APPENDIX 3C – SURFACE WATER MONITORING DATA

Summary of 2019 Surface Water Monitoring Results

SW Monitoring Point	EC (µS/cm)			pH			SO4 (mg/L)			Turbidity (NTU)		
	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave
CC1	432.0	697.0	564.5	7.3	9.1	8.2	56.0	102.0	79.0	663.0	2310.0	1486.5
CC2	3240.0	9910.0	7207.1	7.7	8.0	7.9	884.0	3760.0	2716.3	2.0	16.0	5.1
CC3	5850.0	5850.0	5850.0	7.9	7.9	7.9	2670.0	2670.0	2670.0	4.4	4.4	4.4
WIL (U)*	-	-	-	-	-	-	-	-	-	-	-	-
WIL (U2)	3840.0	5850.0	4428.3	3.6	6.3	4.2	287.0	578.0	400.3	0.9	45.0	11.2
WIL (PC)*	-	-	-	-	-	-	-	-	-	-	-	-
WIL (NC)*	-	-	-	-	-	-	-	-	-	-	-	-
WIL (D)	1440.0	6420.0	4192.9	4.0	7.4	6.7	521.0	1960.0	1273.3	9.7	95.2	44.4
WIL (D2)*	-	-	-	-	-	-	-	-	-	-	-	-
WOL1	1180.0	4780.0	2877.5	7.9	8.5	8.1	240.0	1510.0	752.5	0.8	5.2	3.3
WOL2	1690.0	5610.0	3545.8	7.0	8.2	7.5	311.0	808.0	641.4	1.7	43.7	16.1

Notes: mg/L = micrograms per litre. mS/cm= micro Siemens per centimetre. NTU = nephelometric turbidity units. *Dry

Summary of 2018 Surface Water Monitoring Results

SW Monitoring Point	EC (µS/cm)			pH			SO4 (mg/L)			Turbidity (NTU)		
	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave
CC1	228.0	1280.0	491.7	6.70	7.60	7.23	19.0	384.0	84.2	20.0	5520.0	1321.9
CC2	364.0	7570.0	6262.4	7.60	8.10	7.92	67.0	3000.0	2379.7	1.4	499.0	57.1
CC3	40.0	40.0	40.0	7.80	7.80	7.80	4.0	4.0	4.0	141.0	141.0	141.0
WIL (U)	-	-	-	-	-	-	-	-	-	-	-	-
WIL (U2)	1790.0	4380.0	3441.8	3.50	7.40	6.03	80.0	446.0	58.5	5.1	159.0	58.5
WIL (PC)	-	-	-	-	-	-	-	-	-	-	-	-
WIL (NC)	239.0	383.0	319.1	6.70	7.50	7.28	41.0	100.0	66.3	0.4	2.8	1.4
WIL (D)	278.0	2020.0	669.7	5.20	8.00	6.92	20.0	553.0	134.7	1.3	288.0	44.3
WIL (D2)	236.0	569.0	386.3	4.20	7.80	6.84	33.0	204.0	80.9	1.6	396.0	104.3
WOL1	425.0	2150.0	1260.1	7.20	8.40	8.01	41.0	494.0	294.1	1.0	19.6	6.8
WOL2	1730.0	2850.0	2404.5	7.00	7.90	7.51	209.0	740.0	447.7	1.0	36.2	6.1

Summary of 2017 Surface Water Monitoring Results

SW Monitoring Point	EC (µS/cm)			pH			SO4 (mg/L)			Turbidity (NTU)		
	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave
CC1	279.0	5380.0	2392.3	7.00	8.30	7.58	45.0	1790.0	787.0	4.4	1970.0	600.9
CC2	5470.0	8230.0	6306.0	7.70	8.30	7.99	1700.0	3170.0	2145.0	0.6	15.8	4.1
CC3	4100.0	4990.0	4520.0	8.30	8.50	8.40	1490.0	1920.0	1688.0	0.6	1.8	1.2
WIL (U)*	-	-	-	-	-	-	-	-	-	-	-	-
WIL (U2)	1360.0	3890.0	2851.7	5.40	8.00	6.58	13.0	121.0	20.9	2.4	70.8	20.9
WIL (PC)*	-	-	-	-	-	-	-	-	-	-	-	-
WIL (NC)	230.0	411.0	313.2	6.80	8.30	7.27	10.0	85.0	48.1	0.2	15.2	3.7
WIL (D)	248.0	1480.0	493.5	7.30	7.80	7.55	7.0	87.0	46.4	2.2	5.6	3.8
WIL (D2)	256.0	650.0	386.8	7.30	7.90	7.53	2.0	83.0	47.7	1.7	31.9	10.3
WOL1	336.0	1490.0	872.4	8.10	8.60	8.25	19.0	184.0	97.2	0.9	6.1	2.9
WOL2	1800.0	2950.0	2133.6	7.40	8.00	7.82	184.0	440.0	304.2	0.4	21.1	3.2

Notes: mg/L = micrograms per litre. mS/cm= micro Siemens per centimetre. NTU = nephelometric turbidity units. *Dry

Summary of 2016 Surface Water Monitoring Results

SW Monitoring Point	EC (µS/cm)			pH			SO_4 (mg/L)			Turbidity (NTU)		
	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave
CC1	170.0	4470.0	2802.9	7.10	7.90	7.41	28.0	1710.0	978.9	4.6	6270.0	936.0
CC2	3020.0	7540.0	5036.3	7.50	8.00	7.84	920.0	2940.0	1738.8	0.5	26.4	5.0
CC3	80.0	4860.0	2771.7	7.40	8.40	8.18	8.0	1920.0	972.5	0.7	126.0	25.1
WIL (U)	520.0	950.0	632.0	6.20	7.40	6.94	13.0	83.0	36.8	5.8	43.5	21.2
WIL (U2)	440.0	4420.0	2140.0	6.50	7.60	7.04	14.0	102.0	34.8	3.3	153.0	34.8
WIL (PC)	260.0	1340.0	682.0	6.90	7.40	7.16	7.0	48.0	28.6	9.7	64.6	38.3
WIL (NC)	240.0	1650.0	560.8	7.10	7.80	7.39	8.0	265.0	64.5	8.6	201.0	54.2
WIL (D)	580.0	3030.0	1189.2	6.80	8.00	7.46	12.0	603.0	165.5	1.2	39.4	10.0
WIL (D2)	390.0	1840.0	796.1	6.90	8.10	7.50	9.0	466.0	159.1	3.9	323.0	43.8
WOL1	780.0	2220.0	1226.3	7.80	8.30	8.11	104.0	475.0	205.8	1.3	11.2	5.0
WOL2	740.0	3160.0	1693.3	7.20	8.00	7.56	97.0	650.0	303.1	0.9	70.7	15.3
SGC_1*	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Notes: mg/L = micrograms per litre. mS/cm= micro Siemens per centimetre. NTU = nephelometric turbidity units. *Dry

Summary of 2015 Surface Water Monitoring Results

SW Monitoring Point	EC (µS/cm)			pH			SO_4 (mg/L)			Turbidity (NTU)		
	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave
CC1	120.0	4380.0	2316.3	6.60	7.80	7.31	13.0	1660.0	237.7	3.3	13000.0	3415.4
CC2	350.0	5970.0	3591.4	7.30	7.90	7.67	1400.0	2290.0	1977.8	0.4	20.8	4.7
CC3	150.0	5130.0	2220.0	7.00	8.40	7.93	17.0	2100.0	946.0	1.2	359.0	93.7
WIL (U)	1650.0	7550.0	4306.7	4.80	6.80	5.93	38.0	146.0	99.0	7.4	263.0	77.0
WIL (U2)	790.0	5580.0	3353.8	5.60	7.40	6.71	22.0	118.0	41.9	1.5	158.0	41.9
WIL (PC)*	1170.0	6100.0	3256.3	6.80	7.90	7.23	3.0	42.0	16.0	1.8	222.0	90.4
WIL (NC)	410.0	3960.0	1987.1	6.60	7.80	7.31	4.0	106.0	43.0	1.2	1440.0	284.5
WIL (D)	340.0	5880.0	2713.0	7.10	8.10	7.67	29.0	607.0	253.2	2.6	363.0	63.1
WIL (D2)	500.0	6520.0	2457.5	7.50	8.20	7.73	16.0	693.0	148.4	7.5	557.0	113.2
WOL1	160.0	5540.0	2223.0	7.50	8.20	7.96	208.0	956.0	445.8	1.1	61.8	13.3
WOL2	400.0	5550.0	1830.0	7.30	7.80	7.54	262.0	822.0	532.8	0.6	486.0	53.9

Notes: mg/L = micrograms per litre. mS/cm= micro Siemens per centimetre. NTU = nephelometric turbidity units.

Summary of 2014 Surface Water Monitoring Results

SW Monitoring Point	EC (µS/cm)			pH			SO_4 (mg/L)			Turbidity (NTU)		
	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave
CC1	610.0	5430.0	2055.7	7.10	9.20	8.00	120.0	1880.0	785.0	2.3	352.0	91.3
CC2	160.0	6590.0	4944.0	6.90	7.80	7.44	85.0	2520.0	1733.5	0.2	151.0	16.4
CC3	400.0	5260.0	3522.5	7.60	8.00	7.80	23.0	2100.0	1380.8	1.1	346.0	96.0
WIL (U)	980.0	1540.0	1260.0	6.00	7.10	6.55	70.0	174.0	122.0	3.2	30.0	16.6
WIL (U2)	1340.0	5970.0	2886.0	6.30	7.40	6.78	10.0	110.0	50.1	4.5	290.0	50.1
WIL (PC)	-	-	-	-	-	-	-	-	-	-	-	-
WIL (NC)	310.0	790.0	445.0	7.00	7.40	7.25	6.0	96.0	27.0	1.8	2410.0	664.4
WIL (D)	1520.0	6010.0	3728.3	6.90	8.40	7.68	205.0	1680.0	634.8	1.0	26.8	6.6
WIL (D2)	780.0	7550.0	3756.0	7.00	8.70	8.02	120.0	1670.0	932.4	0.8	42.7	11.7
WOL1	1870.0	3680.0	2582.5	7.00	8.90	8.13	434.0	1120.0	635.6	1.2	18.6	3.8
WOL2	1670.0	4060.0	2779.2	7.20	7.80	7.46	452.0	842.0	589.9	0.6	69.7	16.1

Notes: mg/L = micrograms per litre. mS/cm= micro Siemens per centimetre. NTU = nephelometric turbidity units. * Indicates no sample available during the schedule monitoring programme.

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Summary of 2013 Surface Water Monitoring Results

SW Monitoring Point	EC (µS/cm)			pH			SO_4 (mg/L)			Turbidity (NTU)		
	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave	Min	Max	Ave
CC1	3150.0	5710.0	4568.5	6.9	8.2	7.9	828.0	3160.0	1647.0	0.4	1770	169.6
CC2	4380.0	6070.0	5040.0	7.4	8.1	7.7	1610.0	3110.0	2040.0	0.2	2.6	0.9
CC3	225.0	4890.0	3130.6	7.8	8.2	8.0	94.0	2270.0	1454.1	0.8	360.0	59.4
WIL (U)	448.0	1390.0	1065.0	6.5	7.0	6.8	7.0	63.0	38.1	1.5	74.5	26.5
WIL (U2)	413.0	4620.0	2165.5	6.3	7.6	6.7	4.0	89.0	47.4	6.1	473.0	62.8
WIL (PC)	395.0	1730.0	1158.0	6.7	7.1	6.9	31.0	186.0	93.8	5.2	148.0	47.6
WIL (NC)	340.0	930.0	510.0	7.4	7.9	7.7	5.0	140.0	59.6	2.2	4000	941.5
WIL (D)	1656.0	4200.0	2942.6	7.8	8.8	8.1	216.0	822.0	475.2	1.4	59.1	9.3
WIL (D2)	1500.0	4950.0	3051.6	7.8	8.1	7.9	217.0	1360.0	646.7	1.2	21.8	7.0
WOL1	1180.0	2710.0	1982.3	8.1	8.7	8.4	326.0	675.0	464.8	0.6	8.9	3.0
WOL2	1460.0	3150.0	2153.9	7.3	8.3	7.9	286.0	793.0	487.7	0.6	14.9	6.0

