Temperate Highland Peat Swamps on Sandstone Monitoring and Management Plan LW 415 to 417

Annual Report

Springvale Mine

March 2015

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1. INTRODUCTION

Springvale Coal Pty Ltd (Springvale) is an underground longwall mine located 12km North West of Lithgow in NSW and 3 km south of the Centennial Angus Place Mine. The mine is a joint venture owned in equal share by Centennial Springvale Pty Ltd (a wholly owned subsidiary of Banpu Minerals Ltd) and Springvale SK Kores Pty Limited.

Approval 2011/5949 was issued to Springvale by the Department of Sustainability, Environment, Water, Population and Communities (SEWPAC) on the 14th of March 2012. Approval 2011/5949 is related to a controlled action area of the Springvale mine for mining of longwall panels (LW) 415 – 417 as shown in the figure below.

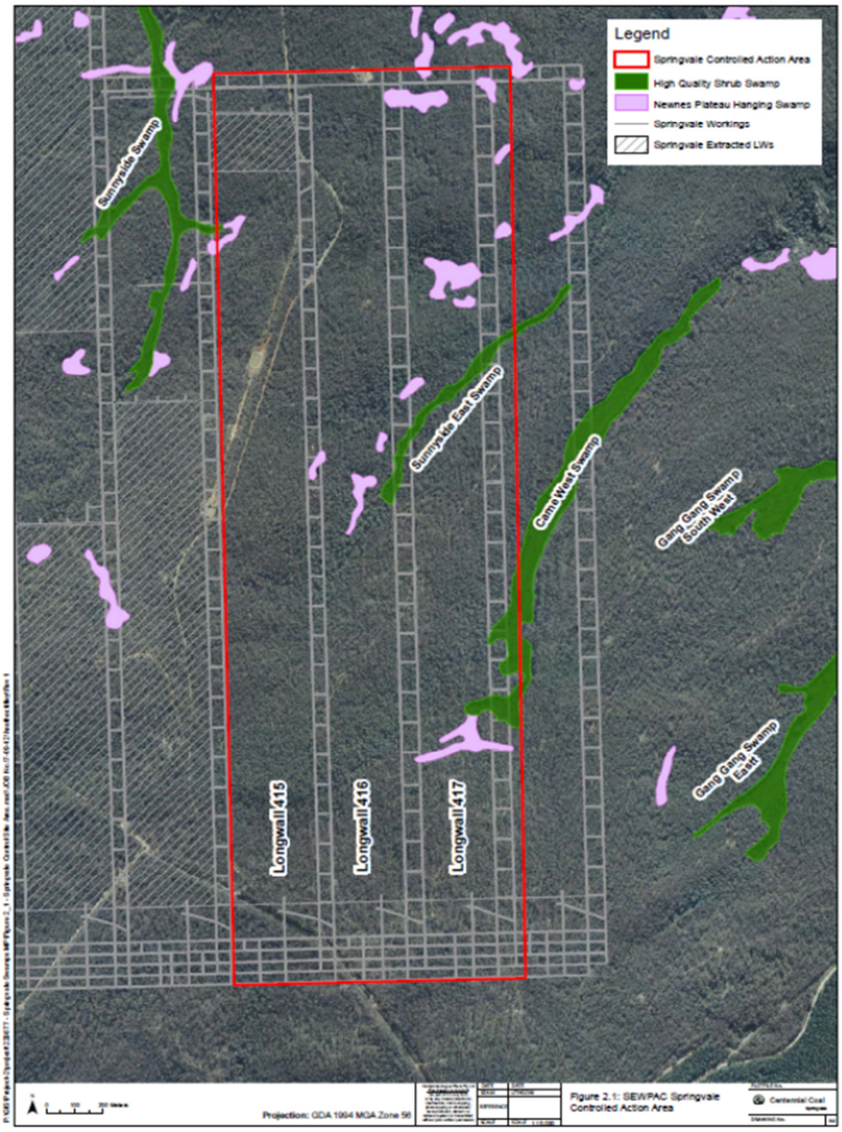

Figure 1 Controlled Action Area 415 to 417

On the 21st of October 2013 Springvale received approval from SEWPAC on the Temperate Highland Peat Swamps on Sandstone Monitoring Plan (THPSSMMP) for LW's 415 to 417 as required under Condition 7 of the EPBC approval.

This annual report has been prepared to satisfy Condition 10 of the EPBC approval which states:

"A report detailing the results of actions carried out under the monitoring and Management plan must be prepared and provided to the department annually on the anniversary date of this approval. The minister may request that the report be reviewed by an independent reviewer approved by the department".

The annual reporting period has been defined as the 1st of January to 31st of December 2014 to allow the compilation of data and input of specialist reports.

2. MONITORING SITES

2.1. Subsidence

Existing survey monitoring lines have already been installed in accordance with the approved *Springvale Subsidence Management and Reporting Plan for LW415 to 417 (September 2011)*. These lines include B, M, T, V, W, X and Y across Sunnyside East and Carne West THPSS. The survey lines installed to date have not been established in the THPSS to minimise impacts during the establishment of the lines and during monitoring.

Additional longitudinal centre lines have been installed at several key locations to provide early-warning and three dimensional (3-D) swamp subsidence data for trigger level review and corrective action management purposes should corrective action be required.

The location of the subsidence monitoring locations are shown in Figure 2.

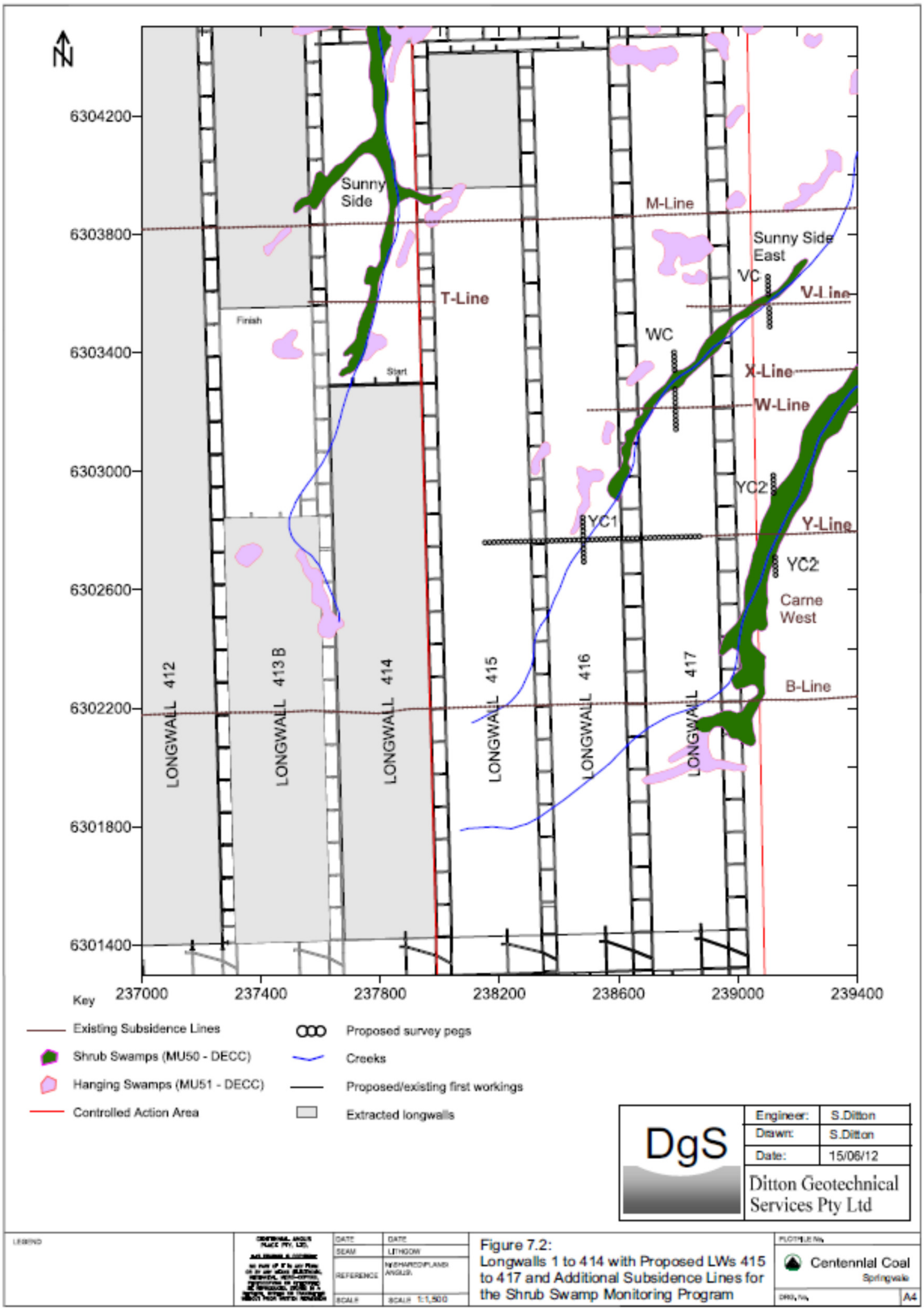

Figure 2 Subsidence Monitoring Locations

2.2. Flora

Centennial Coal has conducted flora monitoring of THPSS across the Newnes Plateau since 2003. Forty-six sites are now monitored which includes undermined swamps and swamps that have not been undermined. The data from these sites will be used as reference data where needed in combination with the specific sites that will be monitored as part of this MMP.

Table 1 provides details of the flora monitoring and reference sites with are part of the THPSSMP while their locations are shown in Figure 3.

Table 1. Flora Monitoring sites

Monitoring site name	Swamp	Easting (GDA94)	Northing (GDA94)	Description
Impact Sites				
WC01	Carne West Swamp	239461	6303219	Permanently wet, groundwater fed swamp. Dominated by *Gymnoschoenus sphaerocephalus*, *Lepidosperma limicola*, *Leptospermum grandifolium*, *Gleichenia dicarpa*, *Xyris gracilis ssp. gracilis* and Baeckea linifolia.
WC02	Carne West Swamp	239461	6303321	Permanently wet, groundwater fed swamp. Dominated by *Gymnoschoenus sphaerocephalus*, *Lepidosperma limicola*, *Leptospermum grandifolium*, *Gleichenia dicarpa*, *Xyris gracilis ssp. gracilis* and Baeckea linifolia.
WC03	Carne West Swamp	239195	6302908	Permanently wet, groundwater fed swamp. Dominated by *Gymnoschoenus sphaerocephalus*, *Lepidosperma limicola*, *Leptospermum grandifolium*, *Gleichenia dicarpa*, *Xyris gracilis ssp. gracilis* and Baeckea linifolia.
WC04	Carne West Swamp	239157	6302773	Permanently wet, groundwater fed swamp. Dominated by *Gymnoschoenus sphaerocephalus*, *Lepidosperma limicola*, *Leptospermum grandifolium*, *Gleichenia dicarpa*, *Xyris gracilis ssp. gracilis* and Baeckea linifolia.
SSE01	Sunnyside East	239022	6303531	Southern half is generally dry and channelized. Northern half likely permanently wet. Dominant species include *Gleichenia dicarpa, Leptospermum grandifolium*, *Baumea rubiginosa* and *Gahnia sieberiana*
Reference Sites				
TG01	Twin Gully	236565	6308755	Permanently wet, groundwater fed swamp. Dominant species include *Baeckea linifolia*, *Grevillea acanthifolia*, *Gleichenia dicarpa* and *Sphagnum cristatum.*
TG02	Twin Gully	236439	6308765	Permanently wet, groundwater fed swamp. Dominant species include *Baeckea linifolia*, *Grevillea acanthifolia*, *Gleichenia dicarpa* and *Sphagnum cristatum.*

TRI01	Tristar	236565	6308755	Permanently wet, groundwater fed swamp. Dominated by *Baeckea linifolia, Gleichenia dicarpa, Grevillea acanthifolia, Lepidosperma limicola, Leptospermum grandifolium*
TRI02	Tristar	236439	6308765	Permanently wet, groundwater fed swamp. Dominated by *Baeckea linifolia, Gleichenia dicarpa, Grevillea acanthifolia, Lepidosperma limicola, Leptospermum grandifolium*
LGG01	Lower Gang Gang Swamp	240148	6303040	Permanently wet, groundwater fed swamp, with channelised flows. Dominated by *Leptospermum grandifolium, Lepidosperma limicola, Boronia deanei and Gleichenia dicarpa.*
UGE01	Upper Gang Gang East Swamp	239928	6301878	Ephemeral, likely rainfall fed. Dominated by *Gleichenia dicarpa, Leptospermum grandifolium, Lepidosperma limicola, Gymnoschoenus sphaerocephalus and Xyris gracilis ssp. gracilis.*
BS01	Barrier Swamp	242111	6303738	Permanently wet, groundwater fed swamp. Dominated by *Gleichenia dicarpa, Leptospermum grandifolium, Lepidosperma limicola, Gymnoschoenus sphaerocephalus and Xyris gracilis ssp. gracilis.*
CCS01	Carne Central Swamp	241196	6302578	Ephemeral, likely rainfall fed. Dominated by *Lepidosperma limicola*, *Empodisma minus*, *Callistemon pityoides*, *Grevillea acanthifolia.*

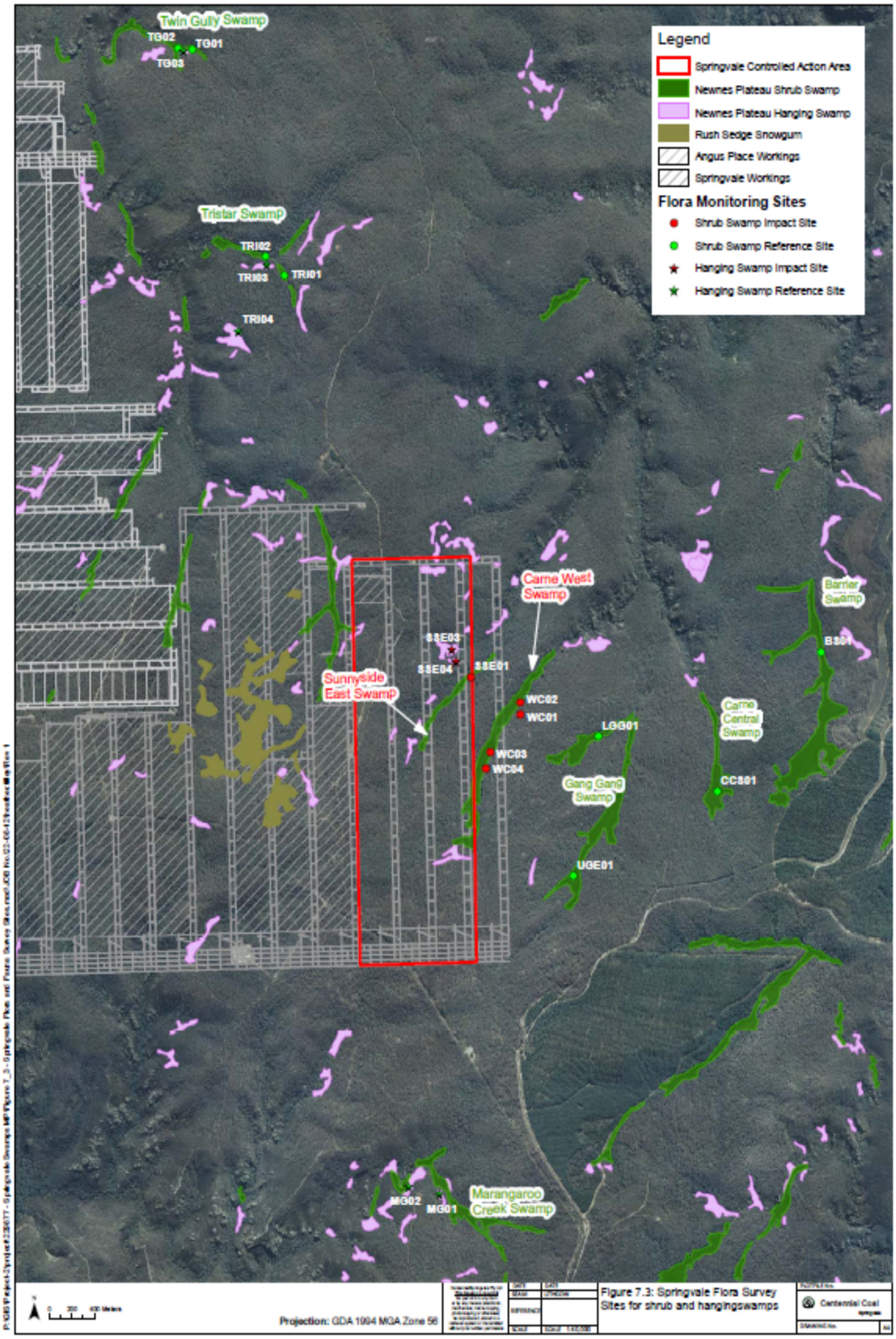

Figure 3 Flora Monitoring locations

2.3. Groundwater

The THPSS baseline groundwater monitoring program commenced in May 2005 and has been gradually expanded to incorporate groundwater level and groundwater quality monitoring.

Piezometers have been installed in swamp systems and are referred to as Swamp piezometers. These piezometers are hand augured to refusal and are shallow with a depth of up to 3 metres. These piezometers are used for direct measurement of swamp groundwater fluctuations.

Piezometers have also been installed outside of swamp systems and are referred to as aquifer piezometers. These piezometers often extend down through ridge lines and are deeper than the swamp piezometers extending to a depth of up to 30 metres. The aquifer piezometers are used to measure groundwater fluctuations outside of swamp systems.

Details of the groundwater monitoring program are presented below.

2.3.1. Swamp piezometers

The swamp piezometers are generally located on the edges of the swamps to minimise damage to swamp vegetation. The groundwater level measured at the swamp margin is representative of the groundwater level across the swamp.

Groundwater chemistry is monitored only in piezometers located in permanently waterlogged swamp conditions as sampling in periodically waterlogged conditions is often not possible due to the lack of groundwater in the piezometer.

Table 2 and 3 provides a summary of the groundwater monitoring undertaken at impact and reference swamps respectively.

Table 2. **Groundwater Impact monitoring sites**

Site name	Easting (GDA94)	Northing (GDA94)	Location	Mining date (estimated)	Parameters monitored	
					Depth	Water Quality
Sunnyside East Swamp						
SSE1	238668	6303143	Over proposed LW416/417	To be undermined December 2013 / March 2015	✓	
SSE2	238831	6303352	Over proposed LW 417	To be undermined December 2014	✓	
SSE3	239064	6303558	Over proposed LW 418	To be undermined November 2015	✓	✓
Carne West Swamp						
CW1	239352	6303196	Over proposed LW 419	To be undermined November 2016	✓	✓
CW2	239382	6303247	Over proposed LW 419	To be undermined November 2016	✓	✓
CW3	238977	6302179	Over proposed LW 417	To be undermined April 2015	✓	
CW4	239070	6302377	Over proposed LW 417	To be undermined April 2015	✓	

Table 3. Groundwater reference monitoring sites

Site name	Easting (GDA94)	Northing (GDA94)	Mining Area	Mining date (estimated)	Parameters monitored	
					Depth	Water Quality
Carne Central Swamp						
CC1	241193	6302693	East of LW 418	No approved mining to date	✓	✓
Marangaroo Swamp						
MS1	238860	6299169	East of LW 418	No approved mining to date	✓	✓
Tristar Swamp						
TS1	237559	6307289	Over Angus Place – NE Area	No approved mining to date	✓	
Twin Gully Swamp						
TG1	236438	6308766	Over Angus Place – NE Area	No approved mining to date	✓	

2.3.2. Aquifer piezometers

The aquifer piezometers are located outside of swamp systems in the laterally extensive shallow aquifer to monitor groundwater fluctuations around the periphery of THPSS. The data collected from these piezometers provides a comparison with any fluctuations measured in the swamp piezometers to detect any mining related impacts.

Groundwater chemistry is not monitored in aquifer piezometers because these piezometers are located at a greater depth from the surface (i.e. on ridge lines) than swamp piezometers and the oxidation of analytes such as Fe and Mn is unlikely due to a lack of freely available oxygen at this depth from surface.

Table 4 and 5 provides a summary of the groundwater monitoring undertaken at impact and reference swamps respectively.

