species habitat may occur within area
Rostratula australis		
Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Fish		
Maccullochella peelii		
Murray Cod [66633]	Vulnerable	Species or species habitat may occur within area
Macquaria australasica		
Macquarie Perch [66632]	Endangered	Species or species habitat may occur within area
Prototroctes maraena		
Australian Grayling [26179]	Vulnerable	Species or species habitat may occur within area
Frogs		

Name	Status	Type of Presence
Heleioporus australiacus		
Giant Burrowing Frog [1973]	Vulnerable	Species or species habitat likely to occur within area
Litoria booroolongensis		
Booroolong Frog [1844]	Endangered	Species or species habitat may occur within area
Litoria littlejohni		
Littlejohn's Tree Frog, Heath Frog [64733]	Vulnerable	Species or species habitat may occur within area
Mixophyes balbus		
Stuttering Frog, Southern Barred Frog (in Victoria) [1942]	Vulnerable	Species or species habitat may occur within area
Insects		
Paralucia spinifera		
Bathurst Copper Butterfly, Purple Copper Butterfly, Bathurst Copper, Bathurst Copper Wing, Bathurst-Lithgow Copper, Purple Copper [26335]	Vulnerable	Species or species habitat likely to occur within area
Mammals		
Chalinolobus dwyeri		
Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat known to occur within area
Dasyurus maculatus maculatus (SE mainland population)		
Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat known to occur within area
Nyctophilus corbeni		
South-eastern Long-eared Bat [83395]	Vulnerable	Species or species habitat may occur within area
Petrogale penicillata		
Brush-tailed Rock-wallaby [225]	Vulnerable	Species or species habitat likely to occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)		
Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat known to occur within area
Pseudomys novaehollandiae		
New Holland Mouse, Pookila [96]	Vulnerable	Species or species habitat may occur within area
Pteropus poliocephalus		
Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Plants		
Asterolasia elegans		
[56780]	Endangered	Species or species habitat known to occur within area
Boronia deanei		
Deane's Boronia [8397]	Vulnerable	Species or species habitat likely to occur within area
Cryptostylis hunteriana		
Leafless Tongue-orchid [19533]	Vulnerable	Species or species habitat may occur within area
Eucalyptus pulverulenta		
Silver-leaved Mountain Gum, Silver-leaved Gum [21537]	Vulnerable	Species or species habitat likely to occur within area
Euphrasia arguta		
[4325]	Critically Endangered	Species or species habitat may occur within area
Lepidium hyssopifolium		
Basalt Pepper-cress, Peppercress, Rubble Pepper-	Endangered	Species or species

Name	Status	Type of Presence
cress, Pepperweed [16542]		habitat may occur within area
Pelargonium sp. Striatellum (G.W.Carr 10345)		
Omeo Stork's-bill [84065]	Endangered	Species or species habitat likely to occur within area
Persoonia marginata		
[10852]	Vulnerable	Species or species habitat likely to occur within area
Prasophyllum sp. Wybong (C.Phelps ORG 5269)		
a leek-orchid [81964]	Critically Endangered	Species or species habitat may occur within area
Pultenaea glabra		
Smooth Bush-pea, Swamp Bush-pea [11887]	Vulnerable	Species or species habitat likely to occur within area
Thesium australe		
Austral Toadflax, Toadflax [15202]	Vulnerable	Species or species habitat known to occur within area
Reptiles		
Aprasia parapulchella		
Pink-tailed Worm-lizard, Pink-tailed Legless Lizard [1665]	Vulnerable	Species or species habitat may occur within area
Eulamprus leuraensis		
Blue Mountains Water Skink [59199]	Endangered	Species or species habitat likely to occur within area
Hoplocephalus bungaroides		
Broad-headed Snake [1182]	Vulnerable	Species or species habitat likely to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Haliaeetus leucogaster		
White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Hirundapus caudacutus		
White-throated Needletail [682]		Species or species habitat known to occur within area
Merops ornatus		
Rainbow Bee-eater [670]		Species or species habitat may occur within area
Monarcha melanopsis		
Black-faced Monarch [609]		Species or species habitat known to occur within area
Myiagra cyanoleuca		
Satin Flycatcher [612]		Species or species habitat known to occur within area
Rhipidura rufifrons		
Rufous Fantail [592]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Ardea alba		
Great Egret, White Egret [59541]		Species or species