2019 Results for Surface Water Monitoring

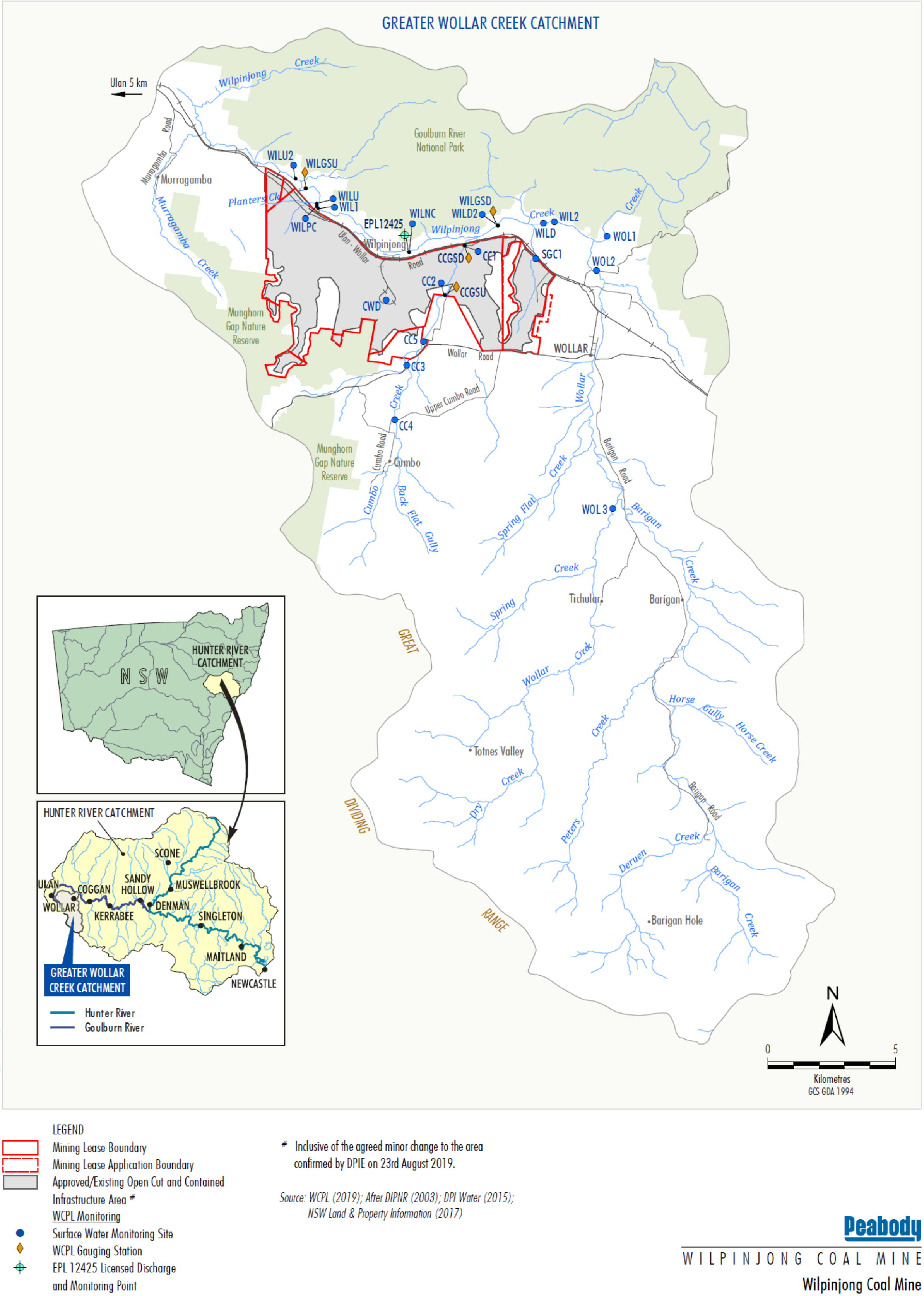
Sample Num	Sample Location	Sampling Date	Sampling Time	Acidity as CaCO3 mg/L	Aluminium mg/L	Ammonia as N mg/L	Arsenic mg/L	Barium mg/L	Beryllium mg/L	Bicarbonate Alkalinity as CaCO3 mg/L	Carbonate Alkalinity as CaCO3 mg/L	Copper mg/L	Electrical Conductivity (Field Reading) µS/cm	Hydroxide Alkalinity as CaCO3 mg/L	Iron mg/L	Lead mg/L	Manganese mg/L	Molybdenum mg/L	Nickel mg/L	pH - Field pH Unit	Selenium mg/L	Strontium mg/L	Sulfate mg/L	Temperature °C	Total Alkalinity as CaCO3 mg/L	Turbidity NTU	Zinc mg/L
ME1900078001	CC_1	18-Jan-2019	1124	10	6.9		0.003	0.068		60	<1	0.017	432	<1	10.4	0.015	0.16	<0.001	0.008	7.3	<0.01	0.094	56	27	60	663	0.03
ME1900078002	CC_2	18-Jan-2019	1453	7	<0.01		0.002	0.028		211	<1	0.005	3240	<1	0.05	<0.001	0.402	0.004	0.006	7.9	<0.01	1.63	884	34.5	211	2.9	<0.005
ME1900078003	CC_3	18-Jan-2019	1537																								
ME1900078004	WIL_U	18-Jan-2019	1059																								
ME1900078005	WIL_U2	18-Jan-2019	1053																								
ME1900078006	WIL_NC	18-Jan-2019	1114																								
ME1900078007	WIL_PC	18-Jan-2019	1057																								
ME1900078008	WIL_D	18-Jan-2019	1204	10	0.18		0.002	0.092		80	<1	0.002	1440	<1	2	<0.001	8.02	<0.001	0.015	7.2	<0.01	0.744	521	31.5	80	19	0.009
ME1900078009	WIL_D2	18-Jan-2019	1140																								
ME1900078010	WOL_1	18-Jan-2019	1337	<1	0.08		<0.001	0.039		150	13	0.002	1180	<1	0.22	<0.001	0.238	0.001	0.004	8.5	<0.01	0.608	240	36.5	163	4.1	<0.005
ME1900078011	WOL_2	18-Jan-2019	1319	13	0.11		0.001	0.077		241	<1	0.003	1690	<1	1.96	<0.001	2.55	0.002	0.004	7.1	<0.01	0.923	311	27.5	241	11.7	<0.005
ME1900078012	SGC_1	18-Jan-2019	1245																								
ME1900209001	CC_1	13-Feb-2019	1157																								
ME1900209002	CC_2	13-Feb-2019	1448																								
ME1900209003	CC_3	13-Feb-2019	1521																								
ME1900209004	WIL_U	13-Feb-2019	1137																								
ME1900209005	WIL_U2	13-Feb-2019	1128																								
ME1900209006	WIL_NC	13-Feb-2019	1152																								
ME1900209007	WIL_PC	13-Feb-2019	1135																								
ME1900209008	WIL_D	13-Feb-2019	1345																								
ME1900209009	WIL_D2	13-Feb-2019	1223																								
ME1900209010	WOL_1	13-Feb-2019	1416																								
ME1900209011	WOL_2	13-Feb-2019	1359	13	0.32	0.002	0.086		459		<1	<0.001	2740	<1	0.82	<0.001	0.832	<0.001	0.002	7.6	<0.01	1.28	456	26	459	43.7	<0.005
ME1900209012	SGC_1	13-Feb-2019	1351																								
ME1900349001	CC_1	13-Mar-2019	1325																								
ME1900349002	CC_2	13-Mar-2019	1443																								
ME1900349003	CC_3	13-Mar-2019	1522																								
ME1900349004	WIL_U	13-Mar-2019	1237																								
ME1900349005	WIL_U2	13-Mar-2019	1146																								
ME1900349006	WIL_NC	13-Mar-2019	1249																								
ME1900349007	WIL_PC	13-Mar-2019	1236																								
ME1900349008	WIL_D	13-Mar-2019	1343																								
ME1900349009	WIL_D2	13-Mar-2019	1306																								
ME1900349010	WOL_1	13-Mar-2019	1415																								
ME1900349011	WOL_2	13-Mar-2019	1356	5	0.36		0.004	0.134		616	6	<0.001	3630	<1	0.97	<0.001	1.04	0.001	0.003	7.9	<0.01	1.89	528	25	622	42	<0.005
ME1900349012	SGC_1	13-Mar-2019	1351																								
ME1900499001	CC_1	11-Apr-2019	1247																								
ME1900499002	CC_2	11-Apr-2019	1505	17	0.56		0.003	0.161		222	<1	0.006	9910	<1	0.39	<0.001	0.081	0.003	0.008	7.8	<0.01	4.57	3350	21.5	222	16	0.005
ME1900499003	CC_3	11-Apr-2019	1549																								
ME1900499004	WIL_U	11-Apr-2019	1224																								
ME1900499005	WIL_U2	11-Apr-2019	1214	135	4.9		0.004	0.12		<1	<1	0.003	5850	<1	54.4	0.002	21.1	<0.001	1.12	3.6	<0.01	1.32	578	18	<1	45	1.51

ME1900499006	WIL_NC	11-Apr-2019	1235																								
ME1900499007	WIL_PC	11-Apr-2019	1222																								
ME1900499008	WIL_D	11-Apr-2019	1345	54	4.92		0.002	0.103		<1	<1	0.009	2420	<1	2.69	0.001	55.2	<0.001	0.639	4	<0.01	1.48	1170	19.5	<1	9.7	1.21
ME1900499009	WIL_D2	11-Apr-2019	1303																								
ME1900499010	WOL_1	11-Apr-2019	1437	8	0.02		<0.001	0.093		114	<1	<0.001	2360	<1	0.2	<0.001	0.374	<0.001	0.006	7.9	<0.01	1.21	623	20	114	0.8	<0.005
ME1900499011	WOL_2	11-Apr-2019	1413	11	0.29		0.001	0.116		233	<1	<0.001	3420	<1	0.89	<0.001	0.646	<0.001	0.003	7	<0.01	1.8	780	19.5	233	15.2	<0.005
ME1900499012	SGC_1	11-Apr-2019	1409																								
ME1900649001	CC_1	20-May-2019	1320																								
ME1900649002	CC_2	20-May-2019	1456	16	0.14		<0.001	0.043		308	<1	0.003	8670	<1	0.09	<0.001	0.052	0.002	0.004	7.8	<0.01	4.38	3760	15.5	308	4.3	<0.005
ME1900649003	CC_3	20-May-2019	1532																								
ME1900649004	WIL_U	20-May-2019	1304																								
ME1900649005	WIL_U2	20-May-2019	1240	35	0.92		0.001	0.073		<1	<1	0.002	5000	<1	17.3	<0.001	30.9	<0.001	0.564	3.7	<0.01	1.08	549	14.5	<1	1.4	0.38
ME1900649006	WIL_NC	20-May-2019	1312																								
ME1900649007	WIL_PC	20-May-2019	1302																								
ME1900649008	WIL_D	20-May-2019	1332	24	1.25		0.002	0.092		326	<1	0.002	4360	<1	11.5	<0.001	36.3	<0.001	0.038	6.9	<0.01	2.56	1510	15	326	95.2	0.014
ME1900649009	WIL_D2	20-May-2019	1329																								
ME1900649010	WOL_1	20-May-2019	1425																								
ME1900649011	WOL_2	20-May-2019	1408	8	0.13		<0.001	0.108		356	<1	<0.001	3840	<1	0.45	<0.001	0.223	0.001	0.001	7.4	<0.01	1.82	808	13.5	356	5.1	<0.005
ME1900649012	SGC_1	20-May-2019	1400																								
ME1900769001	CC_1	21-Jun-2019	1121																								
ME1900769002	CC_2	21-Jun-2019	1447	22	0.1		<0.001	0.024		356	<1	<0.001	7470	<1	<0.05	<0.001	0.179	0.002	0.004	7.7	<0.01	3.88	2600	10.5	356	2	<0.005
ME1900769003	CC_3	21-Jun-2019	1529																								
ME1900769004	WIL_U	21-Jun-2019	1104																								
ME1900769005	WIL_U2	21-Jun-2019	1053	27	0.9		<0.001	0.06		<1	<1	0.003	3990	<1	4.47	0.002	19.6	<0.001	0.379	3.7	<0.01	0.83	326	5	<1	0.9	0.246
ME1900769006	WIL_NC	21-Jun-2019	1115																								
ME1900769007	WIL_PC	21-Jun-2019	1102																								
ME1900769008	WIL_D	21-Jun-2019	1203	34	<0.01		<0.001	0.07		456	<1	<0.001	5220	<1	3.1	<0.001	24.4	<0.001	0.016	7.1	<0.01	4.01	1570	6	456	29.6	<0.005
ME1900769009	WIL_D2	21-Jun-2019	1232																								
ME1900769010	WOL_1	21-Jun-2019	1345																								
ME1900769011	WOL_2	21-Jun-2019	1328	13	0.04		<0.001	0.101		369	24	<0.001	3980	<1	0.17	<0.001	0.127	0.001	<0.001	7.6	<0.01	2.1	548	8	393	3.4	<0.005
ME1900769012	SGC_1	21-Jun-2019	1244																								
ME1900917001	CC_1	16-Jul-2019	1134																								
ME1900917002	CC_2	16-Jul-2019	1455	11	0.12		<0.001	0.023		360		<0.001	7120	<1	0.05	<0.001	0.045	0.002	0.004	8	<0.01	3.92	2710	11	360	3.7	<0.005
ME1900917003	CC_3	16-Jul-2019	1549																								
ME1900917004	WIL_U	16-Jul-2019	1119																								
ME1900917005	WIL_U2	16-Jul-2019	1105	41	1.3		<0.001	0.064		<1		<0.001	3840	<1	11.3	0.002	16.2	<0.001	0.344	3.9	<0.01	0.688	329	10	<1	3.8	0.346
ME1900917006	WIL_NC	16-Jul-2019	1130																								
ME1900917007	WIL_PC	16-Jul-2019	1117																								
ME1900917008	WIL_D	16-Jul-2019	1236	21	0.02		<0.001	0.053		436		<0.001	4930	<1	2.11	<0.001	17.1	<0.001	0.015	7.4	<0.01	3.55	1320	10	436	18.4	<0.005
ME1900917009	WIL_D2	16-Jul-2019	1200																								
ME1900917010	WOL_1	16-Jul-2019	1342																								
ME1900917011	WOL_2	16-Jul-2019	1327	13	0.06		<0.001	0.057		312		<0.001	3440	<1	0.82	<0.001	0.432	0.001	0.001	7.4	<0.01	1.71	723	9	312	6.8	<0.005
ME1900917012	SGC_1	16-Jul-2019	1246																								
ME1901066001	CC_1	19-Aug-2019	1206																								
ME1901066002	CC_2	19-Aug-2019	1527	27	0.12		<0.001	0.028		337	<1	<0.001	6890	<1	0.06	<0.001	0.076	0.002	0.004	8	<0.01	3.41	2700	12	337	3.6	<0.005
ME1901066003	CC_3	19-Aug-2019	1552																								
ME1901066004	WIL_U	19-Aug-2019	1110																								