Table 4. Aquifer impact monitoring sites

Site Name	Easting (GDA94)	Northing (GDA94)	Location	Mining date (estimated)	Parameters monitored	
					Depth	Quality
RSS	238072	6303500	Over LW 415	To be undermined Sep 2012 if approved	✓	
SPR1101	238484	6303627	Over LW 416	To be undermined Oct 2013	✓	
RCW/ SPR1104	239746	6303184	Over LW 420	To be undermined 2017 if approved	✓	
SPR1107	239739	6302330	Over LW 420	To be undermined 2017 if approved	✓	
SPR1109	239186	6303314	Over LW 418	To be undermined December 2015	✓	
SPR1110	238699	6302635	Over LW 416 / 417	To be undermined January 2014 / March 2015	✓	

Table 5. Aquifer reference monitoring sites

Site name	Easting (GDA94)	Northing (GDA94)	Location	Mining date (estimated)	Parameters monitored	
					Depth	Quality
SPR1108	239840	6301075	South of LW 420 Over LW427	To be undermined after 2025 if approved	✓	
SPR1111	240404	6303692	Nth of LW 422	Will not be undermined	✓	
SPR1113	240625	6302160	Over LW 423	To be undermined 2021 if approved	✓	
AP5PR	236523	6308535	NE of Angus Place Mine	Will not be undermined in the foreseeable future	✓	

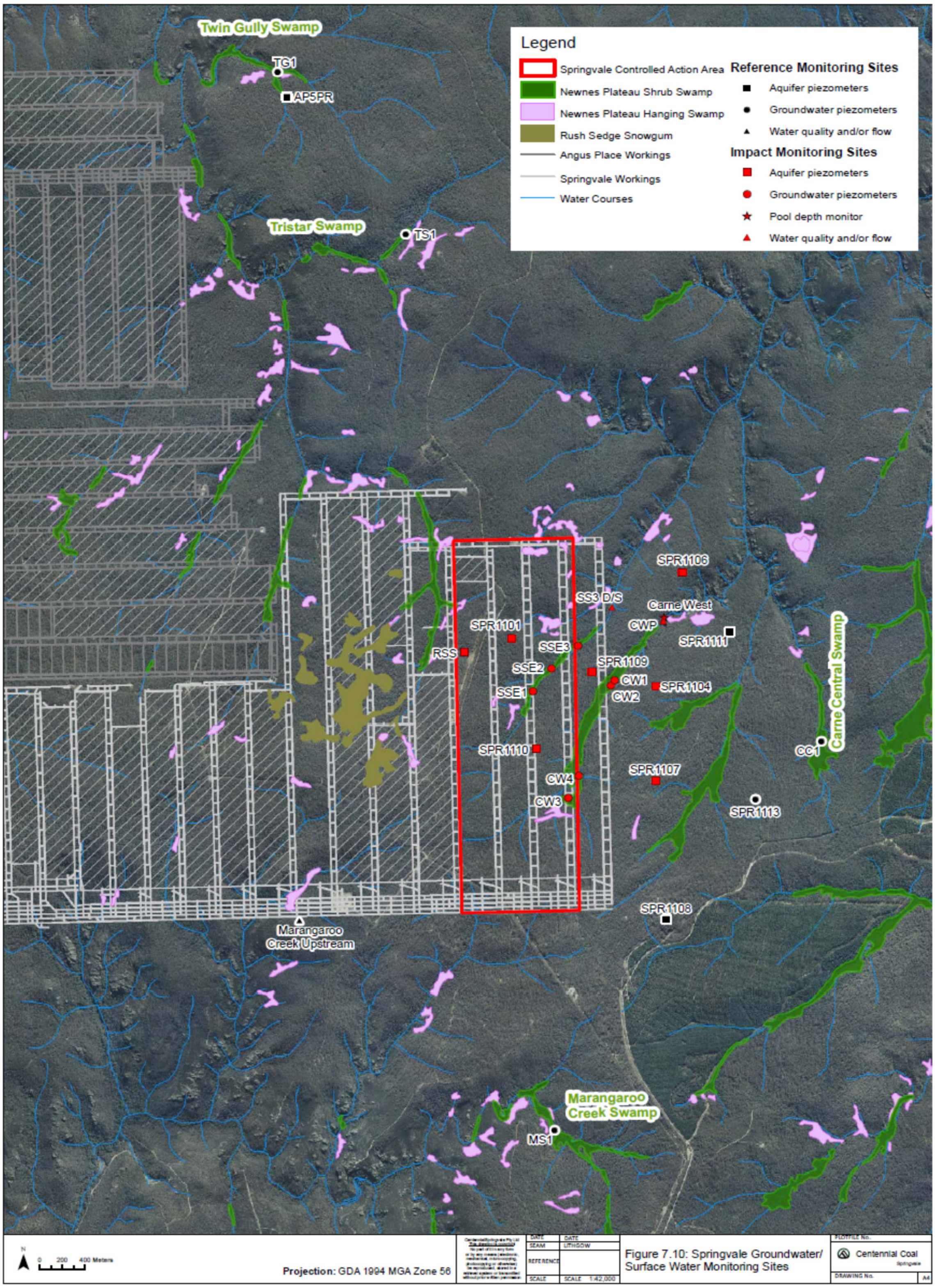

Figure 4 Groundwater and surface water monitoring locations

2.4. Surface water

The most significant surface water flows in the Springvale controlled action area in the drainage lines that feed into the sub-permanently and permanently waterlogged swamps.

Details of the surface water monitoring sites are given in Table 6.

Table 6.Surface water monitoring sites

Site Name	Easting (GDA94)	Northing (GDA94)	Location	Mining date (estimated)	Parameters monitored		
					water depth	flow rate	water quality
Surface Water Quality - Impact Sites							
Carne West	239808	6303782	Nth end of Carne West Swamp	Swamp will be undermined in April 2015 and November 2016		✓	✓
CWP	239816	6303814	Nth end of Carne West Swamp		✓		
SS3 D/S	239363	6303908	Nth end of Sunnyside East Swamp	Swamp to be undermined December 2013, December 2014, March/November 2015, August 2016			✓
Surface Water Quality - Reference Site							
Marangaroo Creek Upstream	236633	6301063	Marangaroo Creek upstream	Will not be undermined		✓	✓

Surface monitoring locations are shown in Figure 4 in Section 2.3.

3. MINING ACTIVITY

In 2014 coal was mined from Longwalls 416 and 417. Longwall 416 commenced on the 25th of September 2013 and was completed on the 19th of August 2014. Longwall 417 commenced on the 11th of October 2014 and is planned to be completed in June 2015. Also during the reporting period the gateroad and 400 mains development continued.

Mining activity undertaken in 2014 is shown in Figure 5.

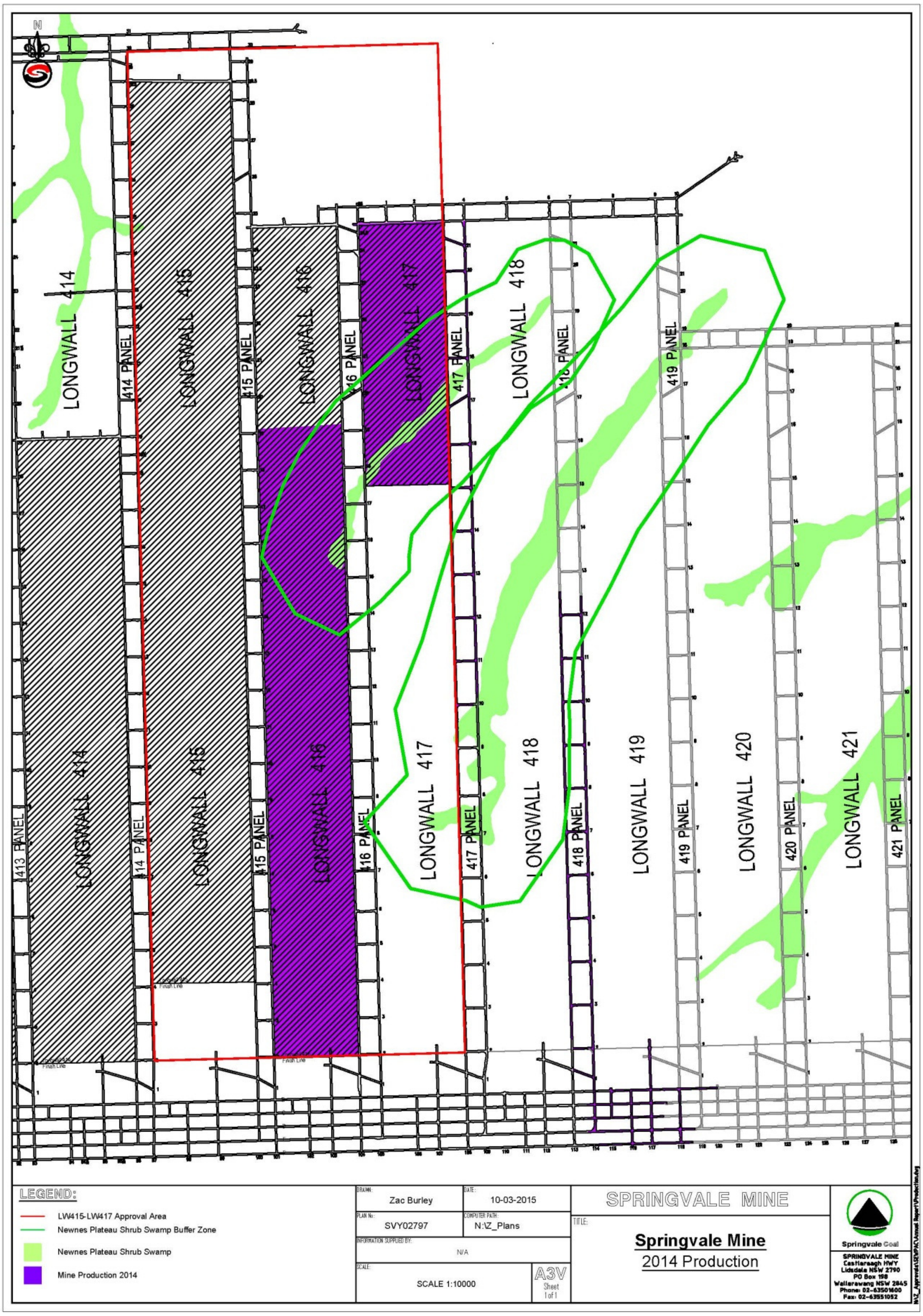

Figure 5 Mining undertaken during 2014

4. METEROLOGICAL CONDITIONS

Monthly rainfall data is summarised in Table 7 and presented in Figure 6.

Table 7. Comparison of Observed and Long-term Average Rainfall Data

	Observed Rainfall		Average Rainfall	
	Newnes Plateau (mm)	**Lithgow Maddox Lane(mm)**	**Newnes Plateau (mm)**	**Lithgow Maddox Lane (mm)**
January 2014	34.5*	9.2	82	83.8
February 2014	7.5*	85	130.4	80.2
March 2014	185.4	155	76.2	65.5
April 2014	54	63	43.8	42.5
May 2014	14.8	14	47.2	49.9
June 2014	47.6	43.2	84.6	49.4
July 2014	37.8	33.6	43.8	50.7
August 2014	94.4	56.4	53.3	64.5
September 2014	40.6	35.2	48.4	53.2
October 2014	59.6	51.6	65.6	67.3
November 2014	51.2	36.8	106.5	72.6
December 2014	247.4	160.4	112.2	73.9
Annual Total	874.8	743.4	894	753.5

*Values taken at the Angus Place Pit Top rainfall gauge to substitute values at the Newnes Plateau rain gauge while it is offline

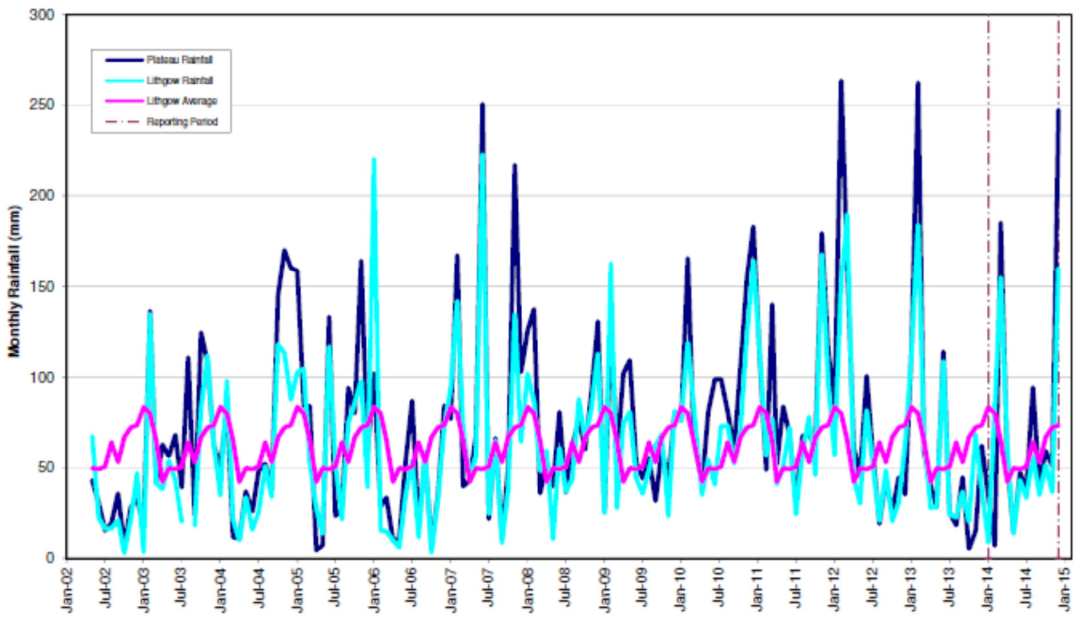

Figure 6 Rainfall

Apart from three above average peaks in March, August and December, both plateau and Lithgow rainfall levels for 2014 remained at or below the Lithgow long-term average.

The year started out with January rainfall levels at approximately 9.2mm, which were comparable to the lowest recorded values in 12 years. Rainfall then increased through to March where the 2014 maximum of 185.4mm was recorded in March. This peak represents the first of two rainfall events in 2014 where rainfall levels exceeded the long-term average.

Rainfall levels then dropped off and receded below the long-term average in May 2014. The rainfall continued to drop reaching a low of approximately 14mm in late May. The levels around this time are comparable to those recorded at the start of the year in January, which are some of the lowest on record. Overall there were 5 dry months with approximately 50% or less average rainfall, the longest consecutive run being two month.

Below average rainfall was recorded for the rest of winter through until August, when rainfall values exceeded the long-term average for the second and final time in 2014. The levels recorded at this peak (94.4mm on the Plateau) are not as high as those in March and they quickly recede back to a below average value of 35.2mm in August. The largest of the three rainfall peaks was recorded in December where rainfall levels reached 247.4mm on the Newnes Plateau. This is the highest monthly rainfall recorded in 2014. Overall there were three very wet months with approximately 40% or more of average monthly rainfall.

Overall, 2014 was characterised by a year of extremes. Rainfall levels remained below the long-term average for the majority of the year apart from three above average months which brought the total rainfall close to the average yearly total. The peak rainfall in December was significantly higher than the average rainfall recorded at this time of year.

5. MONITORING RESULTS

5.1. Subsidence

Subsidence monitoring has occurred in accordance with the Springvale Subsidence Management and Reporting Plan for LW415 to 417 (September 2011).

The following sections documents the maximum monitoring result for surveys undertaken throughout the reporting period.

All recorded subsidence results were below the trigger values established in the THPSSMMP.

5.1.1. B Line Subsidence Monitoring

The following table summarises the results for the B Line. It is important to note that the B line uses the total station method which is known to be less accurate. Supplementary information may therefore be used to confirm results obtained in the event a trigger value is exceeded.

Table 8. B-Line Monitoring Results

	Subsidence (mm)		Tilt (mm/meter)		Tensile Strain (mm/meter)		Compressive Strain (mm/meter)	
	Max Result	**Trigger value**	**Max Result**	**Trigger value**	**Max Result**	**Trigger value**	**Max Result**	**Trigger value**
LW415	1236	1500mm	7.3	10	3.4	15	6.2	18
LW 416 and 417	755	1100mm	6.8	7	0.7	5	5.8	>6(plateaus) >14(valleys)

The table above demonstrates compliance with the trigger values defined in the THPSSMP.

5.1.2. M Line Subsidence Monitoring

The following table summarises the results for the M Line.

Table 9. M-Line Monitoring Results

	Subsidence (mm)		Tilt (mm/meter)		Tensile Strain (mm/meter)		Compressive Strain (mm/meter)	
	Max Result	**Trigger value**	**Max Result**	**Trigger value**	**Max Result**	**Trigger value**	**Max Result**	**Trigger value**
LW415	842	1500mm	7.3	10	3.0	15	2.6	18
LW 416 and 417	518	1100mm	1.7	7	1.5	5	1.4	>6(plateaus) >14(valleys)

The table above demonstrates compliance with the trigger values defined in the THPSSMP.

5.1.3. V and VC Line Subsidence Monitoring – Sunnyside East Swamp

The following table summarises the results for the V and VC Lines.

Table 10. V and VC Monitoring Results

	Subsidence (mm)		Tilt (mm/meter)		Tensile Strain (mm/meter)		Compressive Strain (mm/meter)	
	Max Result	Trigger value	Max Result	Trigger value	Max Result	Trigger value	Max Result	Trigger value
LW417	285	1100	2.9	7	0.2	5	2.9	14

The table above demonstrates compliance with the trigger values defined in the THPSSMP.

5.1.4. W and WC Line Subsidence Monitoring – Sunnyside East Swamp

The following table summarises the results for the W and WC Lines.

Table 11. W and WC Monitoring Results

	Subsidence (mm)		Tilt (mm/meter)		Tensile Strain (mm/meter)		Compressive Strain (mm/meter)	
	Max Result	Trigger value	Max Result	Trigger value	Max Result	Trigger value	Max Result	Trigger value
LW416 and 417	664	1100	5.6	7	1.1	5	5.7	14

The table above demonstrates compliance with the trigger values defined in the THPSSMP.

5.1.5. Y and YC2 Line Subsidence Monitoring – Carne West Swamp

The following table summarises the results for the Y and YC2 Lines.

Table 12. Y and YC2 Monitoring Results

	Subsidence (mm)		Tilt (mm/meter)		Tensile Strain (mm/meter)		Compressive Strain (mm/meter)	
	Max Result	Trigger value	Max Result	Trigger value	Max Result	Trigger value	Max Result	Trigger value
LW416 and 417	144	1100	0.8	7	0.6	5	0.2	14

The table above demonstrates compliance with the trigger values defined in the THPSSMP.

5.1.6. LiDAR

The LiDAR campaign was undertaken in September 2014. There were no anomalous results detected from the flight.

5.2. Flora

Springvale engage Gingra Ecological Surveys to undertake monitoring and examine the results of vegetation monitoring. Data Analysis focuses on trends that have been observed that possibly relate to mining impacts between seasons in 2013 and 2014, in addition to assessing the extent of variation in vegetation composition and condition between monitoring surveys in 2014 and those conducted in previous years.

A summary of the results is presented below.

The following table shows impact and reference sites to assist in the interpretation of data.

Table 13. Flora impact and reference sites

Impact Sites	Reference sites
SSE01	TG01
WC01	TG02
WC02	TRI01
WC03	LGG01
WC04	UGE01
	BS01
	CCS01

5.2.1. Timing of Survey

Data collection for the 2014 summer survey occurred in February and March 2014 and the autumn survey was conducted in late May 2014. A winter survey was conducted in July 2014. The spring survey commenced in October and was completed in November.

As discussed in the following sections in October 2013 bush fire affected the southern and eastern sections of Newnes Plateau including vegetation plots which are part of the monitoring program

Mining did not occur beneath any additional vegetation monitoring plots on the Newnes Plateau in the period between spring 2013 and spring 2014.

At Springvale mining operations are proceeding towards Sunnyside East Swamp and monitoring plots SSE01, SSE02, SSE03 and SSE04.

5.2.2. Species richness

Of the 53 vegetation monitoring sites across the plateau, 41 are in Newnes Plateau Shrub Swamps (MU50). The Spring and Annual Report 2013 (University of Queensland) indicated that the Newnes Plateau Shrub Swamp sites range in species richness from 6 to 56 species, with a mean of 25 species per plot. There are 10 plots in Hanging Swamps (MU51) on the plateau and these ranged in species richness from 10 to 56 species with a mean of 29 species per plot.

In spring 2014 species richness among these sites ranged from 11 to 48 species, with a mean of 27 species per site. The Hanging Swamps (MU51) monitored on the plateau range in species richness from 18 to 48 species with a mean of 32 species per site. The one MU52 site had a species richness of 38.

The following figure presents the results of monitoring plots required under the THPSSMP.

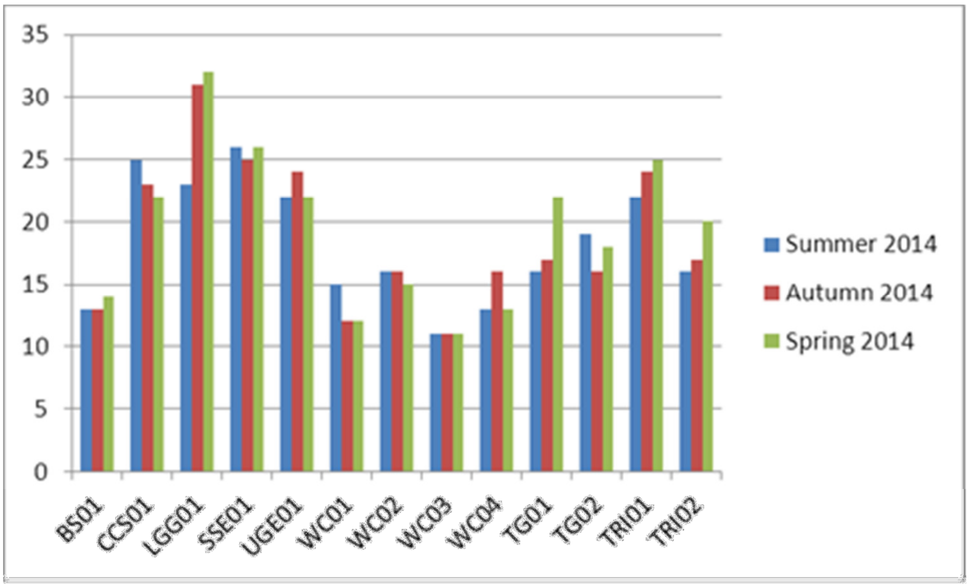

Figure 7 2014 Species Richness of THPSSMP Monitoring Plots

The above figure demonstrates similar trends are observed between impact and reference sites.

5.2.3. Species Composition

Wetland vegetation communities across the Newnes Plateau are highly variable in both species composition and richness. Across the 53 plots surveyed in spring 2014, a total of 213 plant taxa were recorded, with 211 having been recorded in summer 2014.