Name	Threatened	Type of Presence
		habitat known to occur within area
[Ardea ibis](#) Cattle Egret [59542]		Species or species habitat likely to occur within area
[Gallinago hardwickii](#) Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
[Rostratula benghalensis (sensu lato)](#) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -
Commonwealth Land - Australian Telecommunications Commission
Commonwealth Land - Telstra Corporation Limited
Defence - MARRANGAROO

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
[Apus pacificus](#) Fork-tailed Swift [678]		Species or species habitat likely to occur within area
[Ardea alba](#) Great Egret, White Egret [59541]		Species or species habitat known to occur within area
[Ardea ibis](#) Cattle Egret [59542]		Species or species habitat likely to occur within area
[Gallinago hardwickii](#) Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
[Haliaeetus leucogaster](#) White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
[Hirundapus caudacutus](#) White-throated Needletail [682]		Species or species habitat known to occur within area
[Lathamus discolor](#) Swift Parrot [744]	Endangered	Species or species habitat may occur within area
[Merops ornatus](#) Rainbow Bee-eater [670]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area

Extra Information

Places on the RNE [Resource Information]

Note that not all Indigenous sites may be listed.

Name	State	Status
Natural		
The Pagoda Country	NSW	Indicative Place
Mudgee Overpass Road Cutting	NSW	Registered
Historic		
Cooerwull Presbyterian Church	NSW	Indicative Place
Newnes Junction - Sodwalls Original Railway	NSW	Indicative Place
The Hermitage	NSW	Indicative Place
Willowvale Farm	NSW	Indicative Place
Wolgan Valley	NSW	Indicative Place
Bowenfels Railway Station Group	NSW	Registered
Bowenfels Station Masters Residence (former)	NSW	Registered
Cooerwull	NSW	Registered
Cooerwull Gardens	NSW	Registered
Coxs River Rail Bridge at Wallerawang (former)	NSW	Registered
Farmers Creek Rail Bridge (former)	NSW	Registered
Hermitage Cottage	NSW	Registered
Methven and Outbuildings	NSW	Registered
Middle River Rail Bridge at Marrangaroo	NSW	Registered

State and Territory Reserves [Resource Information]

Name	State
FMAs in BATHURST	NSW
Marrangaroo	NSW
Snow Gum	NSW

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Alauda arvensis Skylark [656]		Species or species habitat likely to occur within area
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Pycnonotus jocosus Red-whiskered Bulbul [631]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Lepus capensis Brown Hare [127]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Cytisus scoparius Broom, English Broom, Scotch Broom, Common Broom, Scottish Broom, Spanish Broom [5934]		Species or species habitat likely to occur within area
Genista monspessulana Montpellier Broom, Cape Broom, Canary Broom, Common Broom, French Broom, Soft Broom [20126]		Species or species habitat likely to occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Nassella neesiana Chilean Needle grass [67699]		Species or species habitat likely to occur within area
Nassella trichotoma Serrated Tussock, Yass River Tussock, Yass Tussock, Nassella Tussock (NZ) [18884]		Species or species habitat likely to occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Senecio madagascariensis Fireweed, Madagascar Ragwort, Madagascar Groundsel [2624]		Species or species habitat likely to occur within area

Coordinates

-33.40157 150.10563

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World Heritage and Register of National Estate properties, Wetlands of International Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