ME1901066005	WIL_U2	19-Aug-2019	1055	30	1.02		<0.001	0.064		<1	<1	0.003	3860	<1	7.95	0.003	14.7	<0.001	0.232	4	<0.01	0.688	287	10.5	<1	6	0.206
ME1901066006	WIL_NC	19-Aug-2019	1120																								
ME1901066007	WIL_PC	19-Aug-2019	1109																								
ME1901066008	WIL_D	19-Aug-2019	1232	31	0.04		<0.001	0.05		462	<1	<0.001	4560	<1	4.72	<0.001	11.9	<0.001	0.014	7	<0.01	2.86	862	11.5	462	56.7	0.006
ME1901066009	WIL_D2	19-Aug-2019	1135																								
ME1901066010	WOL_1	19-Aug-2019	1352	10	0.07		<0.001	0.072		252	<1	<0.001	3190	<1	0.31	<0.001	0.35	0.001	0.004	8	<0.01	1.61	637	10.5	252	2.9	<0.005
ME1901066011	WOL_2	19-Aug-2019	1333	10	0.02		<0.001	0.039		248	<1	<0.001	2970	<1	0.23	<0.001	0.133	<0.001	0.001	7.7	<0.01	1.43	665	10	248	1.7	<0.005
ME1901066012	SGC_1	19-Aug-2019	1300																								
ME1901236001	CC_1	18-Sep-2019	1227	9	45.1		0.014	0.127		76	<1	0.049	697	<1	56.1	0.066	0.165	0.004	0.031	9.1	<0.01	0.1	102	16	76	2310	0.092
ME1901236002	CC_2	18-Sep-2019	1515	21	0.05		<0.001	0.023		326	<1	<0.001	7150	<1	0.07	<0.001	2.98	0.002	0.005	8	<0.01	3.7	3010	16.5	326	3.3	0.007
ME1901236003	CC_3	18-Sep-2019	1603	21	0.1		<0.001	0.081		334	<1	0.003	5850	<1	0.14	<0.001	0.213	<0.001	0.002	7.9	<0.01	2.5	2670	16	334	4.4	0.014
ME1901236004	WIL_U	18-Sep-2019	1137																								
ME1901236005	WIL_U2	18-Sep-2019	1123	16	0.13		<0.001	0.081		8	<1	<0.001	4030	<1	3.12	<0.001	10.5	<0.001	0.109	6.3	<0.01	0.765	333	14.5	8	9.8	0.099
ME1901236006	WIL_NC	18-Sep-2019	1150																								
ME1901236007	WIL_PC	18-Sep-2019	1135																								
ME1901236008	WIL_D	18-Sep-2019	1310	30	0.26		0.001	0.092		375	<1	<0.001	6420	<1	8.06	<0.001	25.2	0.001	0.044	7.1	<0.01	3.5	1960	15.5	375	82.1	0.024
ME1901236009	WIL_D2	18-Sep-2019	1202																								
ME1901236010	WOL_1	18-Sep-2019	1356	12	0.13		<0.001	0.084		110	<1	0.002	4780	<1	0.12	<0.001	0.309	<0.001	0.006	7.9	<0.01	3.08	1510	16	110	5.2	0.006
ME1901236011	WOL_2	18-Sep-2019	1337	11	0.04		<0.001	0.049		339	<1	<0.001	3520	<1	0.58	<0.001	0.849	0.001	0.002	7.5	<0.01	1.92	673	13.5	339	4.5	0.007
ME1901236012	SGC_1	18-Sep-2019	1327																								
ME1901361001	CC_1	15-Oct-2019	1146																								
ME1901361002	CC_2	15-Oct-2019	1404																								
ME1901361003	CC_3	15-Oct-2019	1425																								
ME1901361004	WIL_U	15-Oct-2019	1123																								
ME1901361005	WIL_U2	15-Oct-2019	1112																								
ME1901361006	WIL_NC	15-Oct-2019	1133																								
ME1901361007	WIL_PC	15-Oct-2019	1120																								
ME1901361008	WIL_D	15-Oct-2019	1157																								
ME1901361009	WIL_D2	15-Oct-2019	1142																								
ME1901361010	WOL_1	15-Oct-2019	1333																								
ME1901361011	WOL_2	15-Oct-2019	1310	23	0.21		<0.001	0.071		381	<1	<0.001	3520	<1	0.57	<0.001	0.707	0.001	0.004	7.4	<0.01	1.88	699	23	381	12.2	<0.005
ME1901361012	SGC_1	15-Oct-2019	1219																								
ME1901514001	CC_1	14-Nov-2019	1207																								
ME1901514002	CC_2	14-Nov-2019	1418																								
ME1901514003	CC_3	14-Nov-2019	1450																								
ME1901514004	WIL_U	14-Nov-2019	1140																								
ME1901514005	WIL_U2	14-Nov-2019	1134																								
ME1901514006	WIL_NC	14-Nov-2019	1152																								
ME1901514007	WIL_PC	14-Nov-2019	1139																								
ME1901514008	WIL_D	14-Nov-2019	1223																								
ME1901514009	WIL_D2	14-Nov-2019	1253																								
ME1901514010	WOL_1	14-Nov-2019	1352																								
ME1901514012	SGC_1	14-Nov-2019	1313																								
ME1901514011	WOL_2	14-Nov-2019	1325	18	0.39		<0.001	0.086		510	<1	<0.001	4190	<1	1.1	<0.001	0.451	0.002	0.003		<0.01	2.19	729	22	510	42.2	<0.005
ME1901722001	CC_1	19-Dec-2019	1225																								
ME1901722002	CC_2	19-Dec-2019	1601																								
ME1901722003	CC_3	19-Dec-2019	1639																								
ME1901722004	WIL_U	19-Dec-2019	1116																								
ME1901722005	WIL_U2	19-Dec-2019	1052																								

ME1901722006	WIL_NC	19-Dec-2019	1138																								
ME1901722007	WIL_PC	19-Dec-2019	1112																								
ME1901722008	WIL_D	19-Dec-2019	1240																								
ME1901722009	WIL_D2	19-Dec-2019	1203																								
ME1901722010	WOL_1	19-Dec-2019	1425																								
ME1901722011	WOL_2	19-Dec-2019	1353	12	0.11		0.003	0.064		789	<1	<0.001	5610	<1	0.49	<0.001	0.629	0.002	0.004	8.2	<0.01	2.51	777	29	789	4.5	<0.005
ME1901722012	SGC_1	19-Dec-2019	1257																								

Surface Water Monitoring Locations

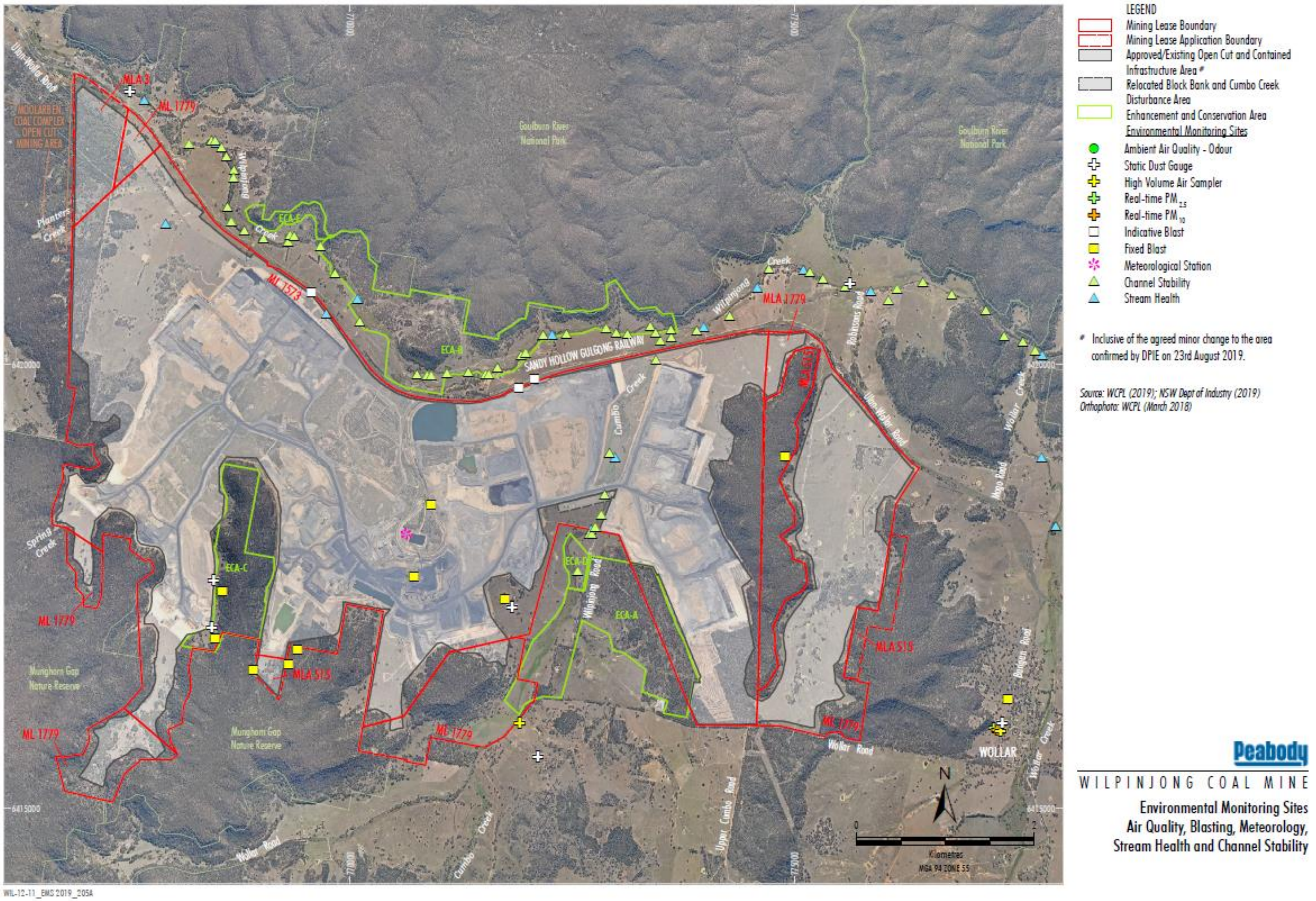


Inclusive of the agreed minor change to the area confirmed by DPIE on 23rd August 2019.

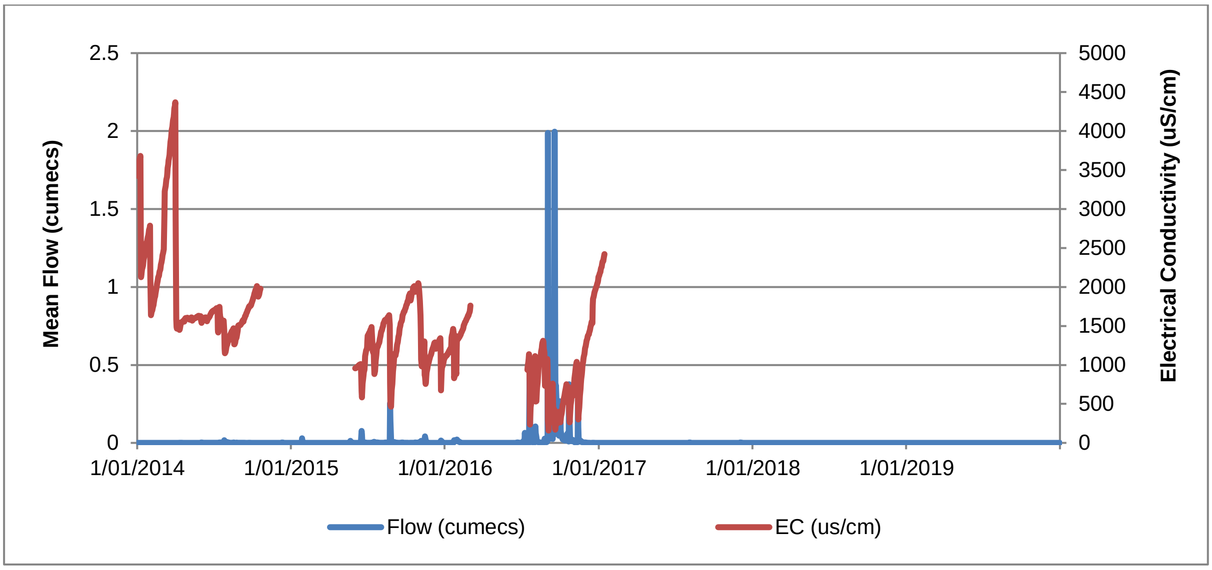
Source: WCPL (2019); After DIPNR (2003); DPI Water (2015); NSW Land & Property Information (2017)

Peabody
WILPINJONG COAL MINE
Wilpinjong Coal Mine
Surface Water Monitoring Network