The long-term pattern reported in the Spring and Annual Report 2013 (University of Queensland) for mean cover/abundance shows a similar level between autumn and spring then either a decrease or increase between spring and summer. Between spring 2013 and summer 2014 there was a decrease at a majority of sites, followed by an increase to longer term trend levels in autumn 2014 and a subsequent small decrease by spring 2014. The higher than average rainfall in February and March may have led to a growth response reflected in higher levels of cover/abundance in autumn. The snow storm damage in spring may have impeded identification of some ground layer plants.

During 2014 a number of new species records were detected with the majority representing germination of soil stored seed at burnt sites.

5.2.4. Plant Condition

Condition and abundance of Coral Fern (Gleichenia dicarpa) has been identified previously as an indicator of swamp condition. In spring 2014 Coral Fern was detected in 38 plots, an increase over that for autumn when it was detected in 35 plots. The cover/abundance score in spring ranged from 2 to 7 and the condition score ranged from 3 to 5, a slight improvement over autumn when a condition score of 2 was recorded at 3 plots.

Results are presented graphically in the following figure.

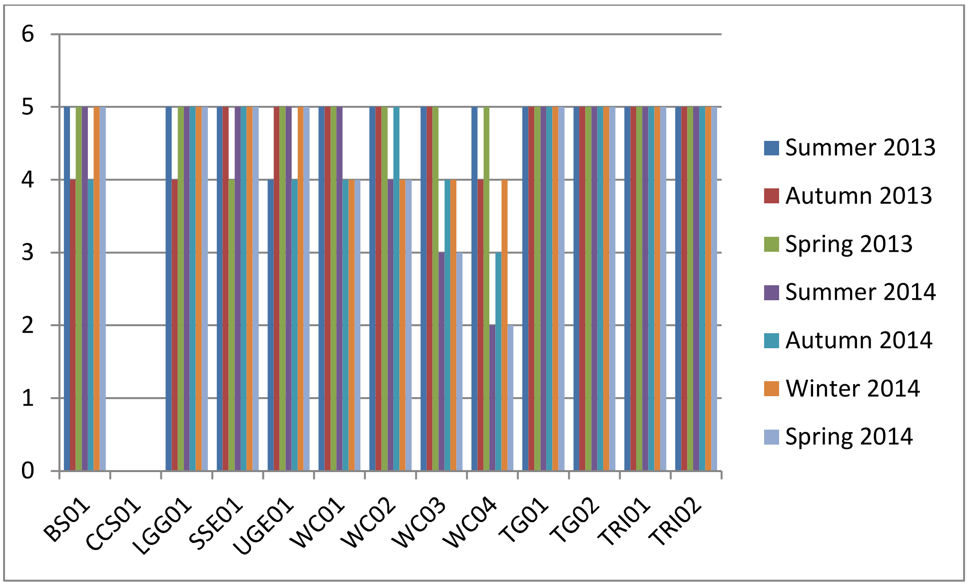

Figure 8 Coral Fern Condition scores of THPSSMP monitoring Plots

Plots at of relevance to THPSSMP where two or more species were suffering from plant disease in spring 2014 were WC01, WC03 and WC04. The table below presents information on the mining status of these plots and the recorded possible causes of plant decline based on field notes undertaken by Gingara.

Table 14. Possible Causes of Coral Fern plant Declines

Plot	Mining Status	Pathology
WC01	Unmined	Scale insects, drying
WC03	Unmined	Drying
WC04	Unmined	Drying

It is important to note there has been my mining within the swamp buffer zone of Carne West Swamp. As such the monitoring results presented indicate baseline mining condition.

5.2.5. Exotic Plant Species

Exotic species are defined as flora that is not native to Australia. While exotic species are generally rare across the Newnes Plateau, they can be locally abundant, with some sites showing relatively high numbers of exotic species.

The following figure presents Exotic Plant Species richness across monitoring plots of relevance to the THPSSMP.

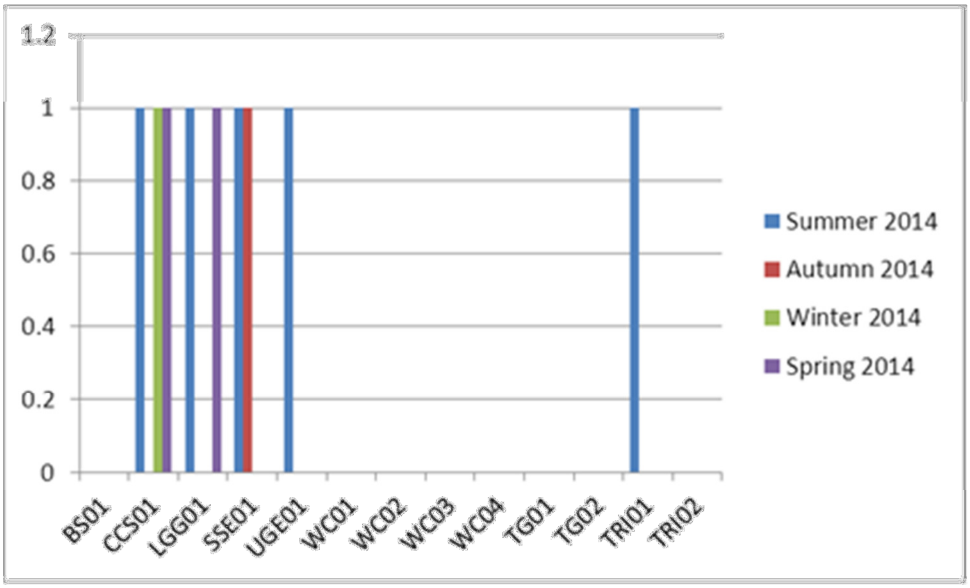

Figure 9 Exotic Species Richness at THPSSMP plots in 2014

As demonstrated by the figure above, the exotic species richness across both impact and reference swamps are extremely low and similar.

5.2.6. Conclusions

Fluctuations in condition and cover/abundance scores are consistent with seasonal conditions and a normal response to the October 2013 bush fire. In particular there was a seasonal spike in species richness at a number of sites in autumn following good rainfall in February and March.

Whilst mining is proceeding towards SSE01, there has been no mining activity directly beneath or within 200m of any of these sites in 2014

Data presented in Figures 7, 8 and 9 indicate:

- an increase in species richness at plot LGG01 (reference site), related to post-fire recovery
- stable species richness at SSE01 (impact site)
- a decline in Gleichenia condition at all West Carne plots (impact sites), indicating localised drying of this Swamp (unmined at this stage)
- stable Gleichenia condition at SSE01 (impact site)
- no increase in exotic species

There has been no indication of vegetation change in any of the parameters which would represent an exceedance of a trigger level.

5.3. Groundwater

RPS Aquaterra has been engaged by Centennial Springvale to analyse groundwater data results. The following sections summarise the results of the monitoring undertaken.

5.3.1. Swamp Results

Hydrographs in Figures 10 to 16 present the baseline level in the swamp monitoring network. The impact swamp hydrograph is shown in red across all the graphs with the reference swamps show in yellow, green blue and purple to help distinguish each series. The 95^{th} percentile from the impact swamp derived between from data from 2005 to 2012 is show as a dashed orange line, and the 95^{th} percentile derived from data between 2005 and 2014 is shown as a dashed pink line. The daily cumulative rainfall deviation (CRD) is presented on each graph as a black dashed line to allow for the interpretation of water level trends.

When the 95^{th} percentiles were originally calculated between 2005 and 2012 the rainfall CRD was predominately influenced by an extended period of increased average rainfall between 2007 and 2012. Between 2012 and 2014 there has been an extended period of below average rainfall. Both 95^{th} percentiles are displayed on the swamp graphs to show why most swamps have experienced such a sharp decline in water level over the reporting period.

The following table presents a comparison of the baseline defined in the THPSSMP to the recalculated baseline based upon additional monitoring data presented prior to 200m from the piezometer location.

Table 15. Comparison of Swamp Piezometers 95^{th} percentile

Impact Site	95^{th} Percentile 2005-2012	95^{th} Percentile 2005 to 2014	95^{th} Percentile: difference between 2005-2012 and 2005-2014
SSE1	2.12	2.16	0.04
SSE2	0.7	0.86	0.16
SSE3	0.17	1.71	1.54
CW1	0.25	0.91	0.66
CW2	0.24	0.36	0.12
CW3	1.01	1.07	0.06
CW4	1.20	1.34	0.14

Sunnyside East

The water level at Sunnyside East Swamp is monitored at piezometers SSE1, SSE2 and SSE3.All three piezometers were installed in March 2010.

The following figure presents results for SSE1.

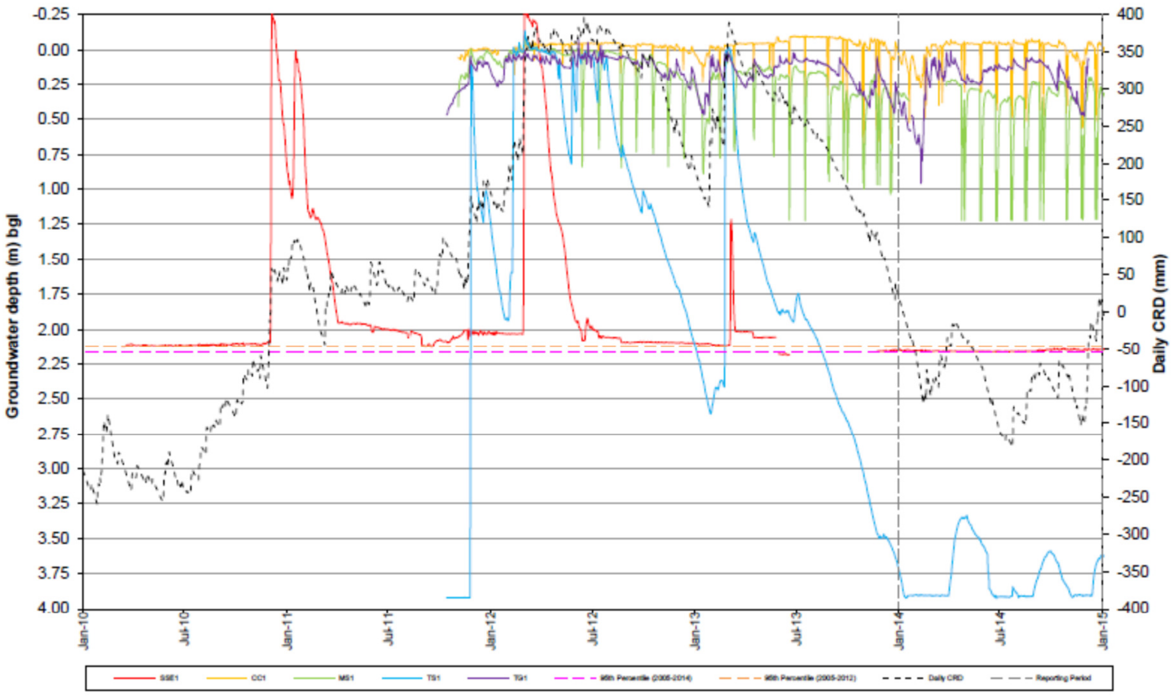

Figure 10 SSE1 Monitoring Data 2010 to 2015

SSE1 is the deepest of the three piezometers installed at Sunnyside East and has shown water levels to be typically 0 to 0.1m above the logger throughout 2014. These levels indicate that the sensors are measuring trapped water in the base of the piezometers. Therefore, these measurements are not representative of the water level in the surrounding horizon. Historically this site has shown some strong responses to rainfall but only after prolonged rainfall and higher than average seasonal rainfall. No responses to rainfall were observed in SSE1 in 2014. This is not uncommon for this piezometer, as frequently in previous years the water level in the piezometer remains unresponsive for durations of 8 to 10 months.

SSE1 is not as responsive to small intensity rainfall events as the reference swamps. SSE1 tends to respond to high intensity rainfall events over an extended period of time. Because the water level tends to remain near the bottom of the piezometer it is difficult to determine any mining influences at this location.

The recalculated 95th percentile has increased by 0.04m (Table 15) with the inclusion of data up to 2014. This reflects the below average rainfall received between 2012 and 2014.

Data presented therefore is considered to exceed the trigger values presented in Table 15 and will further be discussed in Section 6.3.

The following figure presents results for SSE2.

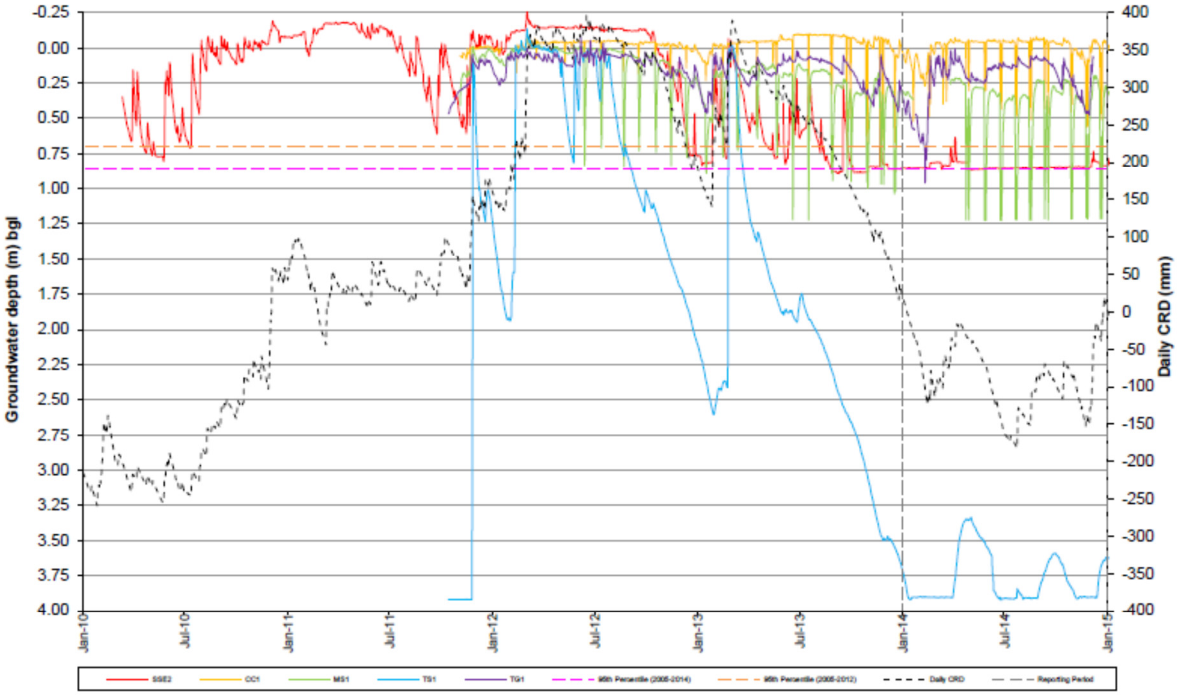

Figure 11 SSE2 Monitoring Data 2010 to 2015

The water level in SSE2 has showed a continued decline which started in March 2013. The onset of this decline coincides with a prolonged period of below average rainfall, which has continued up to March 2014. Two water level responses are observed in this piezometer in 2014 - one in early April where the water level rose by approximately 0.23m, and one in December as a result of the above average December rainfall.

SSE2 is responsive to moderate rainfall intensity events as well as extended period of below average rainfall. SSE2 shows a similar trend to reference swamp TG1. This highlights that the responses observed during the reporting period are likely due to natural climatic variations.

The recalculated 95th percentile has increased by 0.86m (Table 15) with the inclusion of data up to 2014. This reflects the below average rainfall received between 2012 and 2014.

The following figure presents results for SSE3.

There has been no mining within 200m of SSE3. Data presented is therefore considered baseline.

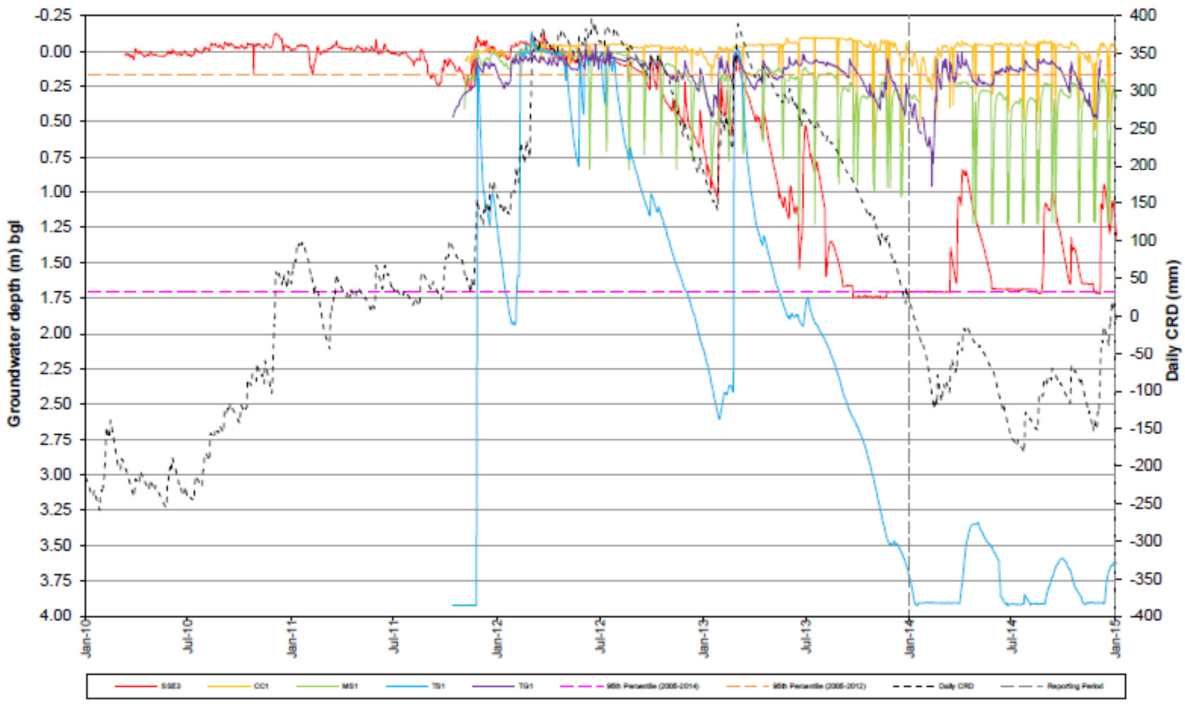

Figure 12 SSE3 Monitoring Data 2010 to 2015

SSE3 water levels have shown a very similar pattern to those in SSE2 with a decline from approximately ground level during the latter half of 2012 and commencing the current review period at around 1.7mbgl. The onset of this decline coincides with a prolonged period of below average rainfall, which has continued up to March 2014. During 2014, SSE3 showed definitive responses to the two significant rainfall events of 2014 – in March and August, where water levels rose to approximately 0.84mbgl and 1.01mbgl respectively. Overall, during 2014 the water levels showed a characteristic rainfall influenced trend only rising after prolonged and significant rainfall events.

SSE3 is responsive to moderate rainfall intensity events as well as extended period of below average rainfall. SSE3 shows similar trends to both SSE2 and TG1 although more accentuated. This highlights that the responses observed during the reporting period are likely due to natural climatic variations.

The recalculated 95th percentile has increased by 1.71m (Table 15) with the inclusion of data up to 2014. This reflects the below average rainfall received between 2012 and 2014.

Carne West

The water level at Carne West Swamp is monitored at piezometers CW1, CW2, CW3 and CW4. CW1 and CW2 were installed in May 2005 while CW3 and CW4 were installed in October 2011 at the southern end of the swamp.

There has been no mining within 200m of Carne West. Data presented is therefore considered baseline.

The following figure presents results for CW1.

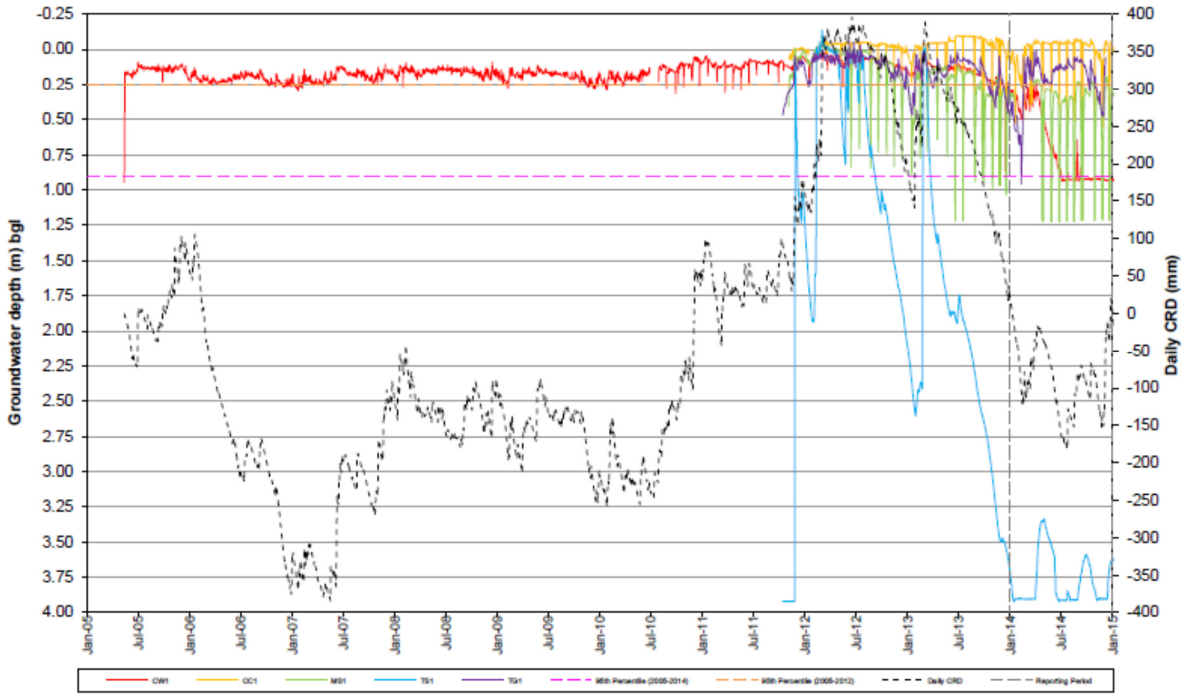

Figure 13 CW1 Monitoring Data 2005 to 2015

The water level observed in CW1 has shown significant drops throughout 2014. The water level in this piezometer started 2014 in decline at a level of approximately 0.29mbgl. This decline started in March 2013 and continued throughout 2014 until the water level reached the bottom of the piezometer (approximately 0.92mbgl) in mid-July. This level represents the lowest water level since monitoring began. Two periods of increasing water level are recorded in this piezometer (in March and August) which coincide with the above average rainfall during these periods. However, it appears that the water levels in this piezometer now display trends that are more rainfall dependent as opposed to predominantly groundwater dependent, which has been the case for the entire monitoring period from 2005 up to 2014.