For species where the distributions are well known, maps are digitised from sources such as recovery plans and detailed habitat studies. Where appropriate, core breeding, foraging and roosting areas are indicated under 'type of presence'. For species whose distributions are less well known, point locations are collated from government wildlife authorities, museums, and non-government organisations; bioclimatic distribution models are generated and these validated by experts. In some cases, the distribution maps are based solely on expert knowledge.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- -Department of Environment, Climate Change and Water, New South Wales
- -Department of Sustainability and Environment, Victoria
- -Department of Primary Industries, Parks, Water and Environment, Tasmania
- -Department of Environment and Natural Resources, South Australia
- -Parks and Wildlife Service NT, NT Dept of Natural Resources, Environment and the Arts
- -Environmental and Resource Management, Queensland
- -Department of Environment and Conservation, Western Australia
- -Department of the Environment, Climate Change, Energy and Water
- -Birds Australia
- -Australian Bird and Bat Banding Scheme
- -Australian National Wildlife Collection
- -Natural history museums of Australia
- -Museum Victoria
- -Australian Museum
- -SA Museum
- -Queensland Museum
- -Online Zoological Collections of Australian Museums
- -Queensland Herbarium
- -National Herbarium of NSW
- -Royal Botanic Gardens and National Herbarium of Victoria
- -Tasmanian Herbarium
- -State Herbarium of South Australia
- -Northern Territory Herbarium
- -Western Australian Herbarium
- -Australian National Herbarium, Atherton and Canberra
- -University of New England
- -Ocean Biogeographic Information System
- -Australian Government, Department of Defence
- -State Forests of NSW
- -Geoscience Australia
- -CSIRO
- -Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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Aboriginal Cultural Heritage Due Diligence Assessment

APPENDIX – L

Newcastle Office
Ground Floor, 241 Denison Street, Broadmeadow, NSW Australia 2292
PO Box 428, Hamilton, NSW Australia 2303

Our Ref: PR127992-3a
Date: 1 March 2016

Attn: Nagindar Singh
Springvale Coal Pty Ltd
Castlereagh Highway
Lidsdale, NSW 2790