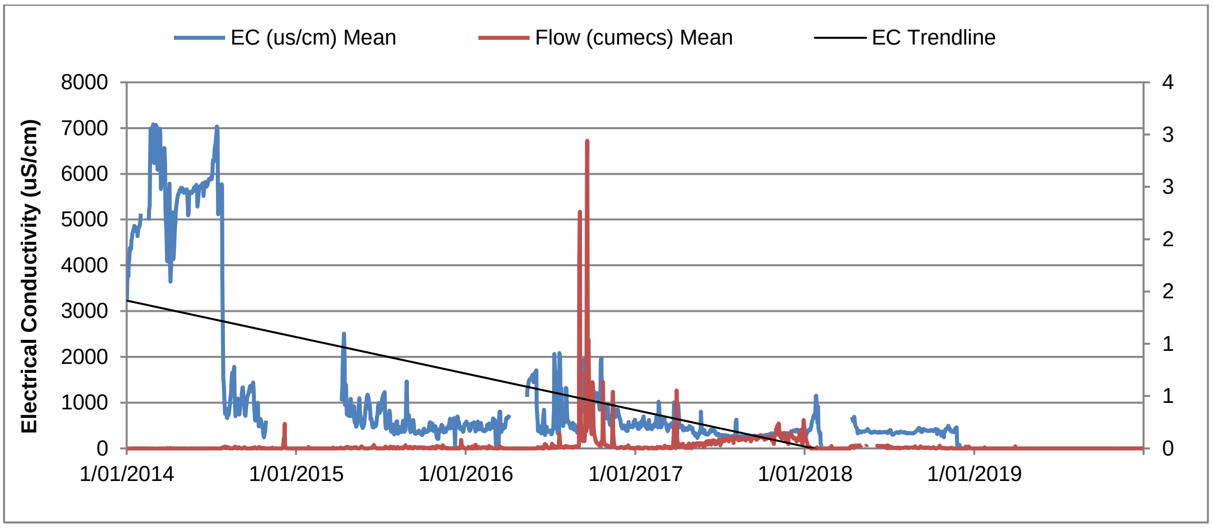
Channel Stability & Stream Health Monitoring Locations



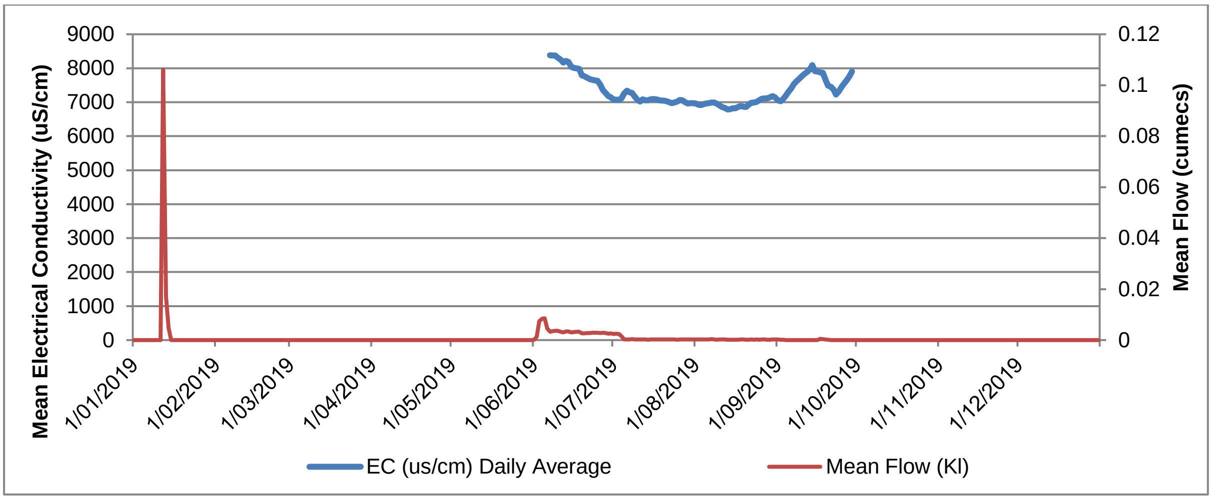
2014-2019 Wilpinjong Creek Upstream Gauging Station



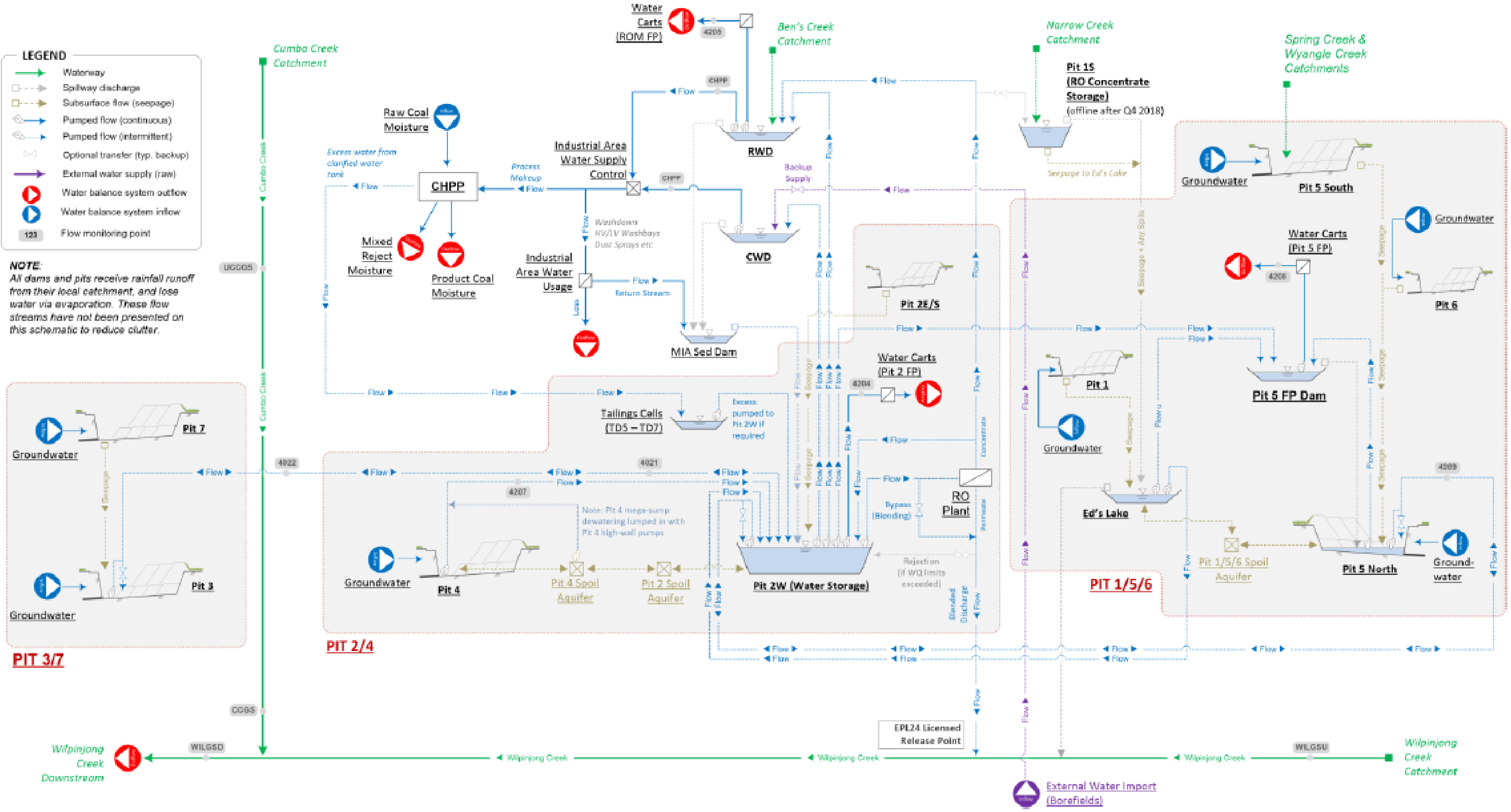
2019 Wilpinjong Creek Downstream Gauging Station



2019 Cumbo Creek Upstream Gauging Station



OPSIM Schematic: Major Components of the WCPL Water Management System



NOTE:
All dams and pits receive rainfall runoff from their local catchment, and lose water via evaporation. These flow streams have not been presented on this schematic to reduce clutter.

Water Management Performance Measures

A summary of the water management performance measures was undertaken by WCPL as they related to the Development Consent SSD-6764 (1 January 2019 to 31 December 2019)

Assessment of Water Management Performance Measures

Feature	Performance Measure	Complied with Performance Measure (Yes/No)	Comments/Actions
General	Maintain separation between clean, dirty and mine water management systems. Minimise the use of clean water on site. Design, install, operation and maintain water management systems in a proper and efficient manager.	Yes	Refer to Site Water Balance (Section 7.7) Refer to Estimate Groundwater Take (Section 7.2) Refer to Surface Water Results (Section 7.6)
Clean water diversion and storage infrastructure	Maximise as far as reasonable and feasible the diversion of clean water around disturbed areas on site.	Yes	Refer to Erosion and Sediment Control (Section 7.5)
Sediment dams	Design, install and/or maintain sediment dams to ensure no discharges to surface waters, except in accordance with an EPL or in accordance with Section 120 of the POEO Act.	Yes	Refer to Erosion and Sediment Control (Section 7.5) Refer to Water Treatment Facility (Section 7.8)
Mine water storages	Design, install and/or maintain mine water storage infrastructure to ensure no discharge of untreated mine water off-site. Discharge treated mine water in accordance with an EPL or in accordance with Section 120 of the POEO Act.	Yes	Refer to Site Water Balance (Section 7.7) Refer to Surface Water Results (Section 7.6) Refer to Water Treatment Facility (Section 7.8)
Wilpinjong, Cumbo and Wollar Creeks	No greater impact than predicted for the development for water flow and quality.	Yes	Refer to Surface Water Results (Section 7.6) Refer to Stream Health (Section 7.9)
Aquatic, riparian and groundwater dependent ecosystems	Negligible environmental consequences beyond those predicted for the development.	Yes	Refer to Surface Water Results (Section 7.6) Refer to Stream Health (Section 7.9)
Flood mitigation measures*	Ensure all open cut pits, CHPP, coal stockpiles and main mine facilities areas exclude flows for all flood events up to and including the 1 in 100 year ARI. All final voids designed to exclude all flood events up to include the PMF event.	Yes	The Wilpinjong Coal Mine open cuts are located outside the extent of flooding from Wilpinjong Creek in the 1 in 1,000 AEP design flood. Flood mitigation works for open cut infrastructure in the vicinity of Cumbo Creek are already being implemented at the Wilpinjong Coal Mine and have been designed to a 1 in 100 AEP flood protection (WRM Water and Environment, 2015).
Overburden, CHPP Reject and Tailings	Design, install and maintain emplacements to prevent or minimise the migration of pollutants due to seepage.	Yes	Waste rock emplacements and coal reject management in accordance with the MOP
Chemical and hydrocarbon storage	Chemical and hydrocarbon products to be stored in bunded areas or structures in accordance with relevant Australian Standards.	Yes	Chemical and hydrocarbon products stored in bunded areas in accordance with relevant Australian Standards

Notes:* Consistent with Condition 29, Schedule 3 of Development Consent (SSD-6764), WCPL have maintained all open cut pits, CHPP, coal stockpiles and main mine facilities areas so that they exclude flows for all flood events up to and including the 1 in 100 year ARI. The final voids would be designed to exclude all flood events up to the probable maximum flood.

Surface Water Reports

30 March 2020

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Wilpinjong Coal Pty Ltd
1434 Ulan-Wollar Road
Wilpinjong NSW 2850

Attention: **James Heesterman**

Dear James

Wilpinjong Coal Mine
SW 2019 Annual Monitoring Review

1 Introduction

This letter report contains the analysis and information required for the review of flow and water quality trends at Wilpinjong Creek and Cumbo Creek near Wilpinjong Coal Mine (WCM). It serves as a supplementary document to the review of hydrogeological data conducted by SLR Consulting Pty Ltd (SLR) for the 2019 Annual Review and 2018-19 Water Year Licensing Audit. This report is presented in three sections and addresses the following requests:

1. Cause-and-effect analysis of data from the Wilpinjong Creek upstream (WILGSU), and Wilpinjong Creek downstream (WILGSD) gauging stations, including a trend analysis in respect to the long-term rainfall trend, discharge from the reverse osmosis treatment plant (Licensed Discharge and Monitoring Point EPL12425) and flow from the Cumbo Creek upstream (CCGSU) gauging station.

2. Assessment of the data in relation to the flow trigger as proposed by Gilbert and Associates (2013)

3. Assessment of key water quality criteria at local creeks during the 2018-19 water year in respect to baseline data, as well as Water Quality Impact Assessment Criteria for downstream gauges at Cumbo and Wilpinjong Creeks defined in the current Surface Water Management Plan (SWMP)

The report consists of commentary on the cause-and-effect analysis and trigger level assessment, with the inclusion of supporting figures.

1.1 Note on the trend analysis

The trend analysis within this report has been conducted for both flow/ discharge and rainfall by assessing monthly data, the monthly deviation from the mean, and the cumulative monthly deviation from the mean. The deviation from the mean and cumulative deviation from the mean are useful tools for the evaluation of temporal correlation of rainfall with surface water flow or groundwater level observations. Short-term variability is filtered out, allowing for the display of longer-term trends. With a cumulative deviation from the mean curve (also referred to in this document as the ‘rainfall trend’ or ‘long-term rainfall trend’), an increase in the curve indicates above average conditions, while a declining trend indicates below average conditions. These trends are calculated in the following way.