CW1 has typically shown similar fluctuation magnitudes to reference sites CC1, MS1 and TG1. The rapid water level decline is not typical for the swamp and indicates there may be a loss of baseflow to the swamp. Whether this is mine related or due to the steady decline observed in the regional groundwater table is unclear. Although, the decline in water levels commenced at a time when the nearest longwall mining was in excess of 700m from the piezometer, so it is not under specific investigation at this time as it has not triggered a response under the THPSS MMP. It also coincided with the start of a 12 month period (March 2013-March 2014) with a CRD of 480mm.

The recalculated 95th percentile has increased by 0.66m (Table 15) with the inclusion of data up to 2014. This reflects the below average rainfall received between 2012 and 2014. CW1 did not exceed any trigger levels to initiate an investigation during the reporting period.

The following figure presents results for CW2.

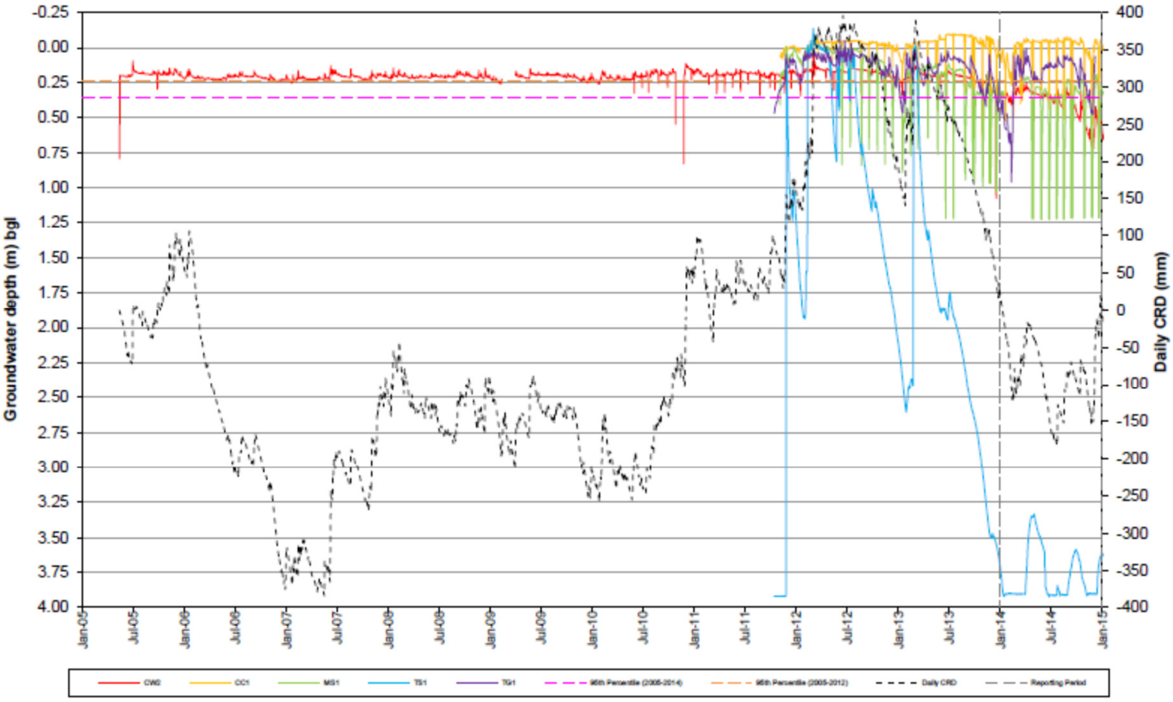

Figure 14 CW2 Monitoring data 2005 to 2015

The water level observed CW2 has shown a decline in standing water level throughout 2014. The water level in this piezometer started 2014 in decline at a level of approximately 0.36mbgl, this decline started in continued throughout 2014 until the water level reached a low point of 0.72mbgl on 01 December 2014, before receiving recharge. This level represents the lowest water level since monitoring began. Three periods of increasing water level are recorded in this piezometer (in March, August and December), which coincide with the above average rainfall during these periods. The decline in water levels commenced at a time when the nearest longwall mining was in excess of 700m from the piezometer, so it is not under specific investigation at this time as it has not triggered a response under the THPSS MMP. It also coincided with the start of a 12 month period (March 2013-March 2014) with a CRD of 480mm.

CW2 has typically shown similar fluctuation magnitudes to reference sites CC1, MS1. This highlights that the responses observed during the reporting period are likely due to natural climatic variations.

The recalculated 95th percentile has increased by 0.12m (Table 15) with the inclusion of data up to 2014. This reflects the below average rainfall received between 2012 and 2014. CW2 did not exceed any trigger levels to initiate an investigation during the reporting period.

The following figure presents results for CW3.

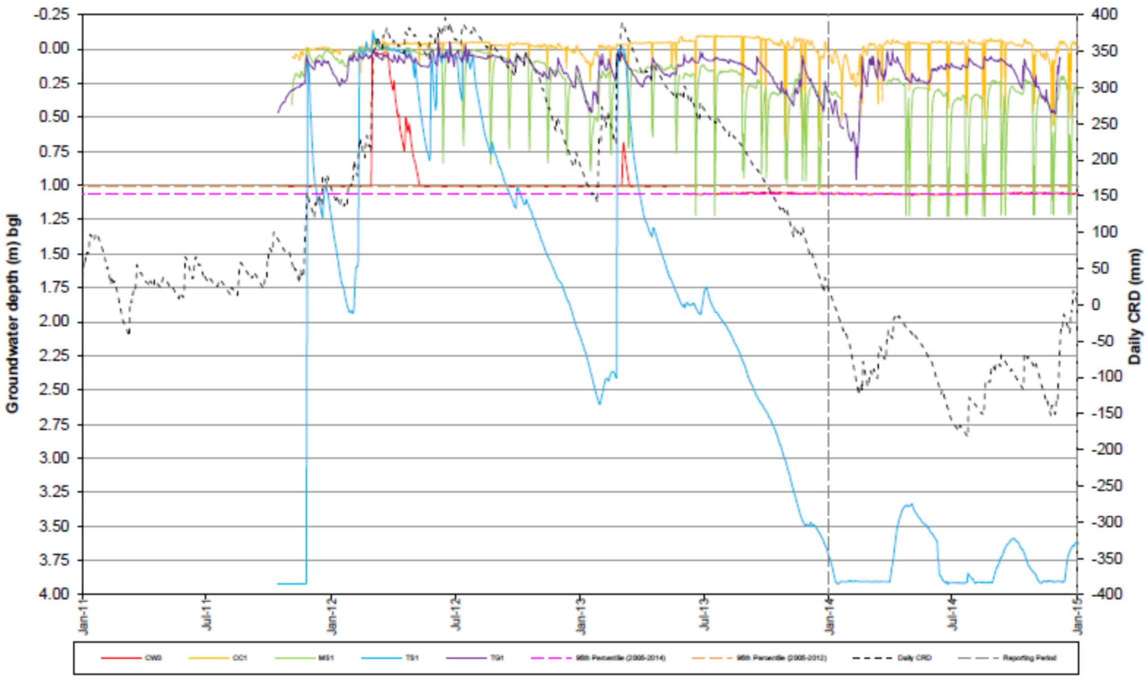

Figure 15 CW3 Monitoring data 2011 to 2015

The water level in CW3 was recorded beneath the groundwater logger throughout 2014. Since monitoring was initiated CW3 only responds to significant and prolonged rainfall events. The characteristic response for this piezometer comprises rapid rises and subsequent declines in water level to a depth below the base of the piezometer. As described previously, a prolonged period of below average rainfall occurred from approximately March 2013 to March 2014. The hydrograph indicates that the influence of this period of below average rainfall was significant enough to lower the water level to a point where the two above average rainfall periods in 2014 did not result in observed water levels above the bottom of the piezometers in CW3.

CW3 has typically shown a subdued version of groundwater fluctuations as observed in reference site TS1.

The recalculated 95th percentile has increased by 0.06m (Table 15) with the inclusion of data up to 2014. This reflects the below average rainfall received between 2012 and 2014. CW3 did not exceed any trigger levels to initiate an investigation during the reporting period.

The following figure presents results for CW4.

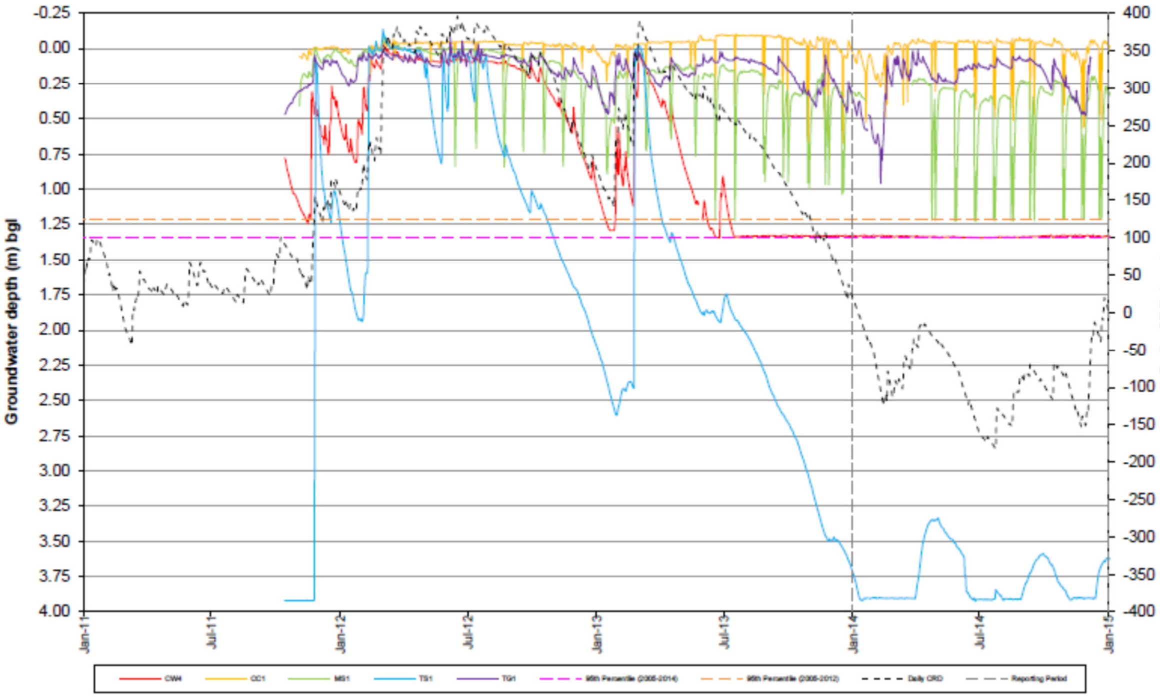

Figure 16 CW5 Monitoring Data 2011 to 2015.

The water level in CW3 was recorded beneath the groundwater logger throughout. Since monitoring was initiated CW4 only responds to significant and prolonged rainfall events. The characteristic response for this piezometer comprises rapid rises and subsequent declines in water level to a depth below the base of the piezometer. As described previously, a prolonged period of below average rainfall occurred from approximately March 2013 to March 2014. The hydrograph indicates that the influence of this period of below average rainfall was significant enough to lower the water level to a point where the two above average rainfall periods in 2014 did not result in observed water levels above the bottom of the piezometers in CW4.

CW4 has typically shown similar magnitude groundwater fluctuations as observed in reference site TS1. The swamp peat thickness is not as thick as CC1 so has gone dry.

The recalculated 95th percentile has increased by 0.06m (Table 15) with the inclusion of data up to 2014. This reflects the below average rainfall received between 2012 and 2014. CW4 did not exceed any trigger levels to initiate an investigation during the reporting period.

5.3.2. Aquifer Results

There are six impact ridge piezometers impact swamps including RSS, SPR1110, SPR1104, SPR1107, SPR1109, and SPR1110 monitor the groundwater level in the near-surface unconfined aquifers in the Burralow Formation and Banks Wall Sandstone. Ridge piezometers are equipped with water level data loggers.

Hydrographs in Figures 17 to 22 present the water level in the regional aquifer groundwater monitoring network. The styling of the series used in each of these graphs follows that of the swamp hydrographs as discussed previously.

As discussed with the swamp results, the following table presents a comparison of the baseline defined in the THPSSMP to the recalculated baseline based upon additional monitoring data presented prior being within 200m of the instruments.

Table 16. **Comparison of Regional aquifer piezometers 95th Percentile**

Impact Site	95th Percentile 2005-2012	95th Percentile 2005 to 2014	95th Percentile: difference between 2005-2012 and 2005-2014
RSS	29.52	29.80	0.28
SPR1101	36.08	N/A	N/A
SPR1104	25.28	26.85	1.57
SPR1107	22.50	24.50	2.00
SPR1109	36.19	41.50	5.31
SPR1110	58.78	65.26	6.48

RSS

The following figure presents results for RSS.

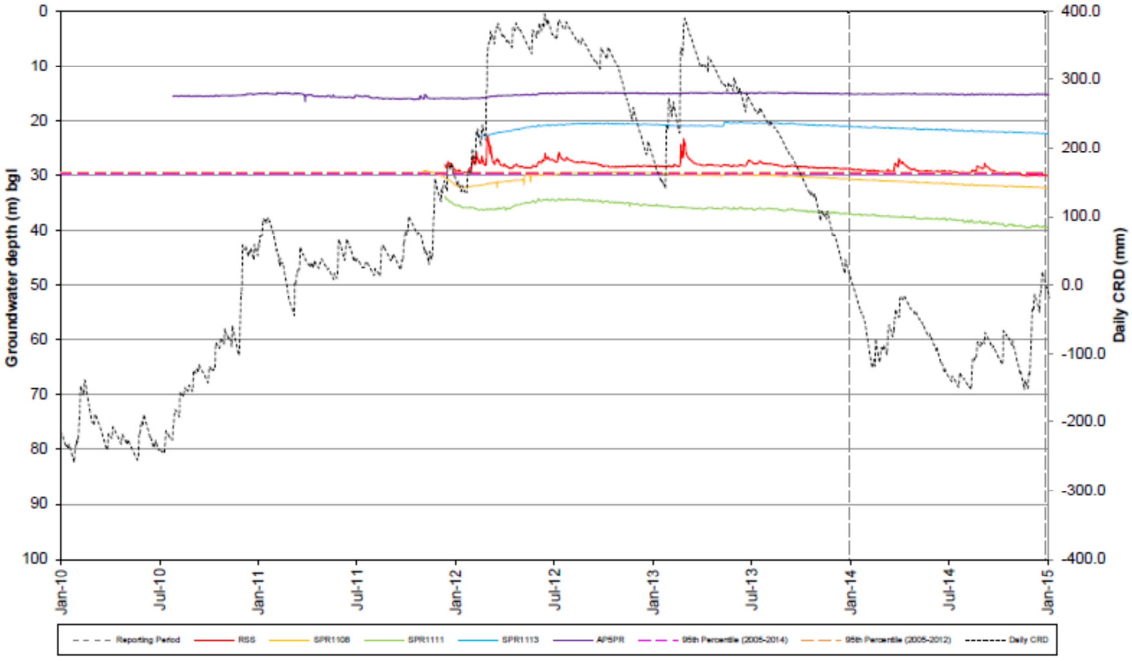

Figure 17 RSS Monitoring data 2010 to 2015

RSS is located directly overlying LW415. Apart from a slight rise in April and September, the water levels in this piezometer maintained a steady trend throughout 2014. This trend is comparable to the response observed in previous years.

The recalculated 95th percentile has increased by 0.28m (Table 16) with the inclusion of data up to 2014. This reflects the below average rainfall received between 2012 and 2014.

SP1101

The following figure presents results for SP1101.

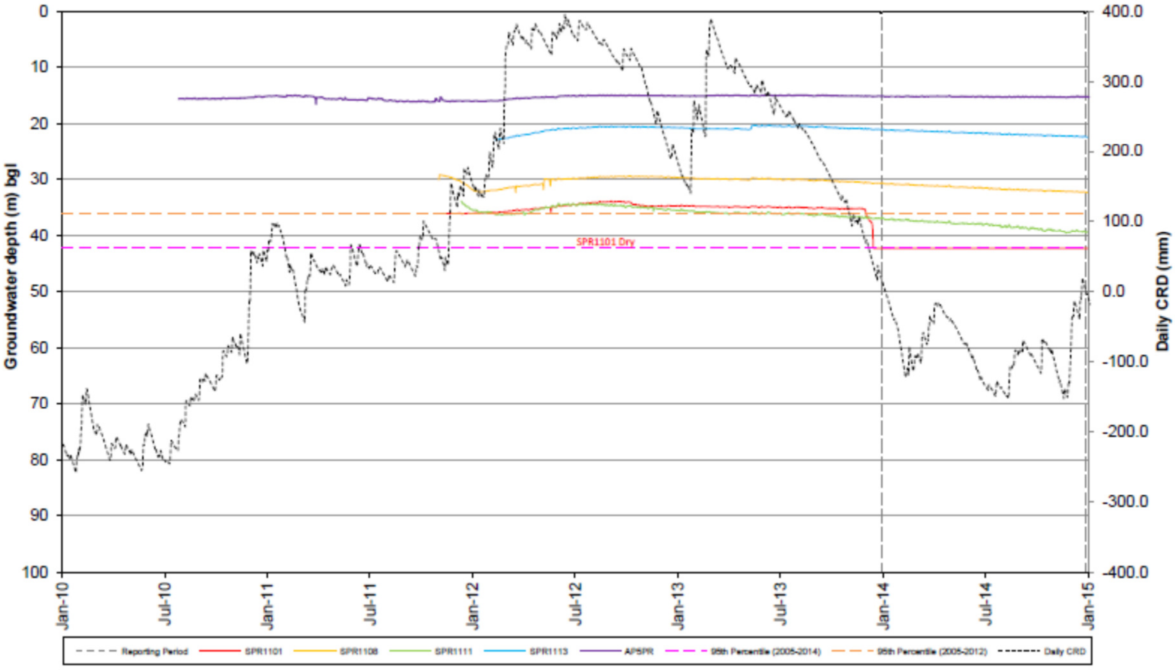

Figure 18 SP1101 Monitoring Data 2010 to 2015

The water level in this borehole has typically remained relatively stable at 35mbgl throughout its monitoring history. However, the water level began to decline on 3 December 2013 to 42.29mbgl on 22 December 2013. This represents a drop of 6.99m to a level below the bottom of the piezometer as the piezometer is dry.

This period also corresponds to the time when the longwall was passing underneath. An investigation into the reason for the rapid drop in the water level in this monitoring point has been conducted. The investigation found that the piezometer hole was previously used as an exploration borehole and was drilled to a depth which intersected strata where bed separation effects and increased storage occurred, and while the water level has declined, it does not represent any net loss of water from the aquifer.

The replacement of SPR1101 with a deeper piezometer to intercept the reduced water level has been completed (SPR1401). A groundwater level logger was installed in this piezometer on 20 November 2014 at which time the water level was manually dipped at 29.47mbgl and has been steadily declining. The water level in SPR1401 has not yet stabilised following installation as the original standing water level at SPR1101 was approximately 36mbgl., however, this piezometer should be used for future reports to compare post mining impacts. The water level on the SPR1101 hydrograph should therefore be deemed anomalous until the data sets from SPR1101 and SPR1401 have been combined appropriately.

Data presented therefore is considered to exceed the trigger values presented in Table 16 and will further be discussed in Section 6.3.

SPR1104

The following figure presents results for SPR1104.