Via: Email

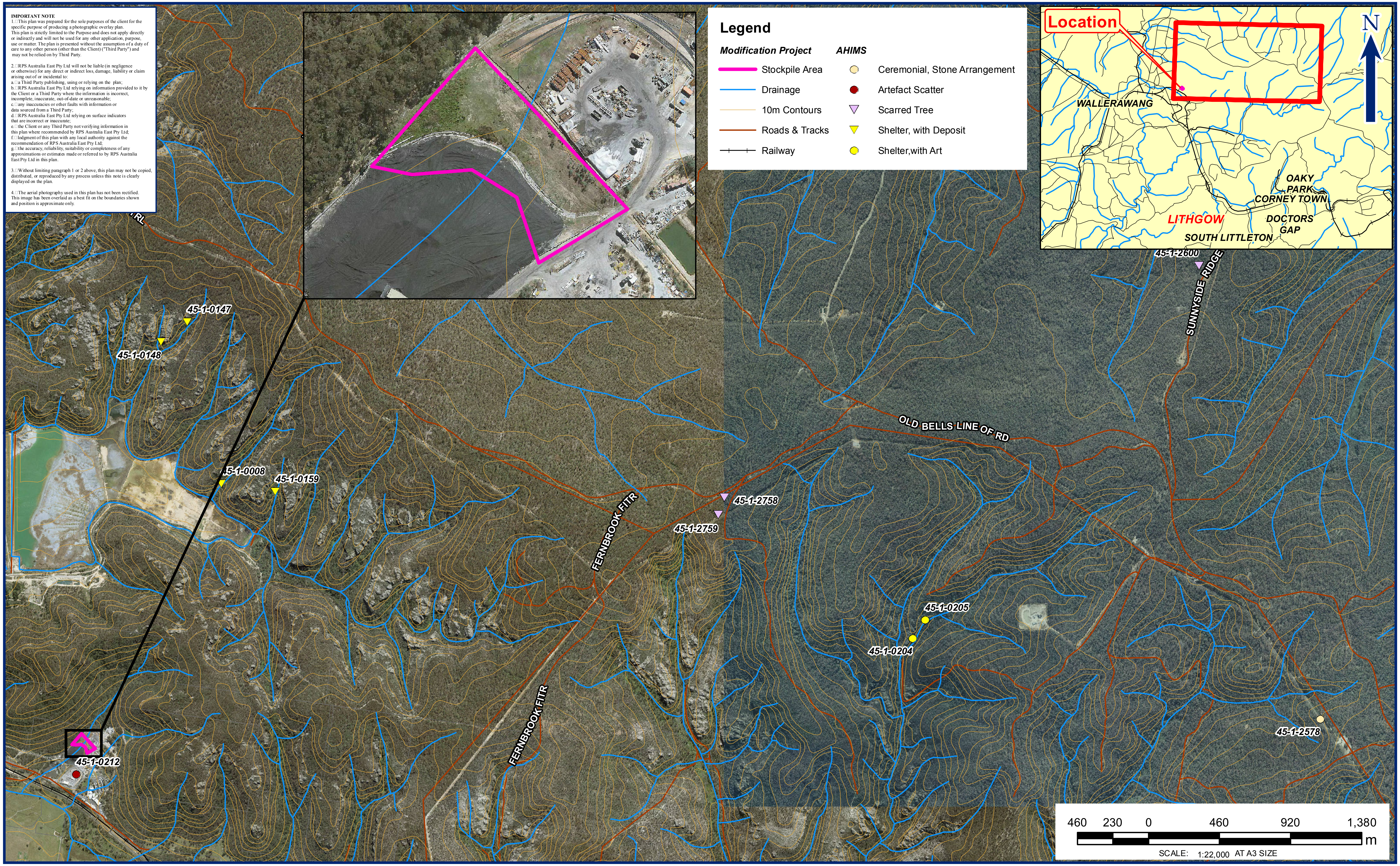
Dear Nagindar,

RE: ABORIGINAL HERITAGE DUE DILIGENCE SURVEY FOR COAL STOCKPILE EXPANSION, SPRINGVALE MINE

This due diligence report details the field investigation conducted by RPS with the assistance of Centennial Coal personnel (Mr Tom Hollis) and the Aboriginal stakeholder groups representing Gundungurra Tribal Council Aboriginal Corporation Native Title Claimants (Mr Thomas Brown), Warrabinga/Wiradjuri People Native Title Claimants (Ms Coral Williams), and North East Wiradjuri Aboriginal Corporation (Ms Kelli Menzi) on the 29th January 2016. This report has been undertaken in accordance with the Due Diligence Code of Practice for the Protection of Aboriginal Objects in New South Wales (DECCW 2010) ("Due Diligence Code") and the NSW Minerals Industry Due Diligence Code of Practice for the Protection of Aboriginal Objects (Minerals Council 2010) ("Minerals Due Diligence Code"). This site inspection has been undertaken in accordance with Centennial Coal's *Western Holdings Aboriginal Cultural Heritage Management Plan 2014* (ACHMP) (DocOne ID APP85862).

Background

RPS has been engaged by Springvale Coal Pty Ltd (Springvale Coal) to provide an Aboriginal Heritage Due Diligence letter report for a proposed expansion of the coal stockpile at Springvale Mine pit top (the Project Area). The Project Area is located within the Springvale Extension of Mining Project Application Area under consent SSD 5594. The proposed activity is for surface disturbance works only and involves the extension of the existing coal stockpile area, which will cover additional ground surface. The extension of the existing coal stockpile footprint to the northeast by 0.3 ha and an increase in the stockpile capacity from the approved 85,000 tonnes to 200,000 tonnes is one of the elements proposed in the modification (Modification 1) to consent SSD 5594. This due diligence assessment report has been prepared to support Modification 1 application.



TITLE : **FIGURE 1: STOCKPILE COAL EXPANSION AREA WITH AHIMS SITES**	LOCATION : **SPRINGVALE**	DATUM:GDA 1994 PROJECTION: GDA 1994 MGA Zone 56	DATE : **22/03/2016** PURPOSE: **HERITAGE**	VERSION (PLAN BY): A A3 (Natalie.Wood) PATH: J:\JOBS\Centennial\All Jobs\129772 Springvale Modification\10 - Drafting\Arcgis Map Documents\Arch\129772 Figure 1 CH CSP A A3 20160229.mxd

CLIENT: **CENTENNIAL COAL**
JOB REF: **129772-1**

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Environmental Background

Geology and Soils

Aboriginal people often made stone tools using siliceous, metamorphic or igneous rocks and therefore understanding the local geology can provide important information regarding resources within the Project Area. The nature of stone exploitation by Aboriginal people depended on the characteristics of the source; for example whether it outcropped on the surface (a primary source) or occurred as gravels (secondary source) (Doelman et al. 2008).