1. Mean monthly rainfall/ streamflow is calculated from all monthly rainfall/streamflow values (i.e. average rainfall for January)
2. Monthly deviation from the mean is calculated between the monthly mean rainfall/streamflow value and the value for a particular month.
3. Cumulative monthly deviation from the mean is determined for each month for the duration of monitoring at each site.

Cumulative deviation from the mean curves are also referred to as residual mass curves within this report.

2 Review of Surface Water Data

2.1 Flow Review

The following section assesses daily data from three continuous surface water monitoring gauges – two on Wilpinjong Creek (WILGSU and WILGSD) and one on Cumbo Creek (CCGSU) – and in conjunction with discharge data from the reverse osmosis treatment plant (RO Plant) Licensed Discharge and Monitoring Point, (LDP24) - (EPL 12425). Supplementary assessment of the long term, monthly trends of the same sites can be found below in Section 2.1.1 - Trend Analysis.

The locations of the gauges on Wilpinjong Creek are shown in **Figure 1**. The upstream site, WILGSU, is located northwest of WCM, WILGSD is northeast of Wilpinjong Coal Mine (WCM), downstream of the reverse osmosis treatment plant discharge site (RO Plant) and downstream of the confluence of Wilpinjong and Cumbo Creek. The Cumbo Creek upstream gauging station (CCGSU) is located near bore GWa5, ~400 m to the East of Pit 2 and ~800m upstream of active mining at Pit4 (not shown on **Figure 1**). Flow/ discharge, electrical conductivity, and pH are all measured and presented against the rainfall trend from the local rainfall station (Wollar, 062032).

Both Wilpinjong Creek gauging stations have been recording since January 2012. The catchment area to the upstream site (WILGSU) is 86km^2 while the downstream site has a catchment area of 216km^2. The RO Plant commenced discharging treated water, in accordance with EPL12425, upstream of WILGSD in June 2012. CCGSU on Cumbo Creek has been recording data since August 2015.

Flows at both gauges, upstream (WILGSU) and downstream (WILGSD), show correlation with the long-term rainfall trend, with a decline from 2012 to July 2014 (**Figure 2**). Flows at both gauges have been less than 0.001 cumecs (<100 m^3/d) 50% of the time since early 2013 and for most of 2014. As this occurs at both gauges, with the rainfall trend during that period declining consistently, climate rather than mining is the primary cause of the low flow conditions. Flows at both gauges respond to the minor increase in the rainfall trend in 2015 and respond strongly to the large peak in late 2016, with peak flow rates ~0.5 and ~1 cumecs for the WILGSU and WILGSD gauging stations respectively. From October 2016 to December 2019, the rainfall trend declines, indicating below average conditions. This period of lower than average rainfall is likely responsible for the low, and no-flow conditions at WILGSU and WILGSD observed during the 2019 water year.

Correlation between the flows at the two gauges is high, with essentially a 1:1 relationship until about April-June 2012. Following the beginning of discharge from the RO Plant, flows at WILGSD are consistently higher than those at WILGSU. The change in proportionality is suggestive of the influence of the RO plant discharge above WILGSD (RO Plant discharges shown in yellow on **Figure 2**). This influence is best demonstrated during 2017 and 2018, when low rainfall conditions have resulted in no flow at WILGSU, but WILGSD shows a near-perfect match with RO Plant discharge rates.

Due to the ongoing below average rainfall conditions and a site-water deficit, there was no discharge from the RO Plant to Wilpinjong Creek during 2019. Therefore, no component of flow at WILGSD was sourced from RO Plant discharge, and WILGSD experienced very low-to no flow rates for a majority of 2019, consistent with the ongoing below average rainfall conditions.

The Cumbo Creek gauging station (CCGSU), which commenced monitoring in August 2015 is also displayed in **Figure 2**. Peaks in flow match the peaks in both the rainfall trend and the two Wilpinjong Creek gauging stations. Flow is maintained during most of the period of below average rainfall in 2017. It is important to note the logarithmic scale used to display the flows in **Figure 2**.

During 2017, CCGSU has an average flow of around 0.001 cumecs, around 1% of the flow rate observed in Wilpinjong Creek as caused by RO Plant discharge (0.1 cumecs). During 2018, flow in CCGSU is observed to increase while flow in WILGSD decreases. Flow at CCGSD (0.003 cumecs) during 2018 was generally around 30% of the flow rate recorded in WILGSD (0.01 cumecs).

During the 2019, CCGSU recorded long periods of no observable flow (approximately 9 months) but does record flow with a maximum of ~0.005 cumecs from June to September 2019. This period of flow may be related to increased baseflow in Cumbo Creek associated with above average rainfall received in March 2019.

Table 1 presents the calculated daily mean discharge from the RO Plant and flows at WILGSU, WILGSD and CCGSU for each year since 2013.

Table 1 Calculated daily mean discharge and flow (cumecs) at the monitoring locations along the Wilpinjong and Cumbo Creeks since 2013

Monitoring Location	Average Daily Flow (cumecs)						
	2013	2014	2015	2016	2017	2018	2019
RO Plant	0.006	0.002	0.003	0.008	0.053	0.009	0
WILGSU	0.019	0.00034	0.0033	0.0033	0.00002	0	0
WILGSD	0.03	0.0025	0.0044	0.066	0.068	0.0078	0.000094
CCGSU	No data				0.0071	0.0043	0.00069

2.1.1 Trend Analysis

The trend analysis conducted on flow from WILGSU, WILGSD, CCGSU, discharge from the RO Plant and the long-term rainfall from BOM Station 062032 (Wollar – Barrigan St), has helped to confirm and clarify the relationships between stream flow, rainfall and discharge at two watercourses near WCM.

Figure 3 (CCGSU), **Figure 4** (WILGSU), and **Figure 5** (WILGSD) present monthly flow, deviation from the monthly mean, and cumulative deviation from the monthly mean in comparison with available data from either streamflow, rainfall, or discharge that may have some influence on recorded flow at a particular gauging station. Trends from CCGSU (**Figure 3**) and WILGSU (**Figure 4**) are assessed only against the trends from the Wollar rainfall station as they are upstream of the discharge plant and the confluence of any other assessed streams. WILGSD (**Figure 5**) is assessed against the rainfall trend as well as the discharge trends from the RO Plant and flow trends from both the WILGSU and CCGSU gauging stations. Water from any of these sources can influence the flow recorded at WILGSD.

As identified in the initial flow review, CCGSU shows a good relationship with the rainfall trend (**Figure 3**) from 2015 to early 2019. In the uppermost chart (showing a comparison between monthly rainfall and average monthly flow rate), peaks in monthly rainfall above 120 mm result in a strong increase in the monthly average flow rate recorded at the gauging station. Flow is sometimes maintained in periods of low monthly rainfall (observed during 2017 and 2018), which may indicate some contribution of baseflow from groundwater in to Cumbo Creek. Months with below average rainfall, indicated by values less than zero in the middle chart also correlate well with periods of below average flow in Cumbo Creek. The cumulative rainfall trend in the bottom chart (**Figure 3**) also shows a good match with the cumulative monthly deviation from mean flow trend at CCGSU. At the beginning of monitoring, below average flow is occurring at CCGSU, correlating with the end of a recession in the rainfall trend that occurred from mid-2012 to mid-2015. The following peak in the rainfall trend in late 2016 and subsequent decline through 2017 and 2018 are both well matched by the trend at CCGSU. The low magnitude flow event observed at CCGSU from June to September 2019 is a result of the prior wet catchment conditions (from the March rainfall event). The lack of streamflow data from February to June has resulted in the full response behaviour not being captured. However, assessment of the individual rainfall events and streamflow readings are consistent with the catchment behaviour from previous years.

In undertaking this review, SLR has been in contact with EISolutions, who administer the flow gauges on site at Wilpinjong and other Western Coalfield sites. The communication identified the following key characteristics for Cumbo Creek catchment:

- The catchment is peaty/ boggy and likely has considerable ability to absorb rainfall/ runoff prior to flow being observed at CCGSU. Therefore, the soil moisture content prior to an event could impact on the amount of runoff observed.

- Large spatial variation in rainfall exists in the Wilpinjong/ Western Coalfield region. Rain in the upper catchment resulting in high flow may not be observed downstream or at the Wollar BOM station.

Analysis of daily rainfall at site (Cumbo Ck Station) and the Wollar BOM station during early 2019 has identified the following key rainfall events (**Table 2**) that have likely contributed to flow observed in Cumbo Creek from June to September 2019. **Table 2** also includes monthly data from December 2018 and January 2019 that have also likely contributed to catchment wetness.

Table 2 Cumbo Creek 2019 rainfall events

Date	Cumbo Ck Station (002) (mm)	Wollar BOM Station (062032) (mm)
December 2018	104	118
January 2019	69	72
17 March 2019	18.8	35
25 March 2019	13.8	18
30 March	58.4	49
3 May 2019	12.4	15.6
3 June 2019	5.4	5

The monthly flow-monitoring, field observation sheets (provided to SLR by EISolutions) have also been examined in order to better understand the flow event. The April 2019 field observation sheet identifies a fault in the flow sensor during March and makes note on the likelihood of a small magnitude flow event associated with the 30 March rainfall event that was not able to be recorded. This note of a small magnitude event serves to highlight the saturation of the catchment in early 2019, following which the sustained period flow could be instigated and sustained by much smaller rainfall events.

Overall, the trend analysis indicates that flow at the upstream station of Cumbo Creek is strongly related to rainfall conditions.

Similar trends between rainfall and flow are observed for WILGSU (**Figure 4**) to those seen at CCGSU. However, WILGSU frequently reports no flow in periods of low monthly rainfall, indicating that baseflow is a smaller component of flow. An excellent correlation between the long-term rainfall trend and the cumulative deviation from mean monthly flow for WILGSU is shown in the bottom chart of **Figure 4**. The flow trend is observed to decline for the period of below average rainfall from mid-2012 to mid-2015 as well as the period of below average flow from early 2017 through to the end of 2019, although it is important to note that no flow has been recorded at WILGSU since late 2017.

Figure 5 used to analyse the flow trends at WILGSD, displays monthly rainfall and deviation from monthly average rainfall as bar charts to allow for clearer analysis of all potential components of flow at WILGSD. As stated in the above flow review, early observations of flow comparing WILGSU and WILGSD show an excellent match before RO Plant discharge begins, resulting in the maintenance of flow at WILGSD when discharge is occurring despite periods of low monthly rainfall.

A period in early 2013 where there is zero discharge from the RO Plant shows the maintenance of flow at WILGSD while no flow is recorded at WILGSU. This may indicate that a component of flow at WILGSD comes from baseflow. It may also indicate the influence of flow from a tributary such as Cumbo Creek, which itself is influenced by baseflow. The influence of the RO Plant discharge on flow at WILGSD, particularly in 2017 and 2018 becomes very clear in **Figure 5**. Prior to the significant (x10) increase in RO Plant discharge in 2017, [1]flow at WILGSD showed a good correlation with the long-term rainfall trend.

In 2017 and 2018, the declining rainfall trend has shown no influence on flow at WILGSD, where the increasing discharge trend from the RO Plant became the major contributor to flow. During 2019, there is no discharge from the RO plant and the flow observed at WILGSD decreases significantly. As was observed prior to the establishment of the RO Plant, flow at WILGSD indicates a strong dependence on rainfall.

2.2 Water Quality Review

Water quality is monitored continuously at WILGSU, WILGSD and CCGSU, with sondes measuring EC, pH (and temperature, which is not shown here). When water levels decline in dry periods, sondes may be ‘banked’ or capped to protect the instrument. These periods are marked on the EC and pH charts in **Figure 2**.

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[1] As a result of the EPL variation in January 2017 to increase the daily discharge limit from 5ML/day to 15ML/day

2.2.1 Electrical Conductivity Trends

Trends in Electrical Conductivity (EC) are a mirror of the flow and rainfall trends, and the daily EC data at each station are highly correlated to the flow data. In early periods, EC is consistently higher at WILGSD than at WILGSU. The usual pattern of higher EC at WILGSD is suggestive of a naturally higher baseflow index at WILGSD (groundwater being typically more saline than runoff) than at WILGSU, and the influence of flow from Cumbo Creek which is also more saline.

During late 2013 and early 2014, the EC pattern reverses, which is probably due to a much greater proportion of flow at WILGSD being from the RO plant, which is less saline than the natural dry-weather EC of Wilpinjong Creek, which is shown at WILGSU. This trend is observed until late 2018, with the remainder of the EC observations at WILGSU generally higher than at WILGSD before the EC recordings stopped at WILGSU due to low flow in early 2017 which has continued through to the end of 2019. .

EC at the Cumbo Creek gauging station (CCGSU) is generally much higher than recorded for Wilpinjong Creek during the data record (Aug 2015-Dec2018) (**Figure 2**). However, the values at an average of around 6000 µS/cm are close to those recorded at WILGSD prior to the start of treated water discharged from the RO Plant. It is likely that Cumbo Creek also has a higher baseflow index than sites further upstream in Wilpinjong Creek, with stream flow being sourced from saline Permian Groundwater.

Declines in the EC at CCGSU are associated with periods of elevated rainfall when fresher surface water runoff would be the dominant source of flow within Cumbo Creek. The period of flow observed in Cumbo Creek from June to September 2019, that is not directly associated with a rainfall event, has EC observations between 7000-8000 µS/cm, which is consistent with the observed baseflow event.