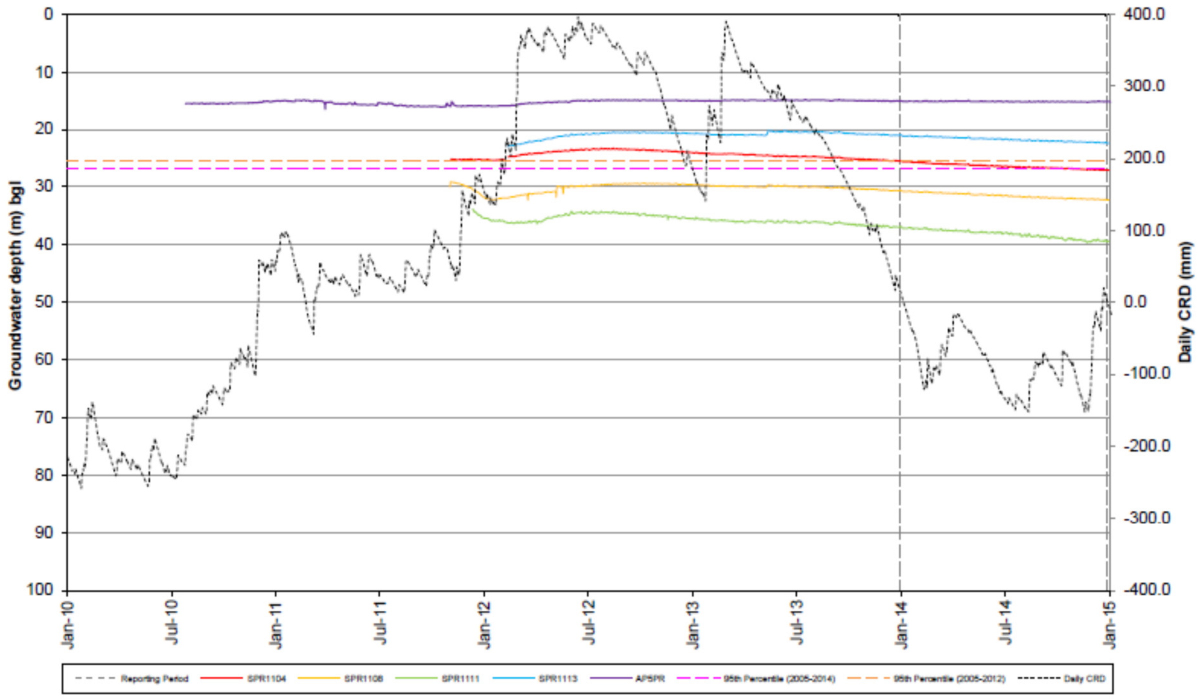

Figure 19 SPR1104 Monitoring Data 2010 to 2015

SPR1104 shows an almost identical groundwater level response to the reference piezometers SPR1113, SPR1108 and SPR1111, both historically and throughout the current review period. The groundwater level has gradually declined during the review period likely responding to longer term climatic influences.

The recalculated 95th percentile has increased by 1.57m (Table 16) with the inclusion of data up to 2014. This reflects the below average rainfall received between 2012 and 2014.

SPR1107

The following figure presents results for SPR1107.

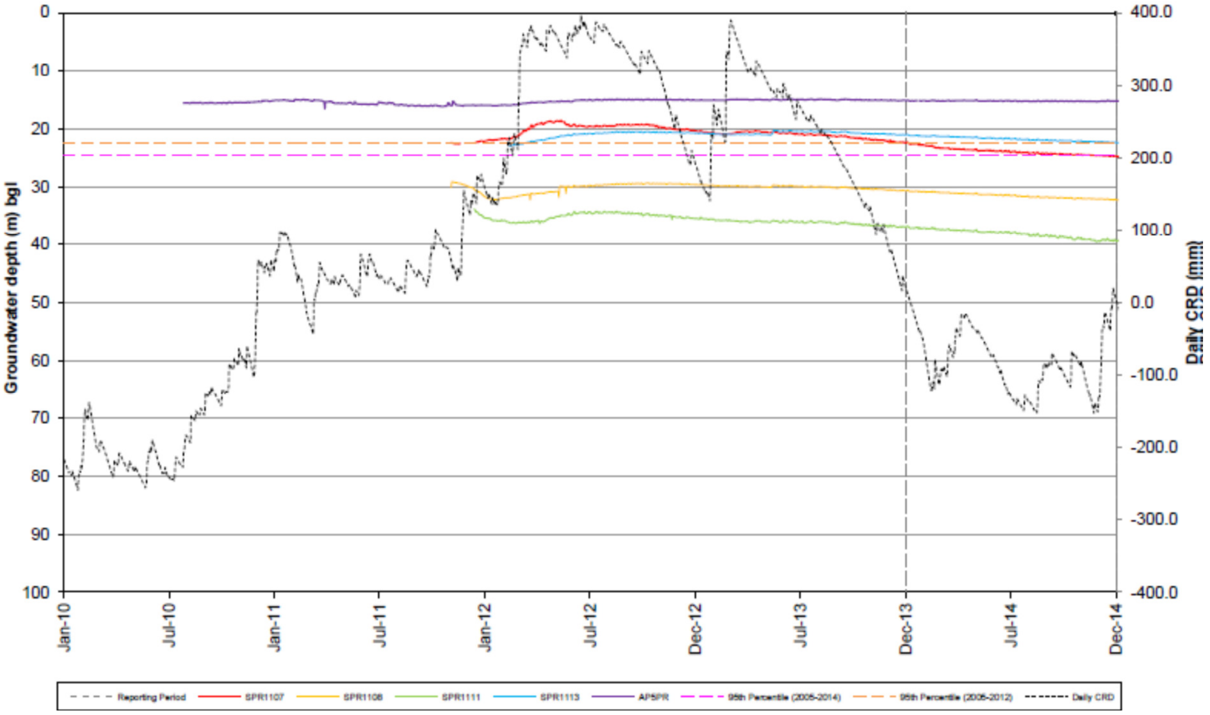

Figure 20 SPR1107 Monitoring Data 2010 to 2015

SPR1104 shows similar groundwater level response to the reference swamps SPR1113, SPR1108 and SPR1111, both historically and throughout the current review period. The groundwater level has gradually declined during the review period likely responding to longer term climatic influences.

The recalculated 95th percentile has increased by 2.00m (Table 16) with the inclusion of data up to 2014. This reflects the below average rainfall received between 2012 and 2014.

SPR1109

The following figure presents results for SPR1109.

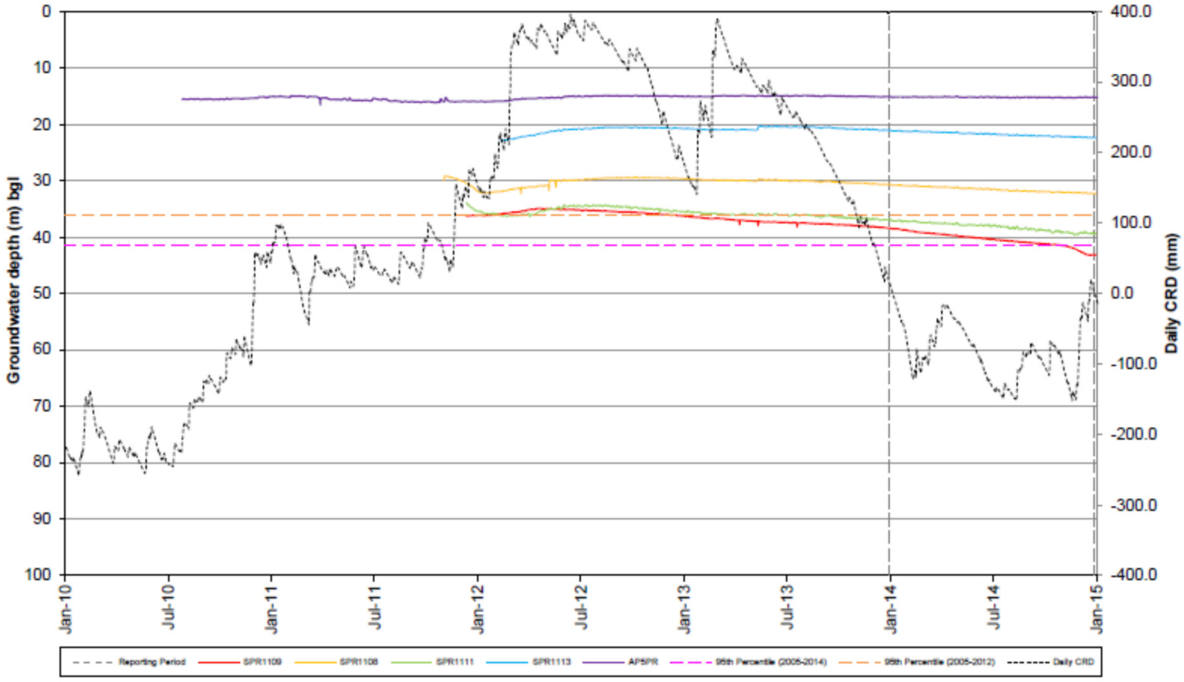

Figure 21 SPR1109 Monitoring Data 2010 to 2015

SPR1109 shows similar groundwater level response to the reference swamps SPR1113, SPR1108 and SPR1111, both historically and throughout the current review period. The groundwater level has gradually declined during the review period likely responding to longer term climatic influences. The water level reduced rapidly during November 2014 which is uncharacteristic of SPR1109. This could be a delayed response to the prevailing dry conditions during 2013 and 2014.

The recalculated 95th percentile has increased by 5.31m (Table 16) with the inclusion of data up to 2014. This reflects the below average rainfall received between 2012 and 2014.

SPR1110

The following figure presents results for SPR1110.

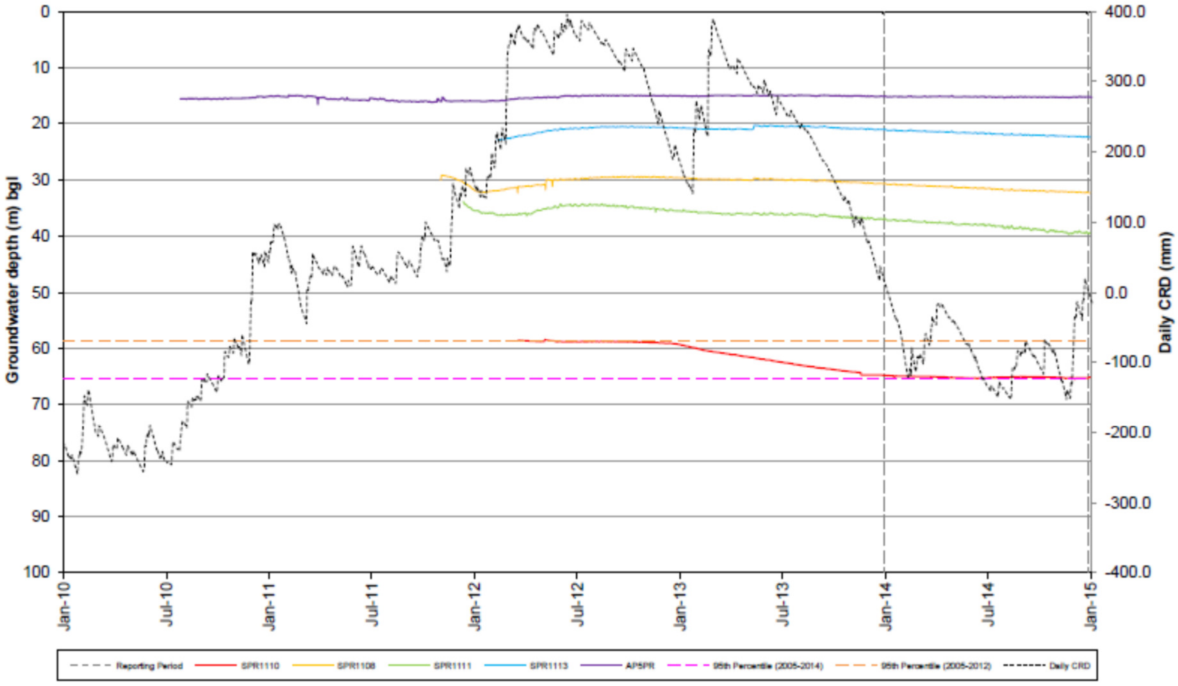

Figure 22 SPR1110 Monitoring Data 2010 to 2015

SPR1110 is located to the east of LW416 panel, a declining trend is observed in this piezometer prior to the current review period, followed by generally stable water levels (during the review period). It is possible that SPR1110 is responding to longer term climatic trends, however no response is observed to individual rainfall events.

The recalculated 95th percentile has increased by 6.48m (Table 16) with the inclusion of data up to 2014. This reflects the below average rainfall received between 2012 and 2014.

5.3.3. Groundwater Quality

Groundwater monitoring samples are collected opportunistically based upon groundwater level which is presented in Section 5.3.1.

All data presented represents baseline condition as there has been no mining within 200m of the piezometer location.

There have therefore been no triggers during the reporting period.

CW1

The following figure presents pH results for CW1.

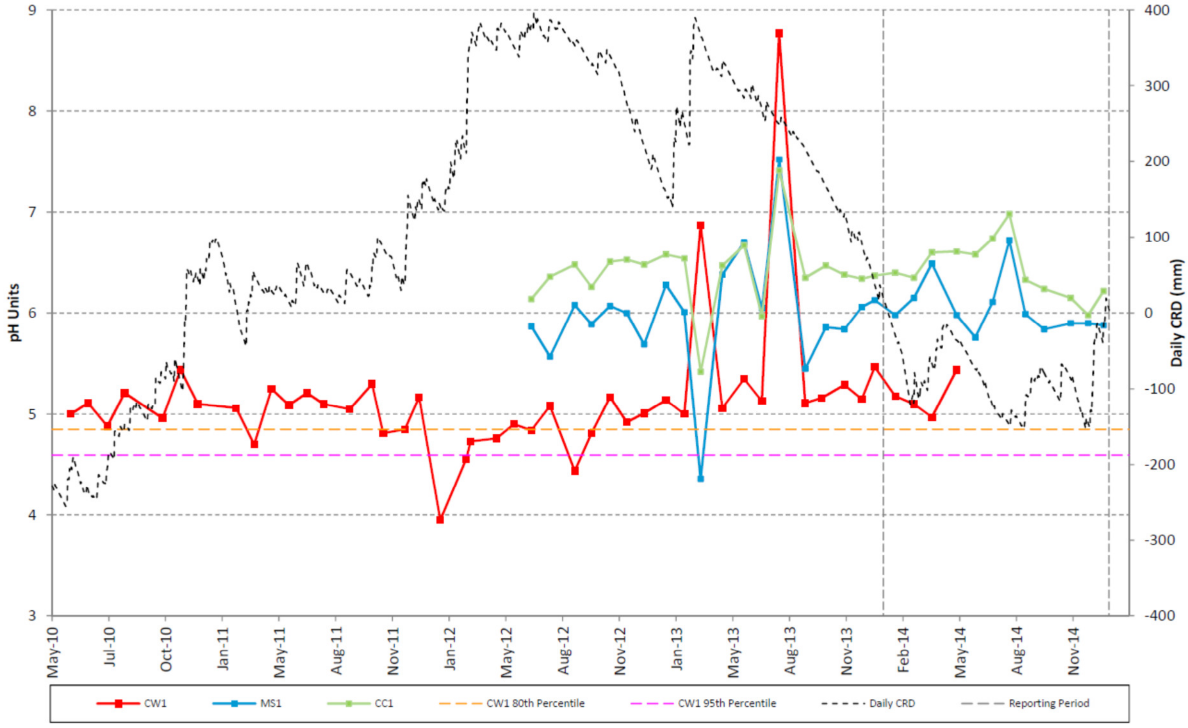

Figure 23 CW1 pH Monitoring Data Feb 2011 to 215

The pH at CW1 has historically ranged between 4.5 and 5.5 pH units, with two spikes of the order of 6.8 and 8.8. The largest spike, observed during July 2013, was also observed at the reference sites.

During the review period, the pH at CW1 remained above the 80th and 95th percentile.

The following figure presents Electrical Conductivity (EC) results for CW 1.

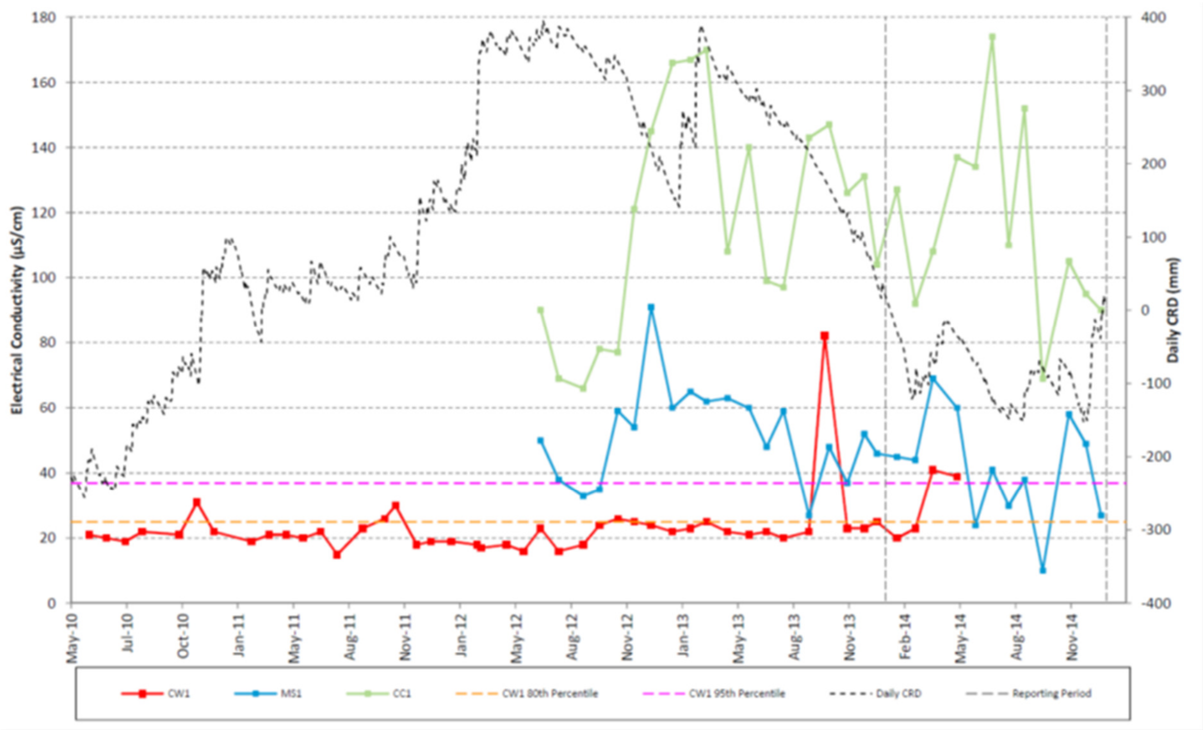

Figure 24 CW1 EC Monitoring Data Feb 2011 to 2015

The EC at CW1 is typically extremely fresh ranging historically ranging between 15 and 40µS/cm, with one spike in September 2013 to 82 µS/cm. Values are typically below those of the reference sites.

During the current review period, two values are observed to exceed the 95th percentile, a corresponding increase in EC is also observed at the reference sites at this time.

The following figure presents Filterable iron results for CW1.

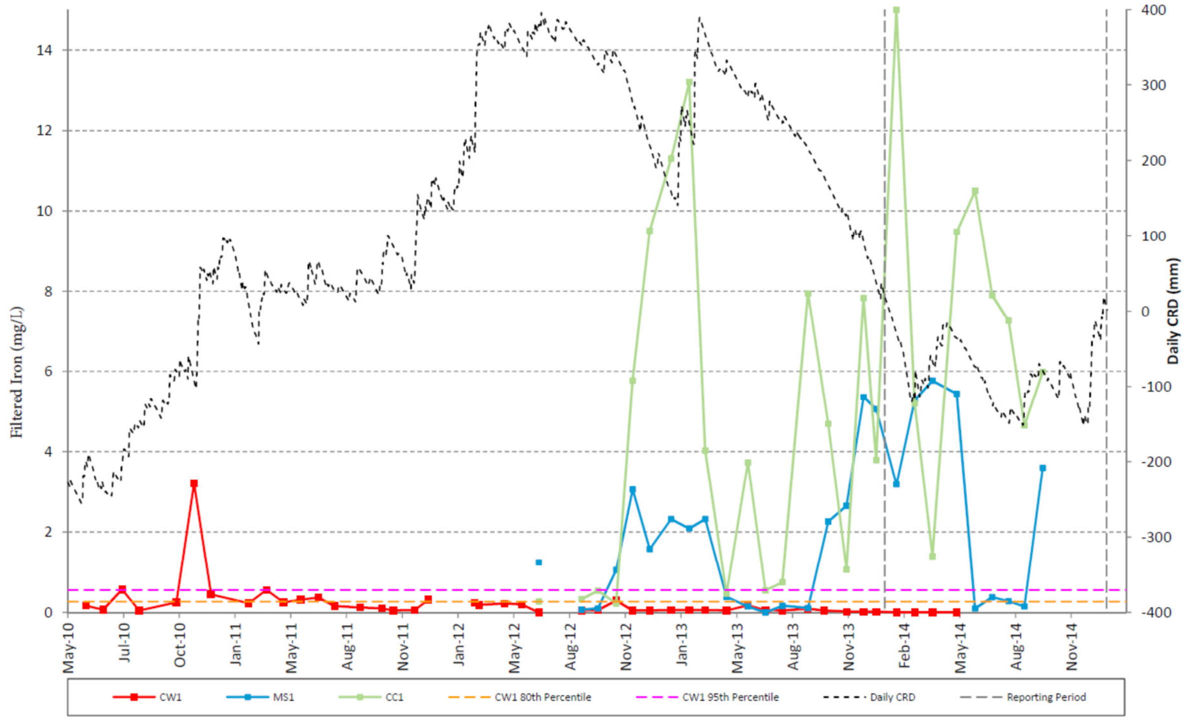

Figure 25 CW1 Filterable Iron Monitoring Data Feb 2011 to 2015

The concentration of filtered iron at CW1 are typically very low, less than 0.5mg/L, and typically an order of magnitude lower than values observed at the reference sites.

Available data over the review period are well below the 80th and 95th percentile values.

CW2

The following figure presents pH results for CW2.