The Blue Mountains area comprises typically of deep incised gorges with sandstone bed-rock, steep sided cliffs and pagodas, narrow incised valleys with spring fed creek lines and inter-bedded sandstone conglomerate rocks. The geology for the Study Area is primarily an undifferentiated mix of sandstone, shale and tuff, formed on the Narrabeen Group, laid down in the Triassic period. This is bounded by nearby deposits of the Illawarra Coal Measures laid down in the Permian period, comprising shale, sandstone, conglomerate and chert, with coal and torbanite seams and a quaternary alluvium of gravel, sand, silt and clay, found mainly along watercourses (Bryan, 1966).

A variety of soil types dominate the landscape - the most common include the dull yellowish-brown sandy loam, the dark reddish-brown clay loam and the hard setting bleached sandy loam. Angular blocky clay is the dominant subsoil, which is characterised by a reddish-brown to bright yellowish-brown colour. Texturally, the subsoil is clayish and forms massive angular blocks when wet. Soil fertility is relatively low whilst the hard-setting topsoil restricts deep root penetration (King 1992). In terms of shrink-swell capacity, the shrinkage can reach depths of up to 35 cm (King 1992).

Topography and Hydrology

The Project Area is located at the foot hills of a moderate hill range at a gradient of approximately 25° slope. A small second order ephemeral drain line intersects the Project Area at an approximately north-south axis. The drainage line has been subjected to modification whereby water has been diverted from its natural alignment to avoid the existing coal stockpile area.

According to the Bureau of Meteorology (2016), Springvale generally experiences greater rainfall in February with a mean average of 123.8 mm, while the month of July is driest with a mean average of 40.6 mm recorded between 1994 -2016. Given that Springvale is located in the hinterland, the temperature in this region generally remains moderate to cool throughout the year. The highest temperature generally occurs in January with a mean average of 23.9°C while during the month of July temperatures can drop below 0°C.

Flora and Fauna

Past Aboriginal people are likely to have encountered the following vegetation communities in the Project Area (DEC 2006 in RPS 2012):

- Tableland Gully Snow Gum – Ribbon Gum Monane Grassy Forest
- Tableland Hollows Black Gum – Black Sally Open Forest;
- Tableland Broad-Leaved Peppermint-Brittle Gum-Red Stringybark-Grassy Open Forest;

- Coxs Permian Red Stringybark - Brittle Gum Woodland.

These vegetation communities provide habitat for a variety of animals and would have also provided potential food and raw material sources for Aboriginal people. Typical animals which may have been hunted by Aboriginal people include kangaroos, wallabies, sugar gliders, possums, echidnas, a variety of lizards and snakes, birds, as well as rats and mice. The bones of such animals have been recovered from excavations of Aboriginal sites suggesting that they were sources of food (Attenbrow 2003:70-76), although the hides, bones and teeth of some of the larger mammals may have been used for Aboriginal clothing, ornamentation, or other implements.

Climate

Approximately 18,000 years ago climatic conditions began to change, affecting the movement and behaviour of past human populations in their environments. During this time, notably at the start of the Holocene (11,477 years ago), the melting of the ice sheets in the Northern Hemisphere and Antarctica caused sea levels to rise, with a corresponding increase in rainfall and temperature. The change in climatic conditions reached its peak about 6,000 years ago (Lambeck, Yokoyama and Purcell 2002; Short 2000:19-21). Up until 1,500 years ago, temperatures decreased slightly before stabilising, about 1,000 years ago, at a point similar to the temperature currently experienced. Consequently, the climate in the locality of the Project Application Area for the past 1,000 years would have been much the same as the present day, providing a year round habitable environment.

Aboriginal Heritage Background

A search of the AHIMS database was undertaken on the 18th January 2016 for the Project Area. The coordinates searched were GDA Zone 56 within the following parameters: Eastings 230160 – 239253 and Northing 6300197 – 6303992. The search revealed 12 previously recorded Aboriginal sites in the local region, of which one previously recorded site (AHIMS 45-1-0212 – GS1; Springvale Colliery) was identified approximately 150 m to the south of the Project Area. According to aerial images of the proposed location of AHIMS 45-1-0212 – GS1; Springvale Colliery coupled with the original site description which identified the site as being in poor condition, it is highly unlikely that AHIMS 45-1-0212 – GS1; Springvale Colliery still exists.