An increase in EC peaking at around 2000 µS/cm is recorded at WILGSD from mid to late 2016. These are associated with periods of high rainfall and high streamflow recorded at all gauging stations. It is likely that this increase is caused by elevated flow rates from Cumbo Creek. While EC from CCGSU declines to near fresh during the flow peak, during the recession, EC is observed to increase rapidly while the flow rate is still elevated, resulting in an EC higher than WILGSU and RO Plant discharge.

EC at WILGSU increases to 2000 µS/cm in January 2017 before monitoring stops due the capping of sondes associated with low flow, while the increase in water being discharged from the RO plant in 2017 and again in 2018 maintains low EC readings at WILGSD, masking the influence of elevated EC at CCGSU during 2017 and 2018 observations.

During 2019, no discharge from the RO Plant allows for the elevated EC from Cumbo Creek to have a greater influence on water quality at WILGSD. However, flow at WILGSD was not sufficient to continuously monitor water quality during 2019 and the influence of Cumbo Creek cannot be determined at this stage.

2.2.2 pH Trends

pH at CCGSU is consistent for the entire monitoring period at a level of 7.7, it shows no correlation with rainfall or streamflow trends. While point sample analysis also shows very stable EC at Cumbo Creek upstream sites (**Figure 8**), it is recommended that the pH sensor at CCGSU be tested to determine it is functioning correctly.

pH at both gauging stations on Wilpinjong Creek appear to be correlated to the long-term trend in rainfall and flow. However, pH also shows a response to short-term variation in flow and does exhibit signals depending on the source of the water in the river. For example, during storm events (e.g. March 2012, July-2012) pH is shown to decline sharply by about 0.5-1 pH unit, before recovering over a period of weeks, back to the baseline of about 7 (upstream) and 7.5-8 (downstream).

The two main periods for which the pH trends deviate from their 'baseline pattern' are January 2013 and April-June 2013. During both periods the water quality sonde at WILGSU is capped due to low water levels at the site (i.e. not monitoring). However, across each period, in-stream pH responds to the low flow conditions. In the first of these periods, pH at WILGSU declines to 6.2 and then recovers to over 7-7.5 within two months. pH at WILGSD appears unaffected at this time. In the second period pH at WILGSD declines to about 7, in response to a marked decline in flow and recovers to almost 8 by June, while at WILGSU the pH falls to 6.5 in May 2013, with a slow recovery back to pH 7 over a period of 5 months.

From Jan 2014 to Dec 2018, pH values at both stations seem to decrease after periods of low flow (Jul 2014, Apr 2015, Jun 2016, Jan 2018, April 2018), and a relatively more acidic environment at WILGSU than at WILGSD is observable.

No pH observations have been made using the continuous monitoring stations at WILGSD and WILGSU during 2019 due to low flow conditions.

Overall, during the last five water years, pH levels at both gauging stations are within the ANZECC and ARMCANZ (2000) default trigger values of 6.5-8.0. Exceptions occur in January 2015, March 2016 and November 2018 with pH values of 8.8, 9.8 and 9.5 respectively. These spikes may be the results of the sondes being exposed to air when near to no-flow conditions were recorded, resulting in unreliable pH values.

The sharp decrease in EC seen above from July 2014 also occurs for pH from April 2015 where a decrease of 0.5 pH unit is seen. It is likely that the measured decline in pH is due to natural processes resulting from saline groundwater discharge in creeks hosting chemical changes such as conversion of sulphates to sulphides, leading to acid generation. Such processes are not necessarily mining-related, but can be exacerbated by human activities, such as land clearing or water demand (e.g. irrigation, potable supply, mining).

3 Assessment with respect to Gilbert and Associates (2013) Trigger

The pH and EC values recorded at the Wilpinjong Creek monitoring sites (WILGSU and WILGSD) for the period of observation since 2012, even those around pH 6 or EC of 7,000 µS/cm, are consistent with those reported in Gilbert and Associates (2013). Gilbert and Associates (2013) concluded that pH, EC (and other parameters) recorded in Wilpinjong Creek did not show any discernible changes due to mining. The water quality parameters for EC and pH at the Cumbo Creek site (CCGSU) for observations since mid-2015 are also within the parameters reported in Gilbert and Associates (2013) and do not indicate changes due to mining.

Two pronounced periods of below average rainfall associated with no-flow conditions at WILGSU (from mid-2012 to mid-2014 and from late-2016 to present) make the assessment of a possible mining effect, that is discernible from climatic influence, difficult without more detailed analysis. This assessment indicates the current trends at WILGSU are likely caused by periods of below average rainfall.

The identification of a mining effect on stream flow at WILGSD is not possible without isolating the contribution of RO Plant discharge from rainfall derived flow. This has not been done in this assessment.

No mining impact on stream flow is apparent at the upstream site on Cumbo Creek.

4 Water Quality Assessment at Additional Locations

The following section reviews surface water quality data from sites specified in Section 8 of the Surface Water Management Plan (Peabody, 2017). This has been conducted with respect to 20th and 80th percentile baseline monitoring data, which was collected from 2004 to 2009, prior to the commencement of mining. Where no water quality triggers are defined, the review aims to identify trends in surface water quality that are not consistent with baseline observations (**Table 3**).

Table 3 Summary of Baseline Water Quality Data – Local Creeks (Peabody, 2017)

Monitoring Site[1]/Guideline		pH	EC (µS/cm)[2]	Turbidity (NTU)[2]
ANZECC (2000) Guideline Trigger Value	**Protection of Aquatic Ecosystems**	6.5-8.0	30-350	2-25
	Primary Industries (Livestock Drinking Water)	6-9	950	-
Wilpinjong Creek Upstream (Sites WIL-U2, WIL-U, WIL 1, WIL-PC)	Average	7	2435	20
	Minimum	5.7	450	6
	Maximum	9	12190	41
	No. Samples	49	49	5
	80th percentile	**7.7**	**4066**	**24**
	20th percentile	**6.9**	-	-
Wilpinjong Creek Downstream (Sites WIL-NC, WIL-D2, WIL 2, WIL-D)	Average	8	3531	22
	Minimum	6.7	680	4
	Maximum	9	7450	70
	No. Samples	55	55	9
	80th percentile	**7.9**	**5166**	**28**
	20th percentile	**7.4**	-	-
Cumbo Creek Upstream (Sites CC2, CC3, CC4, CC5)	Average	8	5303	11
	Minimum	6.8	100	5
	Maximum	9	10500	24
	No. Samples	70	70	15
	80th percentile	**8.2**	**6750**	**16**
	20th percentile	**7.4**	-	-
Cumbo Creek Downstream (Site CC1)	Average	8	6231	43
	Minimum	6.7	540	17
	Maximum	9	10470	94
	No. Samples	27	27	6
	80th percentile	**8.2**	**7510**	**77**
	20th percentile	**7.52**	-	-
Wollar Creek (Sites WOL 1, WOL 2, WOL 3)	Average	8	2311	16
	Minimum	6.5	90	2
	Maximum	8.4	6540	37

Monitoring Site[1]/Guideline		pH	EC (µS/cm)[2]	Turbidity (NTU)[2]
	No. Samples	90	90	20
	80th percentile	**8.0**	**3460**	**25**
	20th percentile	**7.4**	-	-

[2] µS/cm = micro-siemens per centimetre, NTU = Nephelometric Turbidity Units, mg/L = milligrams per litre

Assessment is also made with respect to Water Quality Impact Assessment Criteria (trigger levels) where applicable. Where trigger levels are defined (**Table 4**) the review will identify any exceedances and provide preliminary analysis.

Table 4 Water Quality Impact Assessment Criteria (Peabody, 2017)

Creek	Monitoring Site	Parameter	Trigger
Wilpinjong Creek (Downstream)	WIL_NC, WIL_D2, WIL_D, WIL_2	EC	If recorded value at the monitoring site is greater than **3,440 µS/cm** for 3 consecutive readings
		Turbidity	If recorded value at the monitoring site is greater than **24 NTU** for 3 consecutive readings
		pH (lower)	If recorded value at the monitoring site is less than **6.9 pH** for 3 consecutive readings
		pH (upper)	If recorded value at the monitoring site is greater than **7.7 pH** for 3 consecutive readings
Cumbo Creek (Downstream)	CC1	EC	If recorded value at the monitoring site is greater than **7,510 µS/cm** for 3 consecutive readings
		Turbidity	If recorded value at the monitoring site is greater than **77 NTU** for 3 consecutive readings
		pH (lower)	If recorded value at the monitoring site is less than **7.5 pH** for 3 consecutive readings
		pH (upper)	If recorded value at the monitoring site is greater than **8.2 pH** for 3 consecutive readings

[1] Trigger is only considered to have been exceeded if the recorded value at monitoring site is greater than (or less than for lower pH Trigger) all values from the upstream monitoring sites sampled on the same day. In the event that a single result is recorded above/below the 80th/20th percentile value, WCPL will undertake a preliminary investigation to ascertain whether the result was caused by an obvious anomaly or whether further testing is required.

4.1 Review of Creeks without Trigger Levels

Time-series water quality data from upstream monitoring sites at Wilpinjong (Sites WIL-U2, WIL-U, WIL 1, WIL-PC) and Cumbo Creeks (Sites CC2, CC3, CC4, CC5) as well as monitoring sites at Wollar Creek (Sites WOL 1, WOL 2) (**Table 5**) are reviewed against 20th and 80th percentile observation data for EC, Turbidity and pH from the baseline monitoring period (2004-2009). These monitoring sites are upstream or distant from WCM mining operations and provide a point of reference when assessing downstream sites with trigger levels.

Data at several additional monitoring sites was also provided to SLR by WCM. The observations from these additional sites have been included in the appropriate creek area.

Table 5 Additional surface water monitoring sites

Monitoring Site	Creek Area
CC-GS-U, CC-GS	Cumbo Creek Upstream
CC-GS-D, CC-1 (30m up)	Cumbo Creek Downstream
WIL-GS-U	Wilpinjong Creek Upstream
WIL-GS-D	Wilpinjong Creek Downstream

The review is conducted for each creek area by analysing time-series water quality data (EC, turbidity, pH) from January 2015 to December 2019 on a three-panel chart. It should be noted that turbidity data is assessed using a logarithmic y-axis.

4.1.1 Wilpinjong Upstream

The creek area defined as Wilpinjong Upstream (Peabody, 2017) is assessed using monitoring data from sites WIL-U2, WIL-U, WIL 1 and WIL-PC (**Figure 6**). These sites are located along Wilpinjong Creek near the western edge of current and proposed WCM mining activity (**Figure 1**).

EC observations at Wilpinjong Creek Upstream monitoring sites have shown considerable variation between 2015 and 2018 (<1000 µS/cm to 7500 µS/cm). Although the more elevated observations (>6000 µS/cm) taken during 2015 at WIL-U and WIL-PC are occurring simultaneously with fresher observations at WIL-GS-U and WIL-U2 (~2000 µS/cm). This indicates increases in EC may be from localised effects. A notable freshening at all Wilpinjong Creek Upstream sites occurs in late 2016 in response to above average rainfall conditions.

The only available observations from 2017 to 2019 are from WIL-U2 and WILGSU, where EC observations have fluctuated between 2000-6000 µS/cm at WIL-U2 and <1500 µS/cm at WILGSU. The lack of observations in this period are related to ongoing dry conditions, and no observed streamflow at Wilpinjong Creek upstream sites. Observations at WIL-U2 during 2019 appear to generally be taken during periods of below average rainfall and are consistent with observations at the same site back to 2015. The observations taken at WILGSU appear to have occurred during a minor period of average or above average rainfall which likely explains the lower EC observations. Observations at Wilpinjong Creek Upstream monitoring sites are generally below the 80th percentile baseline value.

Turbidity observations at Wilpinjong Creek Upstream monitoring sites were varied but consistent from 2015 to 2019, with observations ranging from 1.5 – 263 NTU that were above the 80th percentile baseline monitoring value around for around half of the observations. Turbidity observations with higher values generally appear to be associated with periods of below average rainfall. Increases in turbidity at the WIL-U2 monitoring site (the most frequently sampled of the Wilpinjong Creek Upstream Monitoring Sites) occur during periods of below average rainfall in mid-2016, early 2017, late 2017 and late 2018 to early 2019.

Comments made during field sampling commonly use phrases such as ‘muddy brown colour’ and mention that samples are collected from disconnected pools with no-flow conditions. Low turbidity observations during 2019 at WIL-U2 are likely related to sampling from still disconnected pools where particulate material may have settled out of suspension. Sampling in conditions such as these will not be representative of the system as a whole. An example of a surface water sampling sheet (June 2019) describing sampling from disconnected pools is provided for reference as **Figure 7**.

pH observations at Wilpinjong Creek Upstream monitoring sites from 2015 to 2018 have generally been lower than the 20th percentile value defined in baseline monitoring data. Of note is the extended period of low pH recorded at WIL-U2 from mid-2016 to late 2019 during which pH was around 4 for 5 sampling events in 2019.

As was proposed in **Section 1.2.2**, this decline in pH may be associated with saline groundwaters or groundwater discharge into the system hosting chemical changes such as conversion of sulphates to sulphides, leading to acid generation. Sampling from disconnected pools and very low flow conditions will not be representative of system as a whole.

4.1.2 Cumbo Creek Upstream

The creek area defined as Cumbo Creek Upstream (Peabody, 2017) is assessed using monitoring data from sites CC2, CC3, CC-GS and CC-GS-U (**Figure 8**). These sites are located along Cumbo Creek to the south of WCM (**Figure 1**).