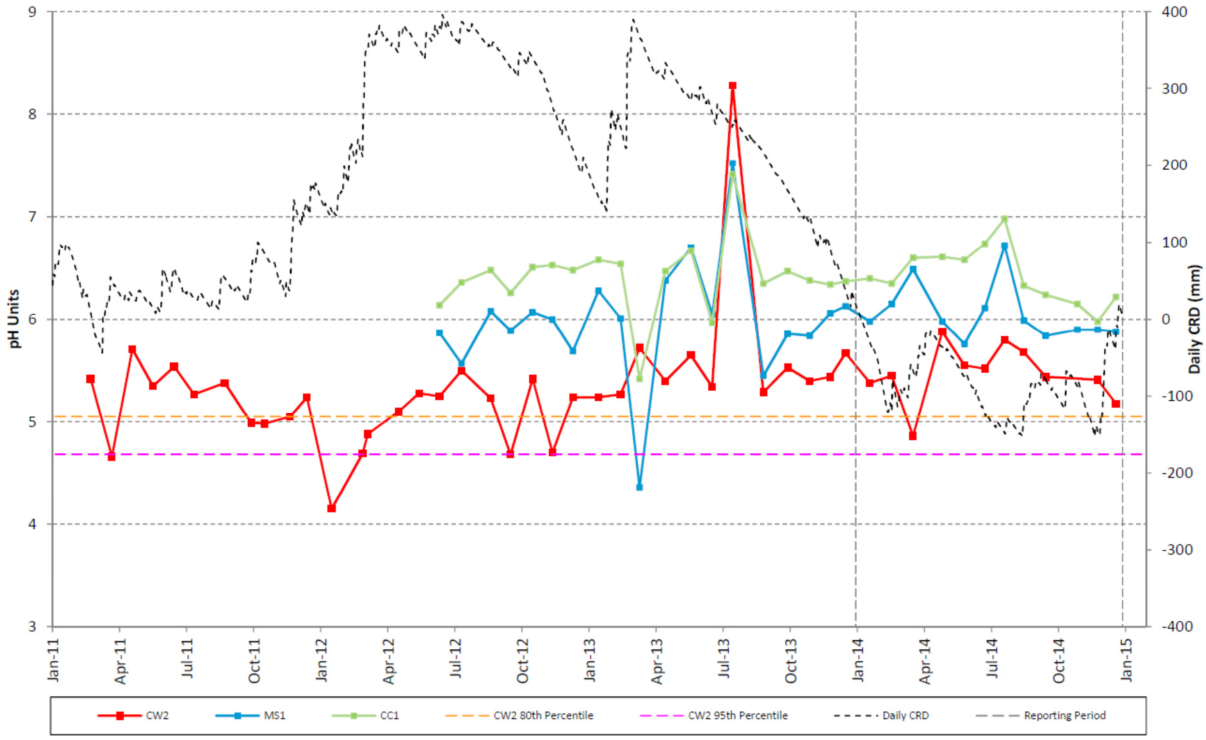

Figure 26 CW2 pH Monitoring Data Feb 2011 to 2015

The pH at CW2 has historically ranged between 4.1 and 5.8 pH units, with one sample spiking to 8.3 pH units. CW2 displays comparable trends, although with marginally lower pH, than the reference sites.

During the review period, the pH at CW2 remained above 95th percentile, with one sample recording below the 80th percentile.

The following figure presents EC results for CW2.

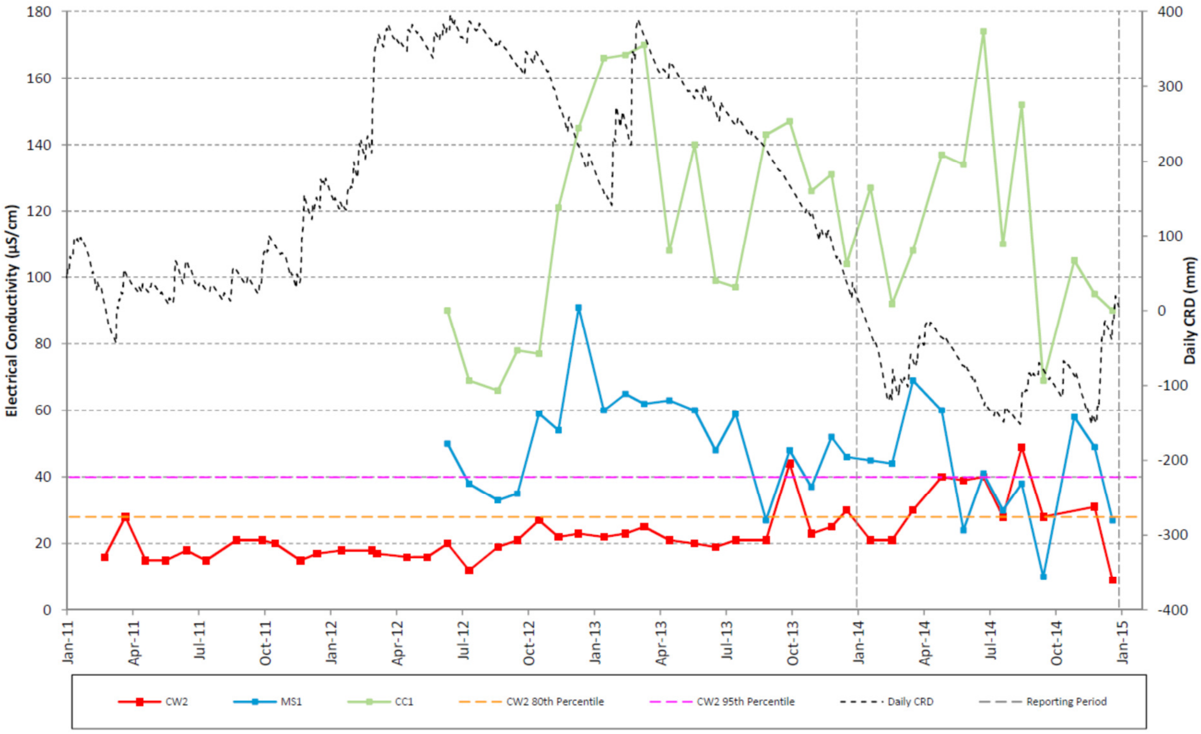

Figure 27 CW2 EC Monitoring Data Feb 2011 to 2015

The EC at CW2 is typically very fresh ranging historically ranging between 9 and 49µS/cm. Values are typically below or equivalent to those of the reference sites.

During the current review period, one value exceeded the 95th percentile, with values then subsequently dropping well below the 80th percentile.

The following figure presents filterable iron results for CW2.

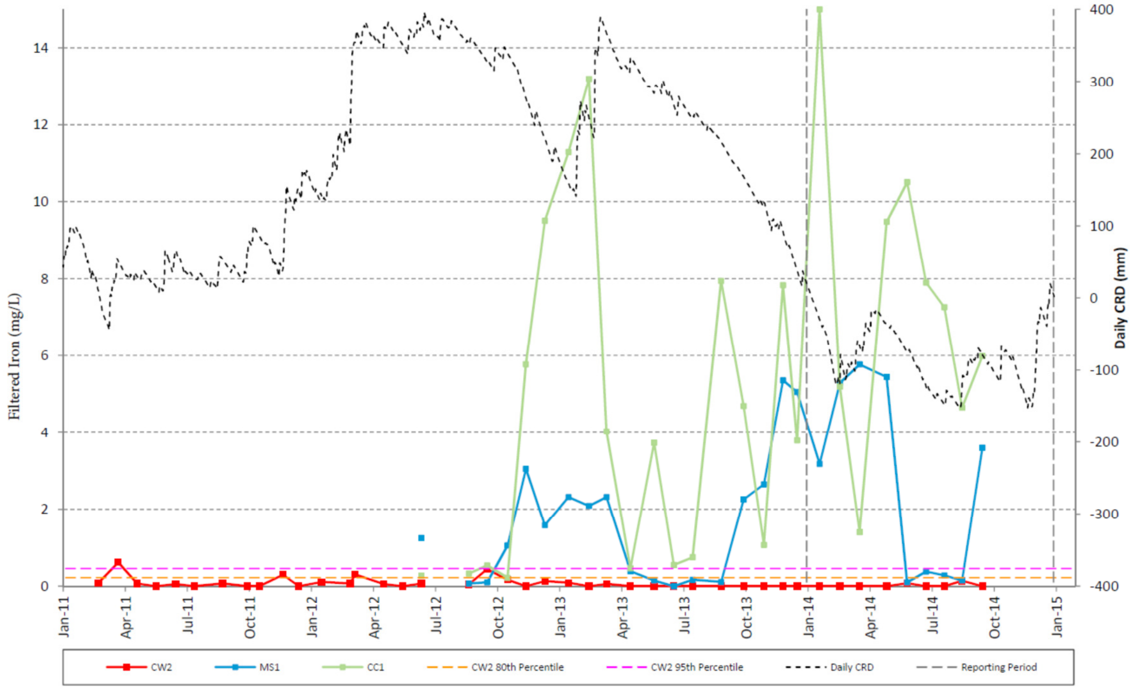

Figure 28 CW2 Filterable Iron Monitoring Data Feb 2011 to 2015

The concentration of filtered iron at CW2 are typically very low, less than 0.5mg/L, and typically an order of magnitude lower than values observed at the reference sites.

Available data over the review period are well below the 80th and 95th percentile values.

SSE3

The following figure presents pH results for SSE3.

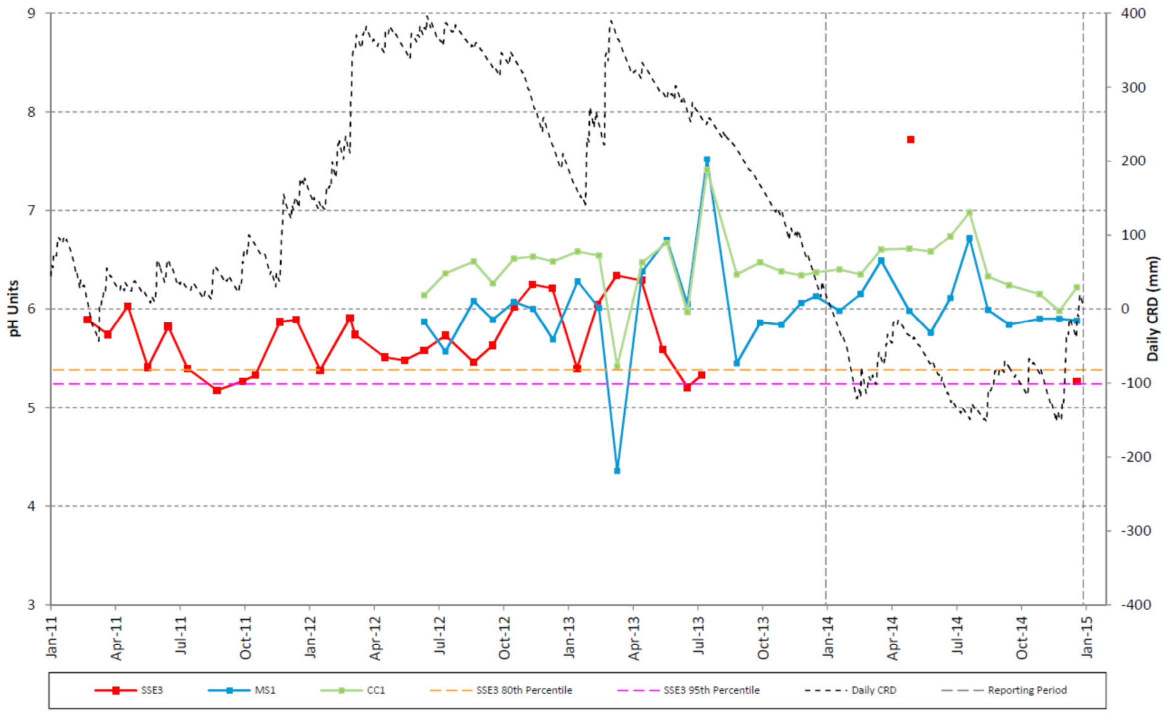

Figure 29 SSE3 pH Monitoring Data Feb 2011 to 2015

The pH at SSE3 has historically fluctuated between 5.2 and 6.3 pH units. These fluctuations are considered natural and are consistent with the reference swamps.

Over the review period both samples from SSE3 were below the 95th percentile for the entire review period. One sample during April was anomalously high (pH 7.72) compared to historical data and is not observed at the reference sites.

The following figure presents EC results for SSE3.

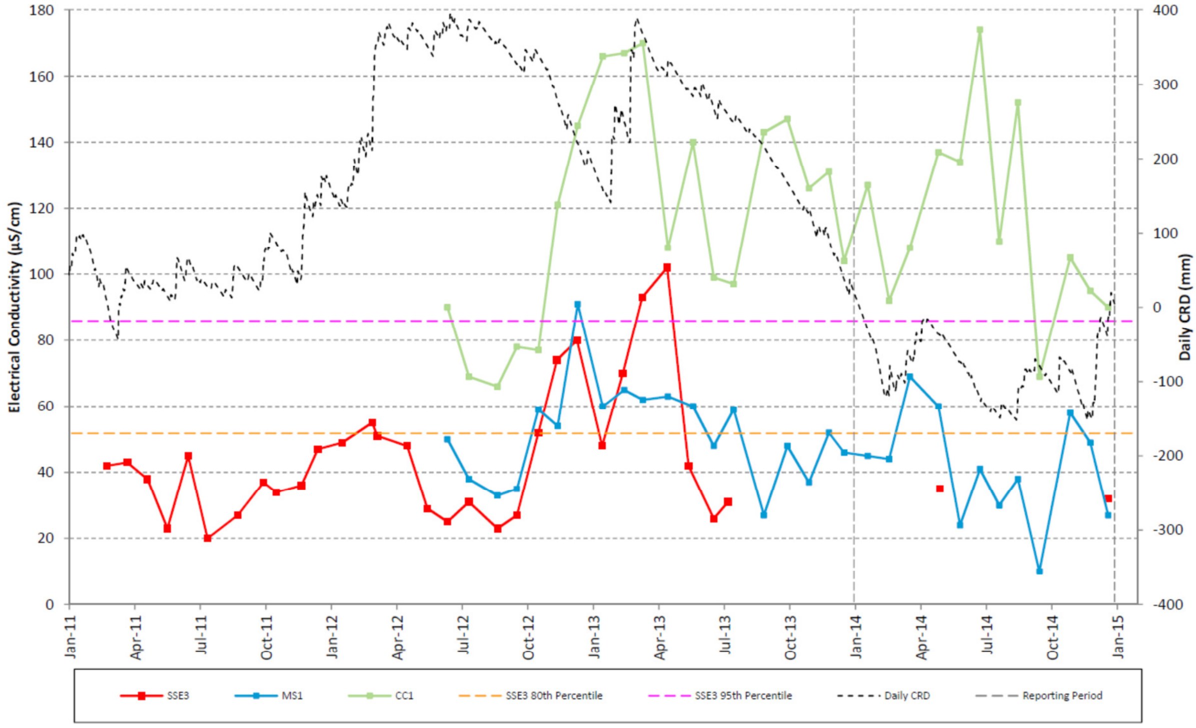

Figure 31 SSE3 EC Monitoring Data Feb 2011 to 2015

The EC at SSE3 is generally very fresh, historically ranging between 20 and 100µS/cm. This is similar to the MS1 reference site and less than the CC1 reference site.

During the review period the two measured EC values were well below the 80th and 95th percentile values.

The following figure presents filterable iron results for SSE3.

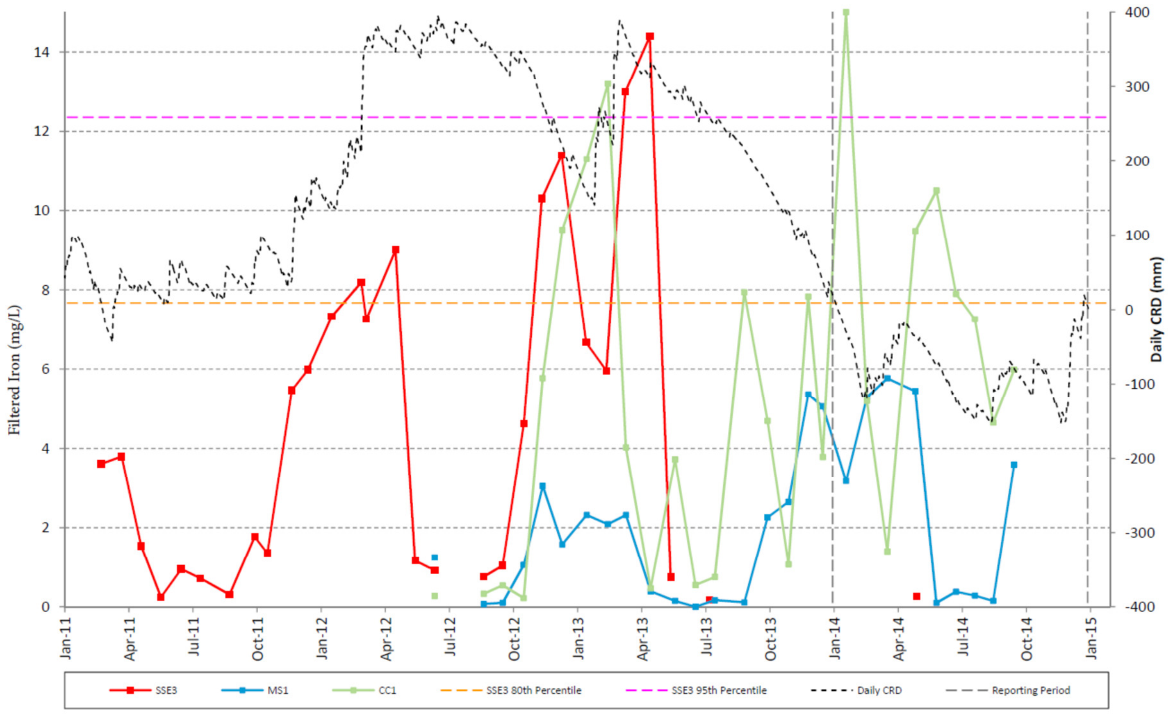

Figure 32 SSE3 Filterable Iron Monitoring Data Feb 2011 to 2015

The concentration of filtered iron at SSE3 has historically ranged between 0.18 and 14.4mg/L with elevated values correlating reasonably well with periods of above average rainfall.

The one concentration obtained during the current reporting period was well below the 80th and 95th percentiles (0.27mg/L).

5.4. Surface Water

Surface water monitoring samples are collected opportunistically based upon groundwater level flow rates.

All data presented represents baseline condition as there has been no mining within 200m of the piezometer location.

There have therefore been no triggers during the reporting period

5.4.1. Carne West

Flow rate

The following figure presents flow rate monitoring results for Carne West.

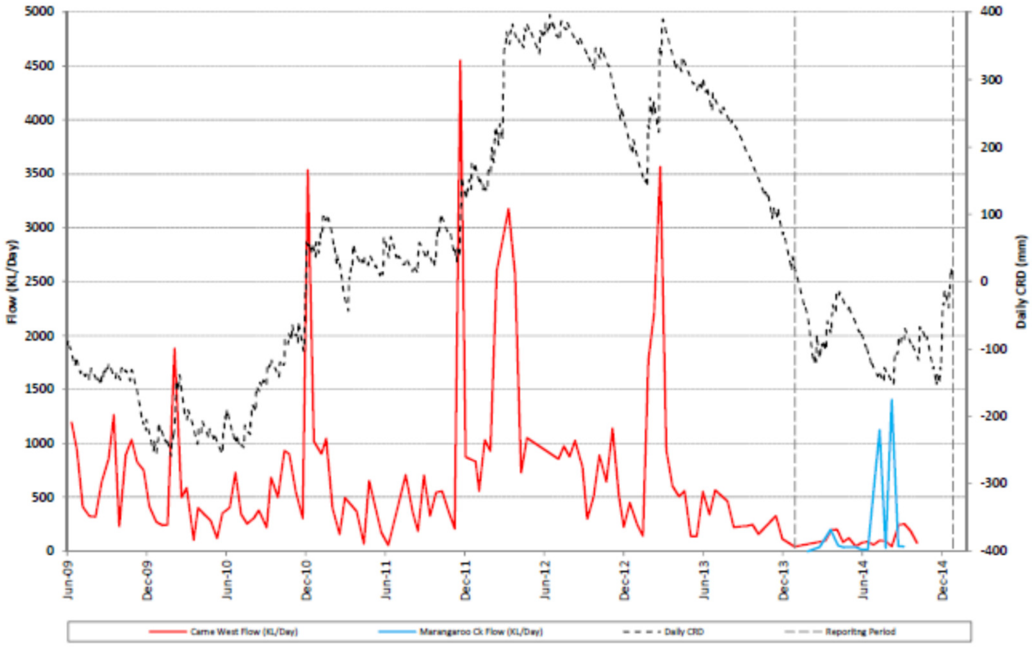

Figure 33 Carne West Flow Monitoring Results June 2009 to 2015

A pool depth monitor was installed at the bottom end of Carne West Swamp on 30 May 2012. Pool data depths show characteristic spikes which correspond to rainfall. Pool depths were generally low during the 2014 period, and regularly dropped below the level of the gauge, consistent with below average rainfall. Despite pool water level falling below the level of the sensor, there is still flow observed coming out of the lower end of Carne West Swamp.

It is noteworthy that spikes in pool depth do not always have a clear, immediate relationship to individual rainfall readings. Progressive increases in pool depth during periods of below average rainfall indicate that there is considerable storage retained in the swamp alluvium/peat, and a delayed release of this water to the stream is occurring. The lag appears to vary between a few days to a few weeks. Carne West generally shows a more subdued response to Marrangaroo Creek flows in response to rainfall, this is likely due to the geometry of the swamps and relative location of the swamp in the sub-catchment.