Site Content Prediction

A review of AHIMS results indicate that stone artefact open camp sites generally consist of flaked stone artefacts made from the following raw materials: chert, quartz, quartzite, tuff and mudstone. It is considered that if stone artefacts (flakes and cores) are identified they would most likely be made of chert, quartz, quartzite and mudstone. It is also predicted that artefact scatter sites will have on average 10 artefact pieces. No isolated finds were identified in the AHIMS search results, but remains possible that this site type may occur in the Project Area.

Survey Methodology

The visual inspection included the following components:

- Documentation of visual inspection;
- Documentation of results; and
- Documentation of sites/areas of significance to the Aboriginal community within the Project Area.

The visual inspection aimed to provide adequate coverage of the proposed area for the expansion of the coal stockpile area. Due to the small localised nature of the Project Area, the entire area was surveyed in one day as a single survey unit. Different landform features in the Project Area were inspected in order to gain an even representative sample of the terrain. Areas with high visibility and exposure generally have a lot of land surface disturbance which can expose high quantities of archaeological material (particularly stone artefacts). Conversely, areas with low visibility and exposure are generally more intact (undisturbed) landscapes.

Visual Inspection Results

The Project Area encompassed a north-easterly extension of the existing Springvale Stockpile area. The survey unit is situated on a moderately steep hill immediately south of an ephemeral drainage line (Plate 1). The area abuts the existing coal stockpile area and is bordered by a concrete drainage channel that directs excess water away from the stockpile. The area had been completely cleared of woodland trees and is dominated by a dense ground cover of grass and weeds (Plate 2; Plate 3). Only small pockets of cleared exposures were observed, all of which showed clear and visible signs of disturbance (Plate 4). The estimated ground surface visibility was low (≈60%) and approximately 30% exposure.

The Project Area was highly disturbed given its close proximity to active mine operations and the existing stockpile. Disturbance in the form of past tree clearance and further modification of the site with current operational activities was observed. The exposed clearings were targeted during the visual inspection, but no artefacts were observed.

▲No artefacts were located in the survey unit, and the probability of Aboriginal sites located in situ is deemed highly improbable due to current land use practices in the area.

Impact Assessment

Based on the outcome of the visual inspection, no artefacts were located in the Project Area and it is unlikely that unidentified artefacts are present in the Project Area. Due to the highly disturbed nature of the survey unit, it is highly unlikely that intact deposits exist in the coal stockpile expansion footprint.

The distance of the AHIMS 45-1-0212 – GS1; Springvale Colliery to the coal stockpile expansion area, in the unlikely event that it still exists, is sufficient to not be disturbed by the proposed development.

Conclusions and Recommendations

This report has considered the available archaeological information for the Project Area, the land condition and the nature of the proposed activity. The purpose of this investigation was to identify if there was risk of impact to Aboriginal objects for the proposed coal stockpile expansion area. The following recommendations are made in relation to the proposed activity:

No Aboriginal objects or places have been identified within the Project Area and therefore an Aboriginal Impact Permit (AHIP) is not required for the proposed development.

Recommendation 1

All relevant Springvale Coal staff and contractors should be made aware of their statutory obligations for heritage under the *National Parks and Wildlife Act* 1974 and the *Heritage Act* 1977, which may be implemented as a heritage induction.

Recommendation 2

This due diligence assessment must be kept by Springvale Coal so that it can be presented, if needed, as a defence from prosecution under Section 86(2) of the *National Parks and Wildlife Act* 1974.

Recommendation 4

If unrecorded Aboriginal object/s are identified in the Project Area during works, then all works in the immediate area must cease and the area should be cordoned off. The area should be managed in accordance with the procedures outlined in Centennial Coal's *Western Holdings Aboriginal Cultural Heritage Management Plan 2014* (ACHMP) (Doc ID APP85862).

Recommendation 5

In the unlikely event that skeletal remains are identified, work must cease immediately in the vicinity of the remains and the area must be cordoned off. Procedures outlined in Centennial Coal's *Western Holdings Aboriginal Cultural Heritage Management Plan 2014* (ACHMP) (Doc ID APP85862) must be followed.

Recommendation 6

If, during the course of development works, suspected historic cultural heritage material is uncovered, work should cease in that area immediately. The Heritage Branch, Office of Environment & Heritage (Enviroline 131 555) should be notified and works only recommence when an approved management strategy has been developed.