EC observations at Cumbo Creek Upstream show considerable variation between 2015 and 2019 (<1000 µS/cm to ~10,000 µS/cm) but are generally saline. Freshening appears to occur following increases in the long-term rainfall trend as is seen in late 2016, with the inverse observed in periods of low rainfall. Most of the 2019 EC observations at CC2 and CCGSU lie above the 80th percentile value taken from 2004 to 2009 baseline observations, with a high EC reading of ~10,000 µS/cm at CC-2 in March 2019, that decreases to ~7,000 µS/cm toward the middle of 2019.

It is likely that an increased influence of saline groundwater discharge at the Cumbo Creek Upstream area is responsible for the general increase in EC observed from 2017 to 2019. However, the high EC value at CC-2 in March 2019 may have resulted from sampling being undertaken in a disconnected pool, as indicated in the field sampling notes (**Figure 7**). With the flow event from June to September flushing out areas of concentrated salinity, reducing the EC in observations to September 2019.

Turbidity observations at Cumbo Creek Upstream monitoring sites from 2015 to 2018 were generally below the 80th percentile baseline value for data collected from 2004 to 2009. Higher values (1000-10,000 NTU) that are not clearly linked with the rainfall trend occurred throughout 2015 and again in early-2018. During 2019, turbidity observations have been below the 80th percentile baseline value. The availability of a longer period of historic data may allow for more in-depth cause and effect analysis between turbidity and external or environmental influences.

pH observations at Cumbo Creek Upstream have been relatively stable from 2015-2018. CC-3 observations were generally marginally higher than the 80th percentile value defined from the baseline monitoring during 2017, While observations at CC-2 were consistently within the 20th and 80th percentile bands defined in the baseline period. All observations during 2019 were within the 20th and 80th percentile bands defined in the baseline period.

4.1.3 Wollar Creek

The creek area defined as Wollar Creek (Peabody, 2017) is assessed using monitoring data from sites WOL1, WOL 2 and WOL3 (**Figure 8**). The sites are located along Wollar Creek to the east and south of WCM, with WOL1 located downstream of the confluence between Wilpinjong and Wollar Creeks (**Figure 1**). The Wollar Creek monitoring sites are located approximately 5 km from the current extent of WCM mining activity.

During 2015, EC observations at both Wollar Creek monitoring sites showed considerable variation, with EC ranging from less than 1000 µS/cm to greater than 5500 µS/cm. From late 2015 to the end of December 2018, the variation in EC between consecutive observations has decreased, with WIL1 EC ranging from 500 µS/cm to 2000 µS/cm and WIL2 EC reasonably stable between 2000 µS/cm and 2500 µS/cm. The lower EC in WIL1, which is further downstream than WIL2, may be related to the low EC discharge from the RO (Reverse Osmosis) plant located upstream on Wilpinjong Creek.

During 2019, EC values have increased at both WOL-1 and WOL-2 from <2000 µS/cm to observations around 5000 µS/cm. Low flow conditions and an increased contribution of saline groundwater from baseflow are the likely causes of the increase in EC at Wollar Creek during 2019.

Turbidity observations at Wollar Creek monitoring sites were relatively stable from 2015 to 2019, and have generally recorded below the 80th percentile of baseline data collected from 2004-2009. Notable increases in turbidity, above the 80th percentile baseline value, occur on two occasions during this time. In late 2015, and in late 2018, for a single observation at both WOL1 and WOL2 monitoring sites. These increases appear to be associated with a period of above average rainfall that follows a period of low or below average rainfall. These periods of low rainfall would be associated with lower flow in Wollar Creek, which may facilitate the settling of suspended material to the stream bed. The higher flow events associated with above average rainfall may resuspend this fine material, resulting in the temporary spikes in turbidity.

pH observations at Wollar Creek have been relatively stable from 2015-2019. WOL2 observations have been generally marginally higher than the 80th percentile value defined from the baseline monitoring. While observations at WOL1 were consistently within the 20th and 80th percentile bands defined in the baseline period.

4.2 Assessment of Creeks with Trigger Levels

Time series water quality data from the downstream monitoring sites at Wilpinjong (Sites WIL-NC, WIL-D2, WIL-D, WIL-GS-D) and Cumbo Creeks (Site CC1) are assessed against Water Quality Impact Assessment Criteria (trigger levels) as defined in the SWMP (Peabody, 2017). These monitoring locations are adjacent to or close downstream from WCM mining activity and are therefore more likely to indicate impacts to surface water quality caused by mining.

4.2.1 Wilpinjong Creek Downstream

The creek area defined as Wilpinjong Creek Downstream (Peabody, 2017) is assessed against water quality trigger levels at sites WIL-NC, WIL-D2, WIL-D and WIL-GS-D (**Figure 9**). These sites are located along Wilpinjong Creek, adjacent to, or just downstream of WCM mining operations (**Figure 1**).

EC observations at Wilpinjong Creek Downstream monitoring sites show some variation and elevated EC levels between individual monitoring sites in 2015, before declining and becoming consistent with one another from mid-2016 through to the end of 2018.

EC observations during 2019 have again increased to levels in exceedance of the trigger level, with observations ranging from 4500-6500 µS/cm. Observations at WIL-D and WIL-D2 during 2015 exceed both the EC trigger level and the 80th percentile baseline observation value defined in the SWMP (Peabody, 2017).

This, however, was not assessed by HydroSimulations (2019) to constitute an exceedance of the trigger level. The EC values recorded at the same time in Wilpinjong Creek Upstream sites also have high EC observations (**Figure 6**), meaning that the elevated salinity levels are unlikely to be related to WCM mining activity.

From the beginning of 2016, EC levels declined at all monitoring sites in the Wilpinjong Creek Downstream area. An increase in discharge from the low salinity RO Plant, in conjunction with low flow conditions are responsible for this decrease in EC.

As for the 2015 exceedance, the exceedance of the trigger level in 2019 has similarly been assessed against observations at the Wilpinjong Creek upstream water quality observation sites. During 2019, EC observations at the upstream sites ranged from 3750-6000 µS/cm, reasonably consistent with observations at downstream sampling points, indicating the increase in EC is unlikely to be related to Wilpinjong mining activity.

Turbidity observations at monitoring sites in the Wilpinjong Creek downstream area show some variability during 2015 (10-1000 NTU), and gradually decline during 2016 and 2017 (0.5-30 NTU), before increasing in turbidity during 2018 and 2019, to levels more consistent with 2015 observations (1-500 NTU) (**Figure 9**).

Turbidity observations at Wilpinjong Creek Downstream monitoring sites are frequently greater than the defined trigger level during 2015 observations. They are also greater than turbidity observations at the Wilpinjong Creek Upstream monitoring sites by 5-10 times (**Figure 6**), possibly indicating an exceedance of the trigger level. HydroSimulations (2019) assessed the period of elevated turbidity at Wilpinjong Creek downstream monitoring sites during 2015 to be related to RO Plant discharge. During 2015, flow recorded at WIL-GS-D was around 10 times higher than WIL-GS-U, due to the contribution of RO Plant discharge (**Figure 2**). A higher flow rate downstream may suspend additional bed material and increase turbidity.

The decreasing and low turbidity trend during 2016 and 2017 may be related to RO Plant discharge becoming the dominant source of flow in the Wilpinjong Creek Downstream area. There is no measurable flow at the WILGSU monitoring site during late 2016 and most of 2017, with the flow rate recorded at WILGSU a near perfect match to the RO Plant discharge volume (**Figure 2**). Clean, processed water discharged from the RO Plant is likely to have a very low turbidity which could be responsible for the decline in observed turbidity levels at Wilpinjong Creek Downstream monitoring sites during this period.

During 2018 RO Plant discharge decreases with no discharge from the RO Plant in 2019, as does flow at WILGSD. While no-flows are recorded at WILGSU corresponding to the extended period of below average rainfall (**Figure 2**).

Turbidity values at Wilpinjong Creek Downstream monitoring site, WIL-D2, are above the trigger value defined in the SWMP (Peabody, 2017) for the last four observations during 2018. However, the October and November 2018 observations at Wilpinjong Creek Upstream monitoring site, WIL-U2, are greater than the observations at WIL-D2, meaning that no trigger exceedance is recorded in line with the footnote below **Table 4** from the SWMP (Peabody, 2017) 'Trigger is only considered to have been exceeded if the recorded value at a monitoring site is greater than (or less than for lower pH Trigger) all values from the upstream monitoring sites sampled on the same day'.

While there are turbidity observations above the trigger level in 2019, no trigger exceedance is recorded as 3 consecutive observations above the trigger level as defined in **Table 4** are not observed. Further analysis of observations during the baseline and early-mining period are required to determine whether turbidity observations during late 2018 and early 2019 may reflect the natural variation between upstream and downstream sites at Wilpinjong Creek.

pH at the monitoring sites in the Wilpinjong Creek Downstream area have been reasonably consistent and did not exceeded the trigger levels defined in the SWMP (Peabody, 2017) from 2015 to the end of 2017. During early 2018, sites WIL-D and WIL-D2 record pH levels considerably lower than the lower trigger value. WIL-D2 has 2 consecutive observations with a minimum pH of 4, below the trigger level, while WIL-D has 3 consecutive observations, with a minimum pH of 5, below the trigger level. Due to low pH values observed simultaneously at Wilpinjong Creek Upstream monitoring site WIL-U2 (**Figure 6**), this does not constitute a trigger exceedance.

As was proposed in Section 1.2.2 and Section 3.1.1, this decline in pH may be associated with saline groundwaters or groundwater discharge into the system, hosting chemical changes such as conversion of sulphates to sulphides, leading to acid generation. Aside from a single observation with a low pH (~pH4), pH observations during 2019 have been stable and do not exceed defined trigger levels.

4.2.2 Cumbo Creek

The creek area defined as Cumbo Creek Downstream is assessed against water quality trigger levels at site CC1, CC-GS-D, CC-1-(up 30m) (**Figure 10**). These sites are located close to the confluence of Wilpinjong and Cumbo Creeks and are near the northern extent of WCM mining operations.

EC observations at Cumbo Creek Downstream monitoring sites show considerable variation from 2015 to mid-2017 (<1000 µS/cm to ~5000 µS/cm), before decreasing and reporting EC levels less than 1000 µS/cm during 2018.

Only two observations have been made at CC-1 and CCGSU in 2019 with an EC of <1000 µS/cm, likely due a lack of water available for sampling due to the extended period of below average rainfall from 2017-2019, with samples only able to be taken following rainfall events.

The decrease in EC during 2018 and 2019 may be related to a decrease in saline baseflow to the Cumbo Creek Downstream area, associated with the depressurisation of Permian strata caused by nearby mining in WCM Pit 3 and Pit 4.

The catchment between the upstream and downstream monitoring sites has also been described to SLR as marshy and containing a number of holes that would require filling prior to flow being observed downstream.

It is recommended that the flow gauge be reinstated at an appropriate location to allow comparison with historical downstream Cumbo Creek flow. This will allow for ongoing investigation into the influence of site activities, such as the haul road joining Pit 3 and Pit 4 on (**Figure 11**) on flow. It will also serve to collect baseline data prior to the construction of the Cumbo Creek diversion.

There are no exceedances of the EC trigger recorded in the Cumbo Creek Downstream area over the past four years.

With respect to the 80th percentile baseline data trigger value, turbidity observations at Cumbo Creek Downstream monitoring sites were elevated for 2015, low during 2016, corresponding with a period of above average rainfall, and again elevated from 2017 to 2019.

Turbidity observations exceeded the trigger level for Cumbo Creek Downstream during late 2015 and early 2016 (**Figure 11**), with turbidity levels above the 80th percentile baseline value for 3 consecutive observations, with greater turbidity values than any simultaneous observation at monitoring sites in the Cumbo Creek Upstream area (**Figure 8**).

An extended period of elevated turbidity at CC-1, with 7 consecutive observations above the 80th percentile baseline value indicates an exceedance of the trigger level has also occurred during 2018, with the two observations made at CC-1 and CCGSU in 2019 also exceeding the trigger level.

The source of this increased turbidity at the Cumbo Creek Downstream area is likely to be a combination of low/no-flow conditions in Cumbo Creek, in conjunction with an increase of sediment to the creek. The CC-1 surface water monitoring site is near to WCM Pit 3 (~50 m) and Pit 4 (~250 m) but is also directly adjacent to the unsealed Ulan-Wollar Road (<10 m) (**Figure 12**). It is likely that the high turbidity levels occurring at the Cumbo Creek Downstream area are due to an increased sediment load caused by the heavily used and unsealed Ulan-Wollar Road during a period of low rainfall.

From 2015 to early 2019, pH observations at Cumbo Creek Downstream monitoring sites are consistently below the trigger level defined in the SWMP (Peabody, 2017) at level of around pH 7 (**Figure 11**). They are also generally lower than pH observations from Cumbo Creek Upstream monitoring sites (**Figure 8**).

While these observations constitute an exceedance of the pH trigger level, all observations are within the pH 6.5-8 range defined in the ANZECC (2000) guidelines for the protection of aquatic ecosystems and do not pose a threat to the health of the system.

The last observation, from September 2019, has recorded a pH 9, the highest recorded in the available data. This single observation does not constitute a trigger exceedance, and is likely related to sampling from a disconnected pool. Investigation into the specific baseline data for this site may assist in determining the validity of the trigger level, and further help to explain why many pH observations fall outside the trigger bounds.