Water Quality

Carne West pH results are presented in the following figure.

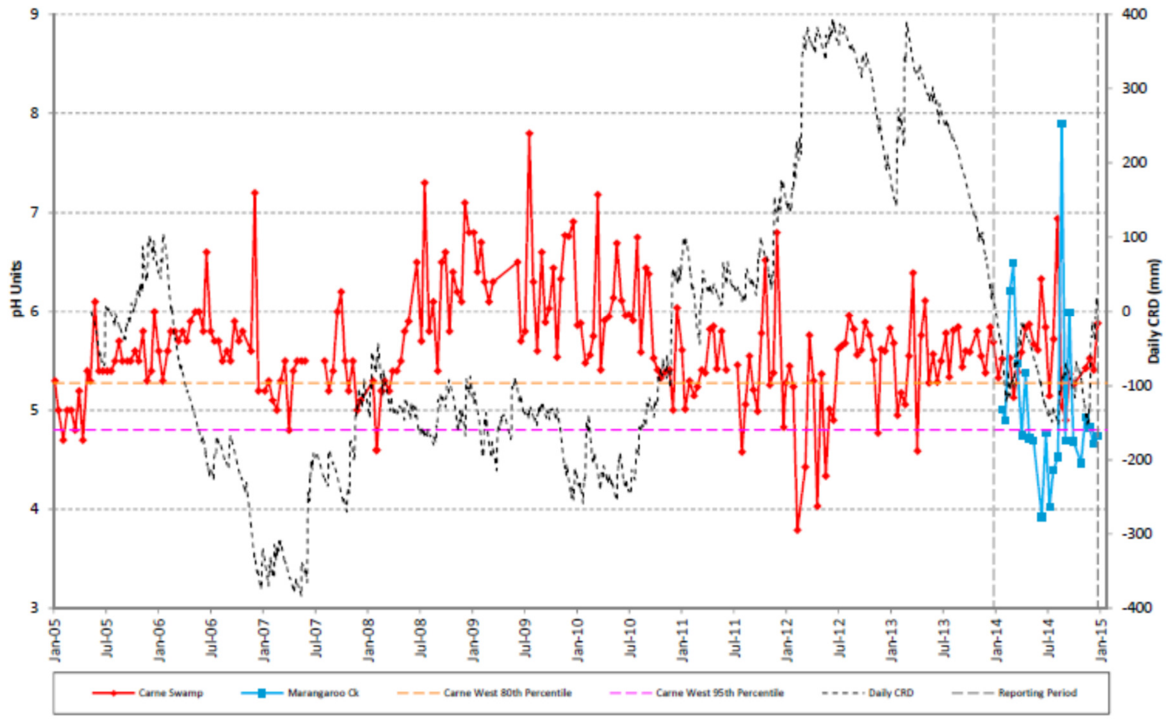

Figure 34 Carne West pH Monitoring Data 2005 to 2015

The pH at Carne West has historically fluctuated between 4 and 8 pH units. These fluctuations are considered natural given that the pH at Marrangaroo Creek fluctuates between similar levels

The pH at Carne West remained above the 95th Percentile for the entire review period and only rarely exceeded the 80th percentile. None of these exceedances were repeated so are interpreted as natural variations.

The following figure presents Carne West Electrical Conductivity (EC) results.

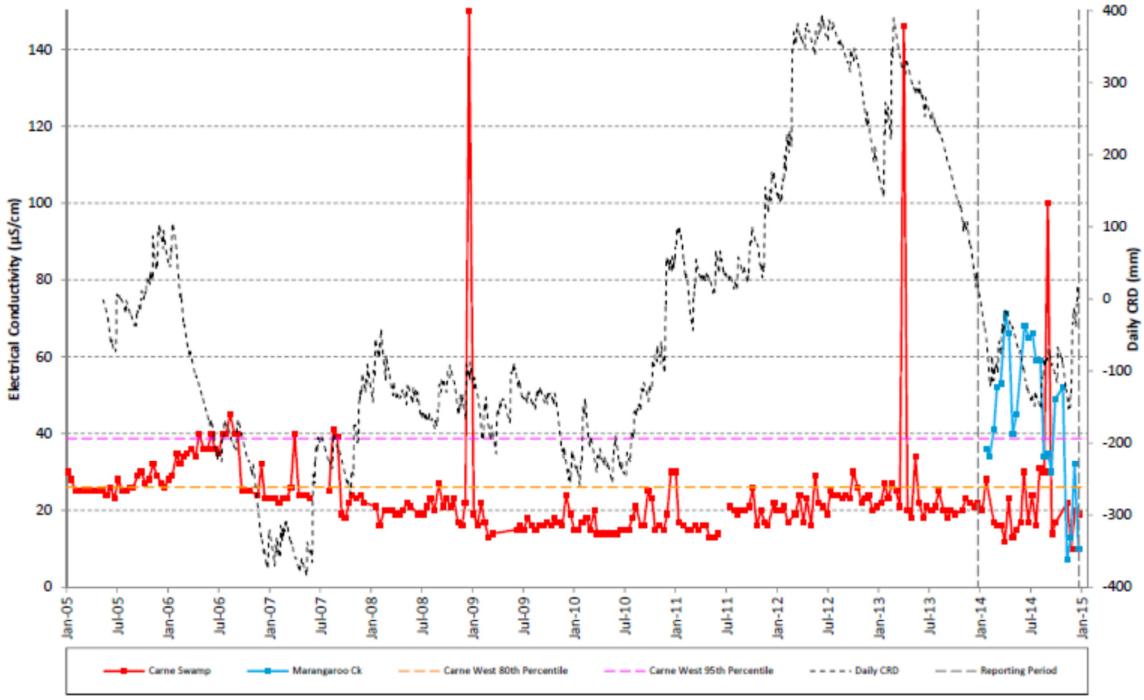

Figure 35 Carne West Monitoring Results 2005 to 2015

The EC at Carne West is extremely fresh ranging historically ranging between 10 and 40µS/cm. which is close to the EC of rain water. Marrangaroo Creek has historically fluctuated between 10 and 70µS/cm, which is also considered fresh. The EC spiked once to 100µS/cm during the review period. This is still considered fresh and is likely due to the flushing out of salts accumulated during the extended dry period during 2013 and 2014.

The following figure present filtered manganese results for Carne West.

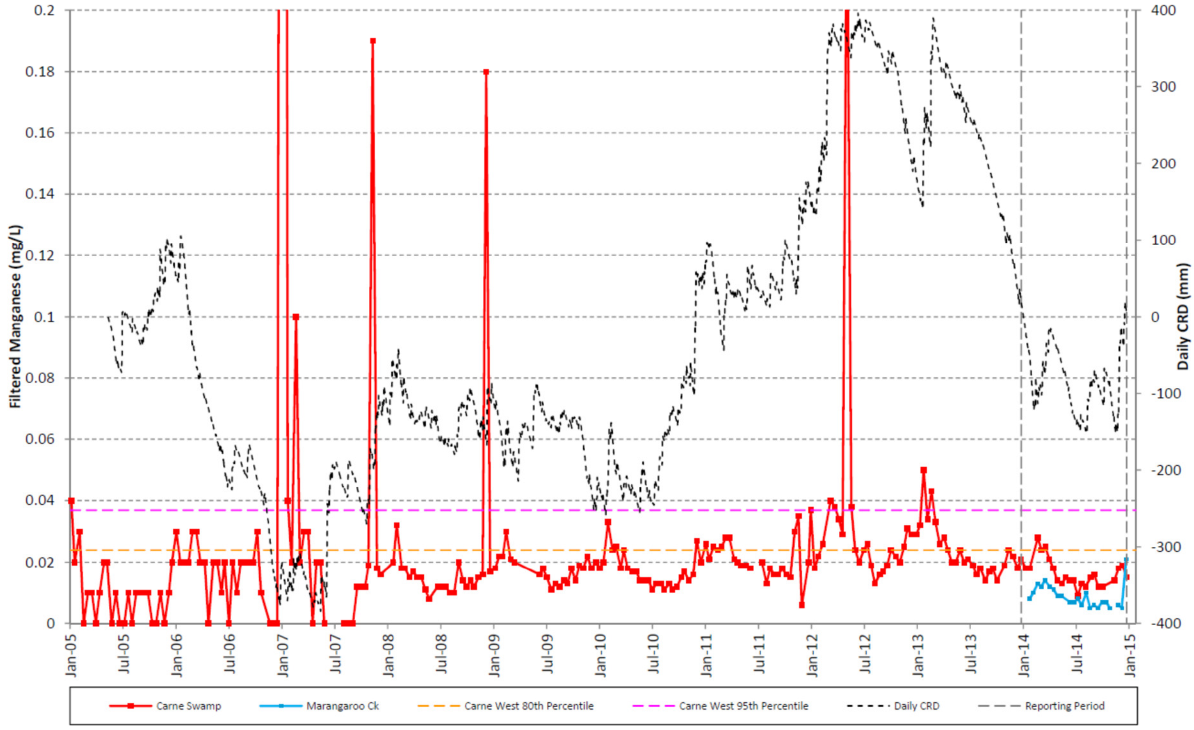

Figure 36 Carne West Manganese Results 2005 to 2015

The concentration of filtered manganese at Carne West historically fluctuates between 0 and 0.05mg/L with occasional spikes recorded during periods of increased rainfall. These results are similar to those recorded at Marrangaroo Creek. Concentrations remained within historic levels throughout the reporting period.

The following figure present filtered iron results for Carne West.

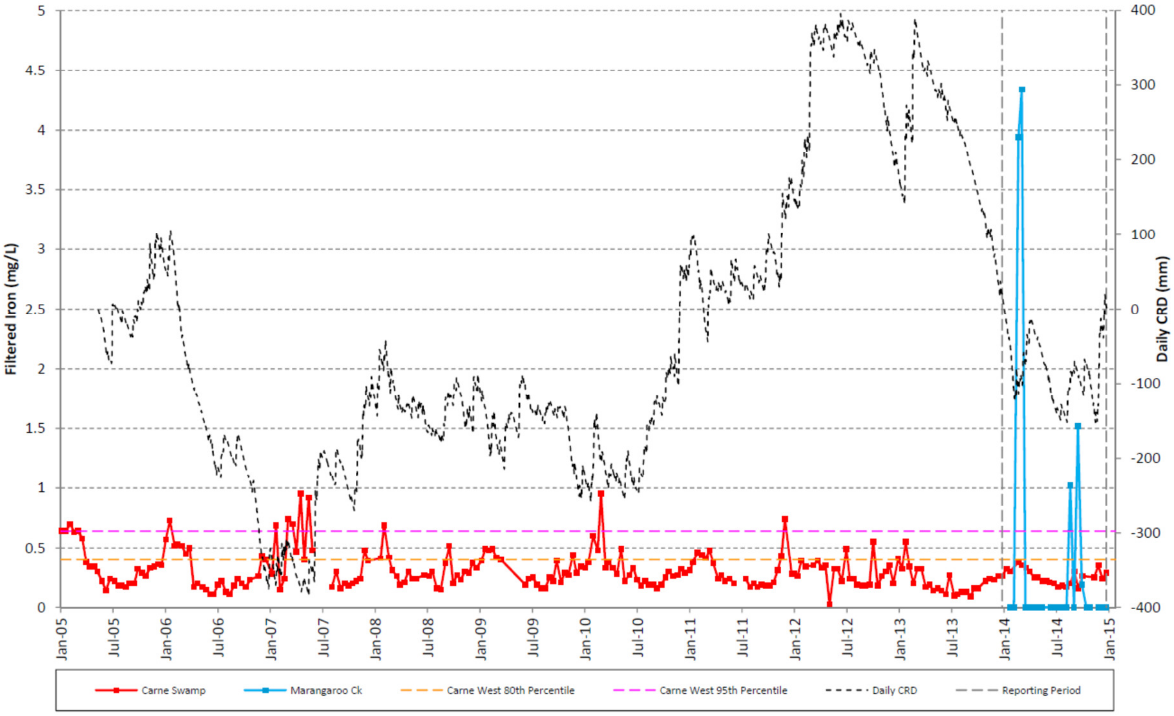

Figure 37 Carne West Filterable Iron Results 2005 to 2015

The concentration of filtered iron at Carne West historically fluctuates between 0.1 and 1.0mg/L with occasional spikes recorded during periods of increased rainfall. These results are similar to those recorded at Marrangaroo Creek. Concentrations remained within historic levels throughout the reporting period.

5.4.2. Carne West Pool

Water Depth

Carne West Pool (CWP) water depth data is presented in the following figure.

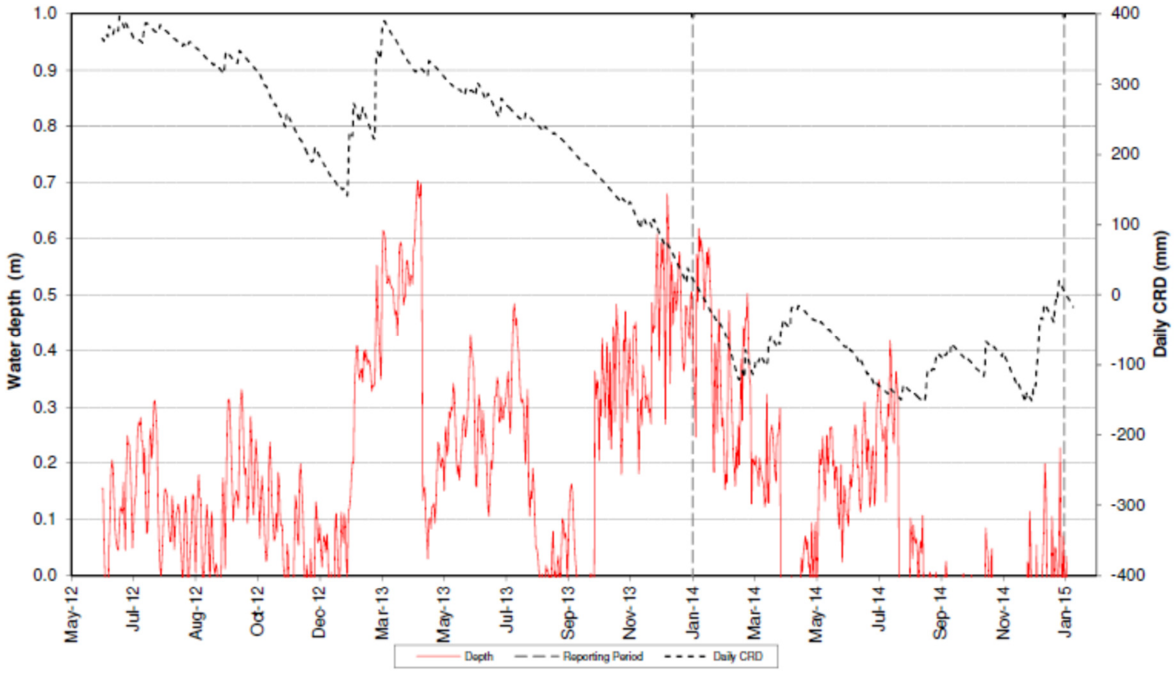

Figure 38 Carne West Pool Monitoring Data May 2012 to 2015

Pool data depths show characteristic spikes which correspond to rainfall. Pool depths were generally low during the 2014 period and dropped below the level of the gauge on several occasions. This response is consistent with below average rainfall. Despite the pool water level falling below the sensors detection limit, flow continues to be observed downstream of the monitoring point.

Spikes in pool depth do not always have a clear immediate relationship with rainfall events. Progressive increases in pool depth during periods of below average rainfall indicate that there is considerable storage retained in the swamp alluvium/peat, and a delayed release of this water to the stream is occurring.

5.4.3. SS3 Downstream

Water Quality

The following figure presents pH results for SS3 Downstream DS.

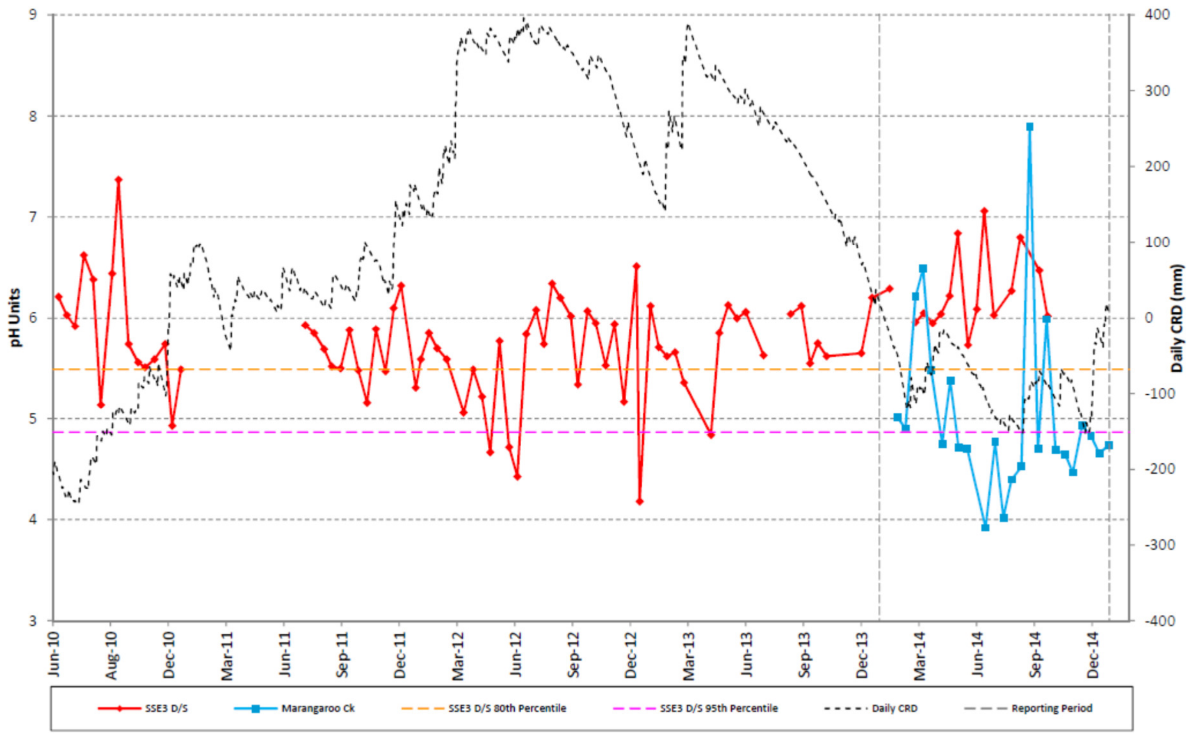

Figure 39 SS3 D/S pH Monitoring Results June 2010 to 2015

The pH at SS3 D/S has historically fluctuated between 4.5 and 7.5 pH units. These fluctuations are considered natural given that the pH at Marrangaroo Creek fluctuates between similar levels.

The pH at SS3 D/S remained above the 80th and 95th Percentile for the entire review period.

The following figure presents electrical conductivity results SS3 D/S.

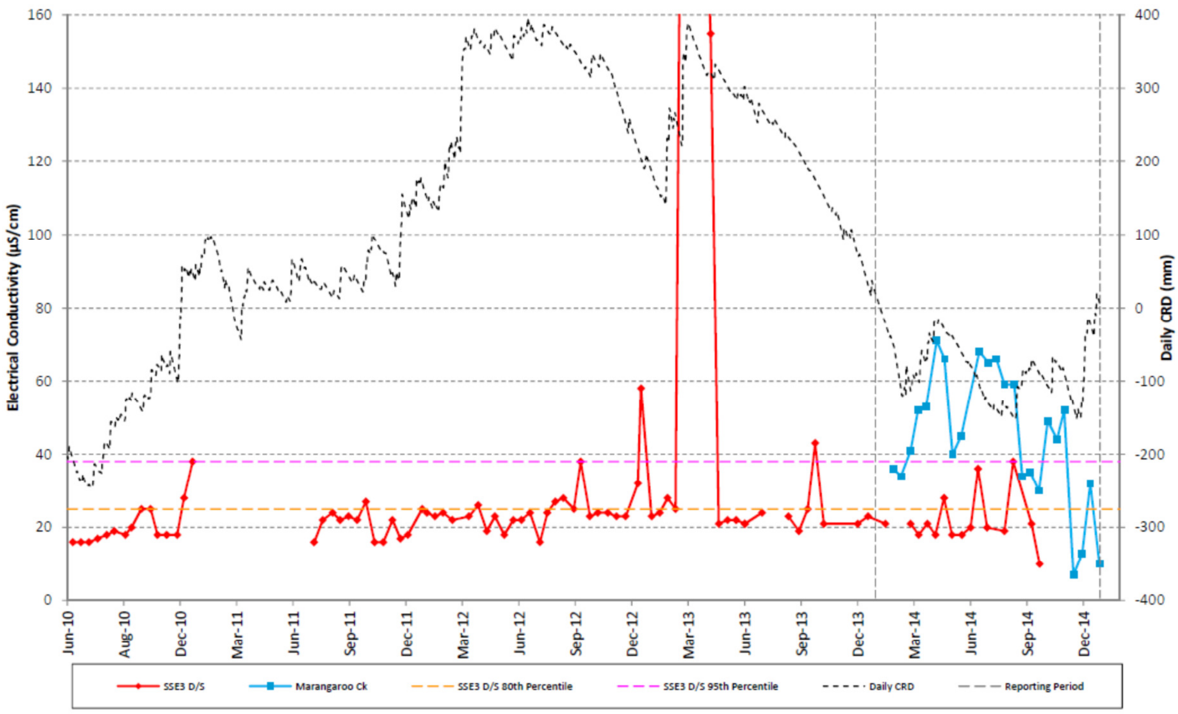

Figure 40 SS3 D/S Electrical Conductivity Results June 2010 to 2015

The EC at SS3 D/S is extremely fresh ranging historically ranging between 10 and 40µS/cm. which is close to the EC of rain water. Marrangaroo Creek has historically fluctuated between 10 and 70µS/cm, which is also considered fresh. The EC spiked once to 100µS/cm during the review period. This is still considered fresh and is likely due to the washing out of built up salts during the extended dry period built up during 2013 and 2014

The following figure presents filterable manganese results for SS3 D/S.