This report has been prepared by Cheng Yen Loo and reviewed by Tessa Boer-Mah.

Yours sincerely
RPS

Cheng Yen Loo
Senior Cultural Heritage Consultant

Plates

Plate 1: SU 1 View of drainage in background

Plate 2: SU 1 Vegetation Cover

Plate 3: SU 1 Vegetation Cover

Plate 4 SU 1 Discrete Exposure

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RPS (2012) Angus Place Ventilation Facility Project CHIA, Centennial Angus Place.

Attachment 1

AHIMS Search Results

AHIMS Web Services (AWS)

Extensive search - Site list report

Your Ref/PO Number : 129772-1 BS

Client Service ID : 207815

SiteID	SiteName	Datum	Zone	Easting	Northing	Context	Site Status	SiteFeatures	SiteTypes	Reports
45-1-2578	Springvale 1	AGD	56	238760	6300377	Open site	Valid	Stone Arrangement : 2		
	Contact	**Recorders** Leila McAdam						**Permits**		
45-1-2758	RPS SV ST1	GDA	56	235004	6302002	Open site	Valid	Modified Tree (Carved or Scarred) : 1		
	Contact	**Recorders** RPS - Echuca						**Permits**		
45-1-2759	RPS SV ST2	GDA	56	234965	6301890	Open site	Valid	Modified Tree (Carved or Scarred) : 1		
	Contact	**Recorders** RPS - Echuca						**Permits**		
45-1-0147	21 Newnes State Forest	AGD	56	231420	6302950	Closed site	Valid	Artefact : -	Shelter with Deposit	339,2016
	Contact	**Recorders** Denise Donlon,R Sim,Doctor.Susan McIntyre-Tamwoy						**Permits**		
45-1-0148	22; Newnes State Forest	AGD	56	231250	6302820	Closed site	Valid	Artefact : -	Shelter with Deposit	339,2016
	Contact	**Recorders** Denise Donlon,R Sim,Doctor.Susan McIntyre-Tamwoy						**Permits**		
45-1-0159	35__PAD 14;Newnes State Forest;	AGD	56	231990	6301850	Closed site	Valid	Artefact : -	Shelter with Deposit	339,2016
	Contact	**Recorders** Ms.Kerry Powell,Doctor.Susan McIntyre-Tamwoy						**Permits**		
45-1-0212	GS1;Springvale Colliery;	AGD	56	230700	6300020	Open site	Valid	Artefact : -	Open Camp Site	2300,2608
	Contact	**Recorders** Elizabeth Rich,Alice Gorman						**Permits**		
45-1-0008	Lindsdale;Kerosene Vale;	AGD	56	231640	6301900	Closed site	Valid	Artefact : -	Shelter with Deposit	
	Contact	**Recorders** Richard Wright						**Permits**		
45-1-0204	S11;Newnes Plateau;	AGD	56	236120	6300900	Closed site	Valid	Art (Pigment or Engraved) : -	Shelter with Art	2300
	Contact	**Recorders** Mr.Neville Baker,Elizabeth Rich						**Permits**		
45-1-0205	S10;Newnes Plateau;	AGD	56	236200	6301020	Closed site	Valid	Art (Pigment or Engraved) : -	Shelter with Art	2300
	Contact	**Recorders** Mr.Neville Baker,Elizabeth Rich						**Permits**		
45-1-0044	Beecroft;	AGD	56	230620	6303780	Open site	Valid	Modified Tree (Carved or Scarred) : -	Scarred Tree	
	Contact	**Recorders** Helen Brayshaw						**Permits**		
45-1-2600	SV3-ST1	AGD	56	237975	6303313	Open site	Valid	Modified Tree (Carved or Scarred) : 1		
	Contact Bathurst LALC	**Recorders** Doctor.Jodie Benton,Mr.Phillip Cameron						**Permits**		

Report generated by AHIMS Web Service on 18/01/2016 for Ben Slack for the following area at Datum :GDA, Zone : 56, Eastings : 230160 - 239253, Northings : 6300197 - 6303992 with a Buffer of 0 meters. Additional Info : Due Diligence. Number of Aboriginal sites and Aboriginal objects found is 12