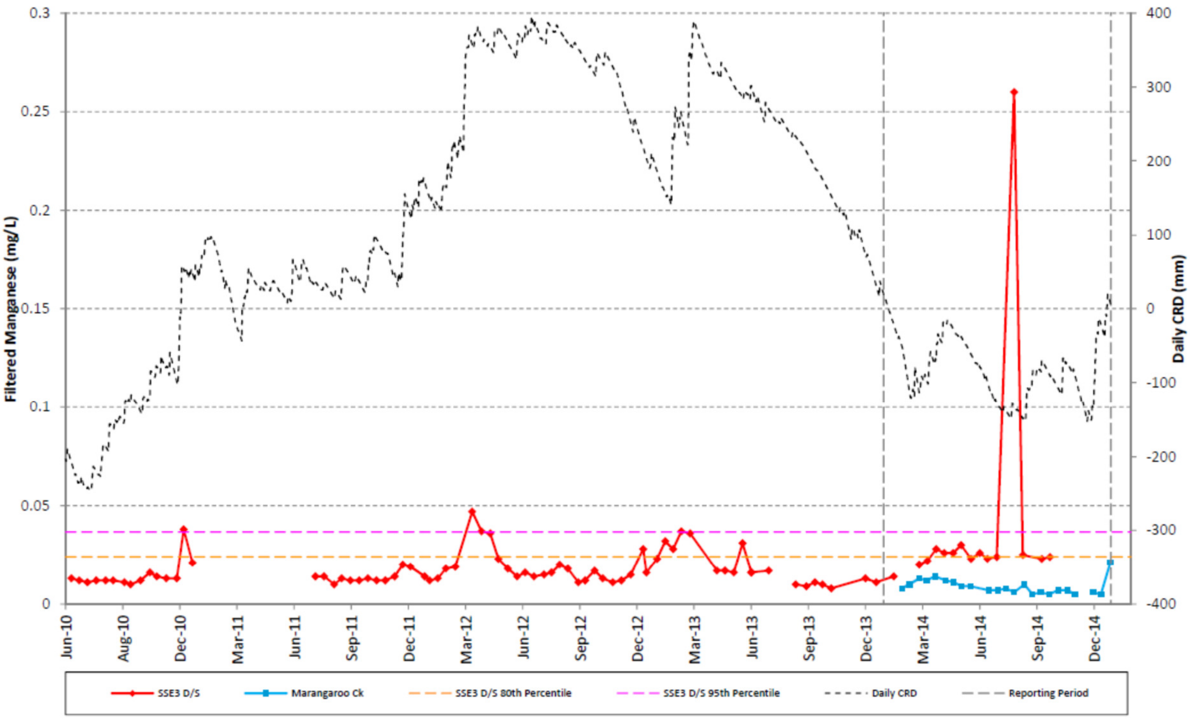

Figure 41 SS3 D/S Filterable Manganese Results

The concentration of Filtered Manganese at SS3 D/S historically fluctuates between 0.01 and 0.05mg/L with occasional spikes recorded during periods of increased rainfall. These results are similar to those recorded at Marrangaroo Creek. Concentrations remained within historic levels throughout the reporting period. One spike of 0.26mg/L was recorded; however this level is not repeated and is considered a natural variation.

The following figure presents filterable iron results for SS3 D/S.

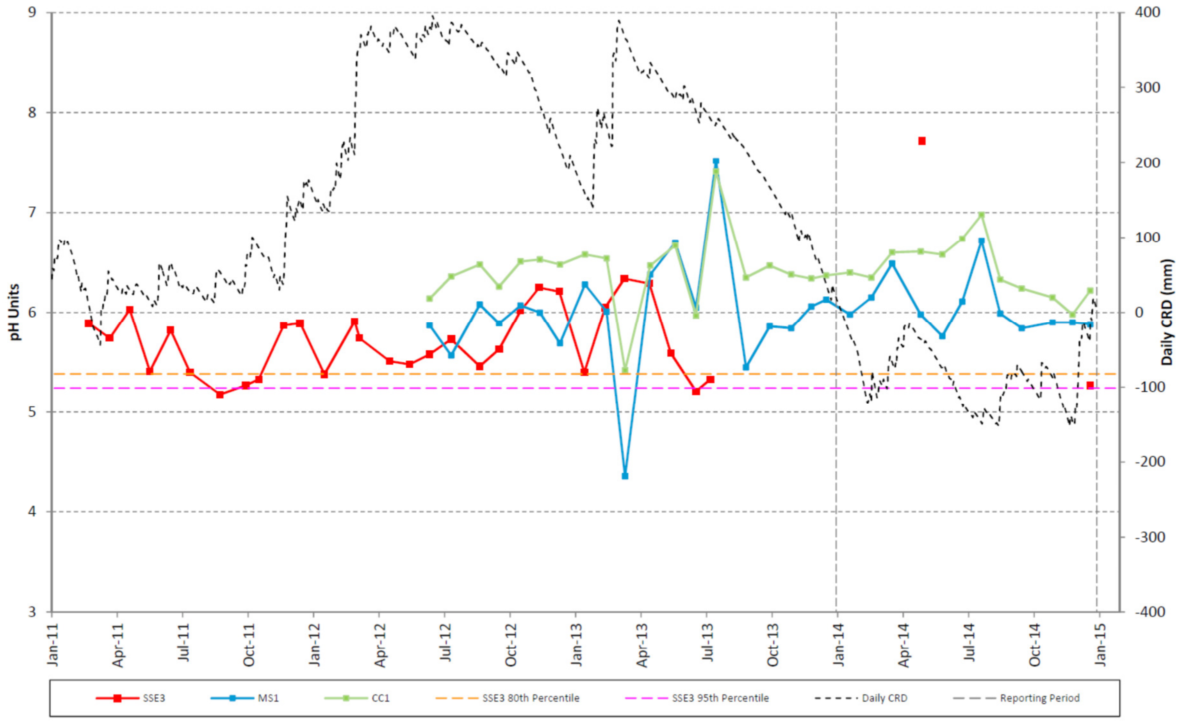

Figure 42 SS3 DS Filterable Iron Monitoring Results June 2010 to 2015

The concentration of Filtered Iron at SS3 D/S historically fluctuates between 0.1 and 0.5mg/L with occasional spikes recorded during periods of increased rainfall. These results are similar to those recorded at Marrangaroo Creek. Concentrations remained slightly elevated throughout the reporting period which is likely the result build up in concentration during the prevailing dry conditions through 2013 and 2014.

6. TRIGGER LEVEL EXCEEDANCES

6.1. Subsidence

Triggers for subsidence have been developed following modelled predictions for subsidence above longwall panels 415, 416 and 417. The modelling is based on previous monitoring data as well as subsidence theory.

Anomalous subsidence is defined in the Springvale Coal EPBC approval 2011/5949. The subsidence trigger levels from the THPSMMP are presented in Table 17.

Table 17. Subsidence Trigger Levels

Location	Survey Sites	Performance Trigger Levels	
		Anomalous Subsidence	
LW415 (W=315 metres)	B and M Cross lines	Subsidence	>1.5 metres
		Tilt	> 10 mm/metres
		Tensile Strain	> 15 mm/metres
		Compressive Strain	>18 mm/metres
LW416 and 417 (W=260 metres)	B and M Cross lines	Subsidence	> 1.1 metres
		Tilt	> 7 mm/metres
		Tensile Strain	> 5 mm/m
		Compressive Strain	> 6 mm/m (plateaus) > 14 mm/m (valleys)
Sunnyside East Swamp	*V-VC and W-WC Lines* *LiDAR*	Subsidence	>1.1 metres
		Tilt	> 7 mm/metre
		Tensile Strain	> 5 mm/metre
		Compressive Strain	>14 mm/metre
Carne West Swamp	Y-YC1, YC2 and B Lines LiDAR	Subsidence	>1.1 metres
		Tilt	> 7 mm/metre
		Tensile Strain	> 5 mm/metre
		Compressive Strain	>14 mm/metre

During the reporting there were no exceedances of the trigger levels.

6.2. Flora

Triggers for flora have been developed using data collected from reference site monitoring carried out since 2003. The triggers have been developed based on an analysis of natural variance in vegetation communities which has been determined following an analysis of reference site data.

Details of trigger levels for flora are set out in Table 18. Each trigger has a defined level of change and a defined timescale in which this change is to be observed to determine whether an impact has occurred.

Table 18. Flora trigger levels

Performance indicator	Parameter measured	Trigger level
Change in species assemblage	Change in diversity of native species	A change in the number of species of greater than 30 % for a given site within a three year period.
	Recruitment of eucalypt species	An increase in eucalypts in an impact site compared to reference sites of more than three individual plants within a one year period.
Change in condition	Condition of key species	A decline in condition score at an impact site of more than 1.5 compared to the average condition score at un-impacted sites within a one year period. Details of the condition scores are shown in Table 7.2
	Non-live ground cover	An increase of bare ground of more than $100m^2$ in a site within a three year period.
	Non-native weeds	An increase in non-native weed species of more than 4 in a monitoring site (each having a cover of greater than 5%) compared to the average number in reference sites within a one year period.

During the reporting there were no exceedances of the trigger levels.

6.3. Groundwater

The methodology for developing groundwater level triggers to determine whether anomalous impacts have occurred is based on statistical analysis and the development of percentile based triggers.

Short-term significant changes in groundwater level are considered to occur at the 95th percentile level. However, exceedance of this level, by definition, will occur five percent of the time under natural conditions. This has led to the development of long term triggers that complement the short term triggers. Any mining-induced changes in groundwater levels will be inferred based on a set of trigger values for the groundwater depths in swamp piezometers and the groundwater elevations at ridge top aquifer piezometers installed beneath the ridges between swamps.

Table 19. Short and Long term change descriptions as relevant to groundwater depth and aquifer groundwater level

Type of change	Description
Swamp groundwater depth (from ground surface)	
Short-term changes	Trigger level is exceeded if the groundwater depth in any piezometer > 95th percentile pre-mining groundwater depth for more than 7 consecutive days
Long-term changes	Trigger level is exceeded if the post-mining 50th percentile groundwater depth for any piezometer > 80th percentile pre-mining level
Aquifer groundwater level	
Short-term changes	Trigger level is exceeded if the groundwater level > baseline 95th percentile or < baseline 5th percentile pre-mining groundwater level for more than one month
Long-term changes	Trigger level is exceeded if the post-mining 50th percentile groundwater level for any bore is > baseline 80th percentile or < baseline 20th percentile pre-mining level

Due to the relatively short time period since undermining long term changes to groundwater depth cannot yet be determined.

The trigger levels are based on the monitoring record from 1 January 2005 up to 31 December 2011 at the swamp piezometers and up to 30 April 2012 for aquifer piezometers.Groundwater triggers for swamp piezometer water are presented in table 20 while aquifer piezometer trigger levels are presented in table 21.

Baseline data collection is however considered up to the time until mining is within 200m of the piezometer. Trigger levels have therefore been recalculated when considering the results presented. Accordingly Centennial Coal will update the THPSSMP in consultation with Department of Environment (formally SEWPaC).

Table 20. Groundwater trigger levels for swamp piezometers

Location	Short-term Change 7-day moving average greater than the Pre-mining 95th Percentile for 7 days (metres below ground level)	Long-term Change Post-mining median greater than the Pre-mining 80th Percentile (metres below ground level)
Permanently Waterlogged		
CW1	0.25	0.21
CW2	0.24	0.22
SSE3	0.17	0.04
Periodically Waterlogged		
CW3^	1.01	1.01
CW4	1.21	1.13
SSE1	2.12	2.11
SSE2	0.70	0.41

A THPSS MMP TARP trigger (trigger) has been activated in a swamp piezometer (SSE1) in Sunnyside- East Swamp. The trigger was based on historical monitoring data which indicated a decline in the water level in SSE1 piezometer. Notification of the trigger was received by Centennial from RPS on 24 March 2014 following data verification and specialist hydrological interpretation.

Notification of the triggers was provided to the Federal Department of Environment on 28 March 2014, as required under the response protocol in the THPSS MMP TARP.

Section 7 provides details on the response strategy undertaken.

Table 21. Groundwater trigger levels for aquifer piezometers

Location	Short-term Change (7-day moving average less than the Pre-mining 5th Percentile for 1 month)	Short-term Change (7-day moving average greater than the Pre-mining 95th Percentile for 1 month)	Long-term Change (Post-mining median less than the Pre-mining 20th Percentile)	Long-term Change (Post-mining median greater than the Pre-mining 80th Percentile)
RSS	1125.6	1131.4	1127.9	1129.8
SPR1101^	1089.9	1090.8	1090.0	1090.6
SPR1104	1070.1	1073.1	1071.8	1072.8
SPR1107	1090.0	1093.7	1090.5	1093.2
SPR1109	1077.0	1078.3	1077.1	1078.0
SPR1110	1089.8	1090.1	1089.8	1090.0

A trigger has been activated in an aquifer piezometer (SPR1101) installed on the topographic ridge to the west of Sunnyside-East Swamp. The trigger was based on historical monitoring data which indicated a decline in the water level in SPR1101 piezometer. Notification of the trigger was received by Centennial from RPS on 24 March 2014 following data verification and specialist hydrological interpretation.

Notification of the triggers was provided to the Federal Department of Environment on 28 March 2014, as required under the response protocol in the THPSS MMP TARP.

Triggers for groundwater quality have been developed using data collected from reference sites. This data has been assessed using the ANZECC (2000) Water Quality Guidelines for the Protection of Aquatic Life (95% species protection levels) to calculate the triggers. Groundwater quality triggers were developed using the ANZECC (2000) guidelines procedure for setting local guidelines when the water quality does not meet the default ANZECC (2000) guideline values because of local conditions. The 80th percentile value of background water quality is used as the local water quality value in the case where the background concentrations are higher than the ANZECC (2000) guidelines. The default is used if the 80th percentile is lower than the default trigger value. This approach has been used to develop the water quality triggers for groundwater.

Trigger levels for groundwater quality are presented in Table 22.

Table 22. **Groundwater quality trigger levels**

Element	Short-term Minor Change (1)	Short-term Major Change (2)	80th Percentile Baseline
CW1			
pH	4.6 – 5.3	4.1 – 5.8	4.8 – 5.0
EC (uS/cm)	30	30	22
Fe (Filterable Mg/L)	0.57	1.69	0.37
CW2			
pH	4.5 – 5.6	4.0 – 6.2	4.8 – 5.4
EC (uS/cm)	23.1	27.1	20.2
Fe (Filterable Mg/L)	0.48	0.67	0.30
SSE3			
pH	5.2 – 5.9	4.8 – 6.5	5.3 – 6.1
EC (uS/cm)	52	69	48
Fe (Filterable Mg/L)	8.43	13.51	7.27

As there has been no mining within 200m of these locations the triggers all data collected is considered baseline and there has been no exceedances of the trigger values defined in Table 22.

6.4. Surface Water

Surface water quality triggers have been developed using the ANZECC (2000) water quality guidelines for protection of aquatic life (95% species protection levels). Minor and major variation / impacts will be assessed by using the ANZECC protocols of comparing the pre-mining 80th and 95th percentile baseline with the 50th percentile of the post-mining data and allowing for the effects of short-term spikes due to rainfall runoff events.

Table 23 provides a description short term and long term changes in reference to minor or major variations. The surface water triggers levels are presented in Table 24.

Table 23. Short and Long term change descriptions as relevant to minor and major changes in surface water

Type of change	Description
Minor Changes	
Long-term minor changes	For each analyte, if the post-mining 50th percentile ≤ baseline 80th percentile, the changes are considered minor and would not have an unacceptable impact on aquatic life (i.e. provided the long-term increase in concentrations is such that the 50th percentile does not exceed the baseline 80th percentile, the increase is considered to be minor)
Short-term minor changes –	For each analyte, if any measured parameter > baseline 80th percentile, but ≤ baseline 95th percentile (5th percentile for pH) trigger value for ≤ two months, the changes are considered minor and would not have an unacceptable impact on aquatic life. It should be noted that about 20% of observations will exceed the 80th percentile and these are usually short-term spikes in concentrations, which are often due to rainfall runoff events. These short-term spikes generally occur for less than two consecutive months.
Major Changes	
Long-term major changes	For each analyte, if the post-mining 50th percentile > baseline 80th percentile, the changes are considered major.
Short-term major changes	For each analyte, if any measured parameter > baseline 80th percentile by two standard deviations for more than two months, the changes are considered major

Table 24. Surface Water Quality Triggers

Element	Short-term Minor Change (1)	Short-term Major Change (2)	80th Percentile Baseline
Carne Swamp			
pH	4.80 – 6.8	4.1 – 7.3	5.3 – 6.1
EC (uS/cm)	40	51	27
Mn (Filterable Mg/L)	0.036	0.174	0.022
Fe (Filterable Mg/L)	0.69	0.77	0.44
Sunnyside East Swamp			
pH	5.0 – 6.5	4.5 – 6.5	5.5 – 6.0
EC (uS/cm)	27	33	24
Mn (Filterable mg/L)	0.037	0.037	0.019
Fe (Filterable Mg/L)	0.313	0.363	0.260
Marrangaroo Creek Upstream (Reference Site)			
pH	5.2 – 6.7	4.5 – 7.1	5.5 – 6.1
EC (uS/cm)	40	47	33
Mn (Filterable Mg/L)	0.02	0.11	0.01
Fe (Filterable Mg/L)	0.10	0.26	0.08

As there has been no mining within 200m of these locations the triggers all data collected is considered baseline and there has been no exceedances of the trigger values defined in Table 24.

7. RESPONSE STRATEGIES

As indicated in section 6 above both SSE1 and SP1101 exceeded the trigger values defined in the THPSSMP. Accordingly, Centennial has notified the Department and undertaken an investigation into the exceedance. This report was provided to the Department on the 18th of May 2014. The following paragraphs summarise the results of the investigation and summarises the response strategy actions being undertaken.

7.1. SSE1

7.1.1. Investigation

In the case of the SSE1 swamp piezometer trigger, the preliminary investigation indicates that the likely cause was an extended period of dry weather, which also caused trigger levels to be exceeded at all of the reference swamp piezometers (which are located away from mining activities).

7.1.2. Response Strategy

The following actions are currently being undertaken by Centennial:

- Recalculation of triggers to accommodate ambient condition changes since April 2012 will result in a more representative baseline 95th percentile value. It is likely that the recalculation would result in the current SSE1 water levels no longer activating a trigger response.
- Swamp ecosystem health assessment and reporting by University of Queensland ecologists
- Groundwater monitoring assessment and reporting by Heritage Computing (Noel Merrick).

7.2. SPR1101

7.2.1. Investigation

In the case of the SPR1101 aquifer piezometer trigger, the preliminary investigation indicates that the likely cause was the excessive depth of drilling of the SPR1101 exploration borehole, which was subsequently inappropriately used as a water level monitoring bore. Due to the depth of drilling of the SPR1101 borehole, it is likely to have intersected the zone of discontinuous fracturing (B-Zone) caused by subsidence related to the extraction of Longwall 416 at Springvale. Historical monitoring indicates that the aquifers which supply groundwater to the swamp have not been impacted by adjacent mining activities. The SPR1101 borehole was drilled to a depth well below the aquifers which supply groundwater to the swamp, and it is considered that the trigger based on data from this borehole does not represent an impact to the groundwater system which supplies water to the swamp. Furthermore, RSS is adjacent to SP1101 and experienced no water declines.

7.2.2. Response Strategy

The following actions are currently being undertaken by Centennial:

- Investigative Drilling Program - SPR1101SP Redrill Proposal
- Investigative Drilling Program - RSS Redrill Proposal
- Swamp Ecosystem Health Assessment (University of Queensland)
- Swamp Hydrological Assessment (Heritage Computing)

8. SUMMARY

Springvale received conditional approval to mine Longwalls 415 to 417 which are beneath Temperate Highland Peat Swamps on Sandstone (THPSS). A THPSS Management Plan (THPSSMP) has been developed and implemented in accordance with the conditions of approval. This includes and extensive monitoring program which covers both the controlled action and the surrounding environment to assist in identifying any potential impact from mining.

During 2014 coal was mined from Longwalls 416 and 417.

Subsidence monitoring has been undertaken in accordance with the Springvale Subsidence Management and Reporting Plan for LW415 to 417. Subsidence, tilt, tensile strain and compressive strain results demonstrates compliance with the trigger values defined in the THPSSMP.

Climatic conditions must be considered when analysing monitoring data. Rainfall levels remained below the long-term average for the majority of the year apart from three above average months which brought the total rainfall close to the average yearly total.

Groundwater levels have exceeded trigger values at two monitoring locations during the reporting period. Springvale has accordingly reported, investigated and undertaken action to determine any potential impact from mining. There has been no mining within the area of influence for groundwater chemistry monitoring sites.

While no mining has been undertaken within 200m of the impact flora sites, baseline data collected shows no indication of vegetation change in any of the parameters which would represent an exceedance of a trigger value.

Surface water flows and chemistry show trends that are consistent with that observed in previous years monitoring showing no discernable effects from mining.

Overall the annual report prepared shows compliance with the requirements of the THPSSMP and no discernible impact from mining on THPSS.

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