4.3 Assessment with respect to SWMP (Peabody, 2017) water quality triggers

Table 5 identifies Water Quality Impact Assessment Criteria defined in the SWMP (Peabody, 2017) that have been exceeded during monitoring from (2015-2018). This assessment, in line with the SWMP (Peabody, 2017) has only considered triggers to be exceeded under the following circumstances:

- *Trigger is only considered to be exceeded if recorded value at the monitoring site is greater than (or less than for lower pH trigger) for 3 consecutive readings.*
- *Trigger is only considered to have been exceeded if the recorded value at monitoring site is greater than (or less than for lower pH Trigger) all values from the upstream monitoring sites sampled on the same day.*

Table 6 Exceedances of Water Quality Impact Assessment Criteria (Peabody, 2017)

Creek	Site	Parameter	Trigger[1,2]	Exceedance[1,2] during 2019 reporting period	Summary of Assessment
Wilpinjong Creek (Downstream)	WIL_NC, WIL_D2, WIL_D, WIL_2	EC	**3,440 µS/cm**	No	EC observations above defined trigger level, but high EC values also observed at upstream monitoring locations. Trigger not exceeded.
		Turbidity	**24 NTU**	No	
		pH (lower)	**6.9 pH**	No	
		pH (upper)	**7.7 pH**	No	

Creek	Site	Parameter	Trigger[1,2]	Exceedance[1,2] during 2019 reporting period	Summary of Assessment
Cumbo Creek (Downstream)	CC1	EC	**7,510 µS/cm**	No	
		Turbidity	**77 NTU**	Yes	Further investigation may be required. Proximity of monitoring site to unsealed Ulan-Wollar Road, and ongoing dry conditions may all be contributing to exceedances. **Section 4.2.2**
		pH (lower)	**7.5 pH**	Yes	pH near-neutral and within ANZECC (2000) Guideline Trigger Values. Trigger not likely related to WCM mining. **Section 4.2.2**
		pH (upper)	**8.2 pH**	No	Single observation does not constitute trigger exceedance

[1] Trigger is only considered to have been exceeded if the recorded value at monitoring site is greater than (or less than for lower pH Trigger) all values from the upstream monitoring sites sampled on the same day. In the event that a single result is recorded above/below the 80th/20th percentile value, WCPL will undertake a preliminary investigation to ascertain whether the result was caused by an obvious anomaly or whether further testing is required.
2 Trigger is only considered to be exceeded if recorded value at the monitoring site is greater than (or less than for lower pH trigger) for 3 consecutive readings.

Both the Turbidity and pH (lower) triggers have been exceeded during the 2019 observation period at Cumbo Creek Downstream monitoring locations. Due to low/ no-flow conditions during the observation period, the cause of these trigger exceedances cannot be clearly identified. The exceedances that have been identified require further investigation to determine their most likely cause.

5 Recommendations

Recommendations for Sections 1 and 2 and Section 3 of the report are presented below.

5.1 Recommendations with respect to Gilbert and Associates (2013) Trigger

The Gilbert and Associates (2013) trigger has not been assessed as part of this review due to no flows being recorded at Wilpinjong Creek, and the trigger level not accounting for and incorporating RO Plant discharge.

As recommended by HydroSimulations (2019), the development of a new trigger level that can determine flow loss due to WCM independent of RO Plant discharge could be undertaken. Failing this, the development of a method to remove the influence of the RO Plant discharge on the Wilpinjong Creek downstream flow gauge (WILGSD) to allow ongoing assessment of the Gilbert and Associates (2013) trigger may be of use.

5.2 Recommendations with respect to SWMP (Peabody, 2017) water quality triggers

Investigation into the specific baseline data used to create the pH trigger value for the Cumbo Creek Downstream area is recommended. This may assist in determining the validity of the trigger level.

Further investigation into the relationship between turbidity observations at upstream and downstream monitoring sites at Cumbo Creek during the baseline period (2004-2009), as well as Ulan-Wollar Road, and the haul road across Cumbo Creek is recommended. This may assist in determining whether turbidity trigger exceedances are likely to be related to WCM activity.

Further investigation into the relationship between turbidity observations at upstream and downstream monitoring sites at Wilpinjong Creek during the baseline period (2004-2009) is recommended. This may assist in determining the influence of RO Plant discharge on turbidity at Wilpinjong Creek Downstream monitoring sites and determine whether it is valid to identify the discharge as the cause of the exceedances.

Future assessments would benefit from a longer range of time-series data covering the baseline monitoring period as well as the early period of mining at WCM. It may be possible to gain a better understanding of the relationship between climatic influences and upstream and downstream monitoring sites to better determine the presence of any mining related impacts.

5.3 Additional Recommendations

The re-installation of a flow monitoring station at downstream Cumbo Creek is recommended, in a location as near as possible to previously destroyed flow monitoring station. This will allow for ongoing monitoring and analysis regarding the following objectives:

- Changes to the flow relationship along Cumbo Creek between sites that are upstream and downstream of Wilpinjong mining operations.
- Assist in isolating whether changes to water quality downstream of the site are related to activity at Wilpinjong Creek or Cumbo Creek.
- Provide baseline data as a means to measure the efficacy of the approved Cumbo Creek diversion.

Yours sincerely,

Adam Skorulis
Senior Hydrogeologist/Modeller

Checked/
Authorised by: NB

6 References

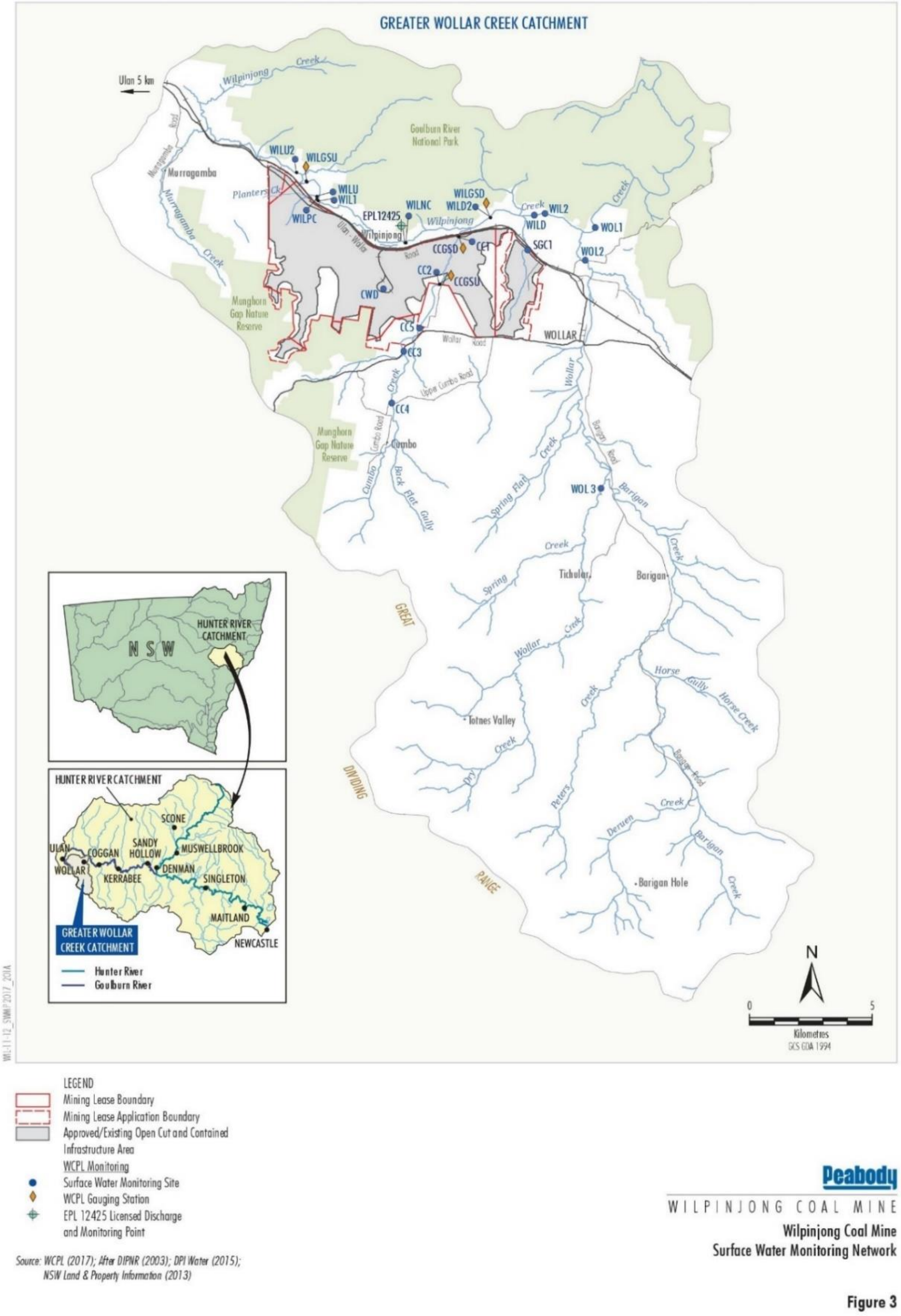
ANZECC, ARMCANZ (2000). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Paper 4 National Water Quality Management Strategy.* Australian and New Zealand Environment and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand, Canberra. Vol. 1, pp. 4.2-15.

Gilbert and Associates, 2013. *Wilpinjong Coal Mine Modification [5] – Surface Water Assessment.* Report for Wilpinjong Coal Pty Ltd. Available at: http://www.peabodyenergy.com/mm/files/Operations/Australia/Wilpinjong/MOD%205/Appendix%20D%20-%20Surface%20Water%20Assessment.pdf

HydroSimulations, 2019. *Wilpinjong Coal Mine – Surface Water Analysis*. Report WIL015 – HS2019/18 for Wilpinjong Coal Pty Ltd. March 2019

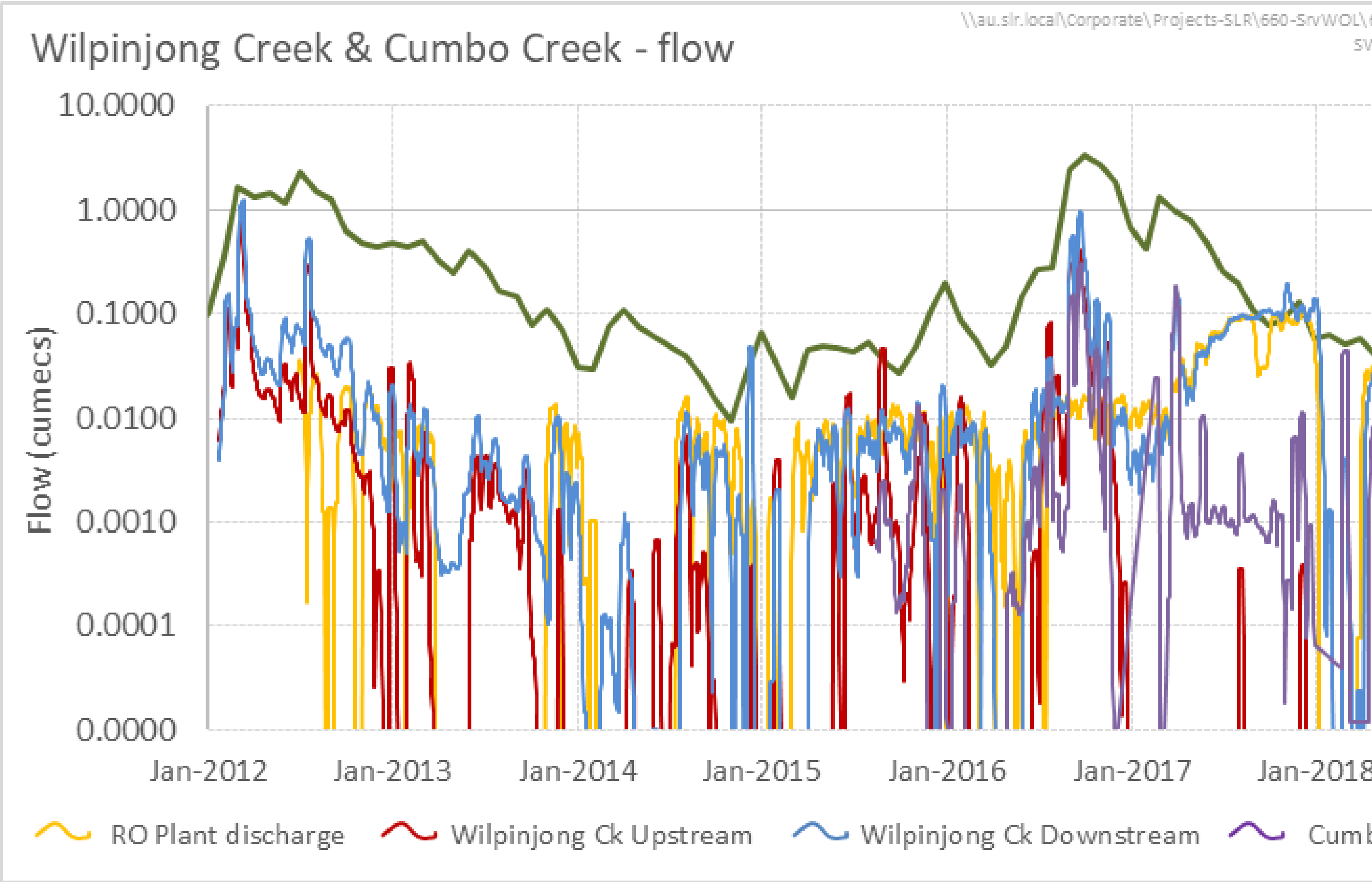
WCPL, 2017. *Wilpinjong Coal - Surface Water Management Plan.* August 2017. Document number: WI-ENV-MNP-0040

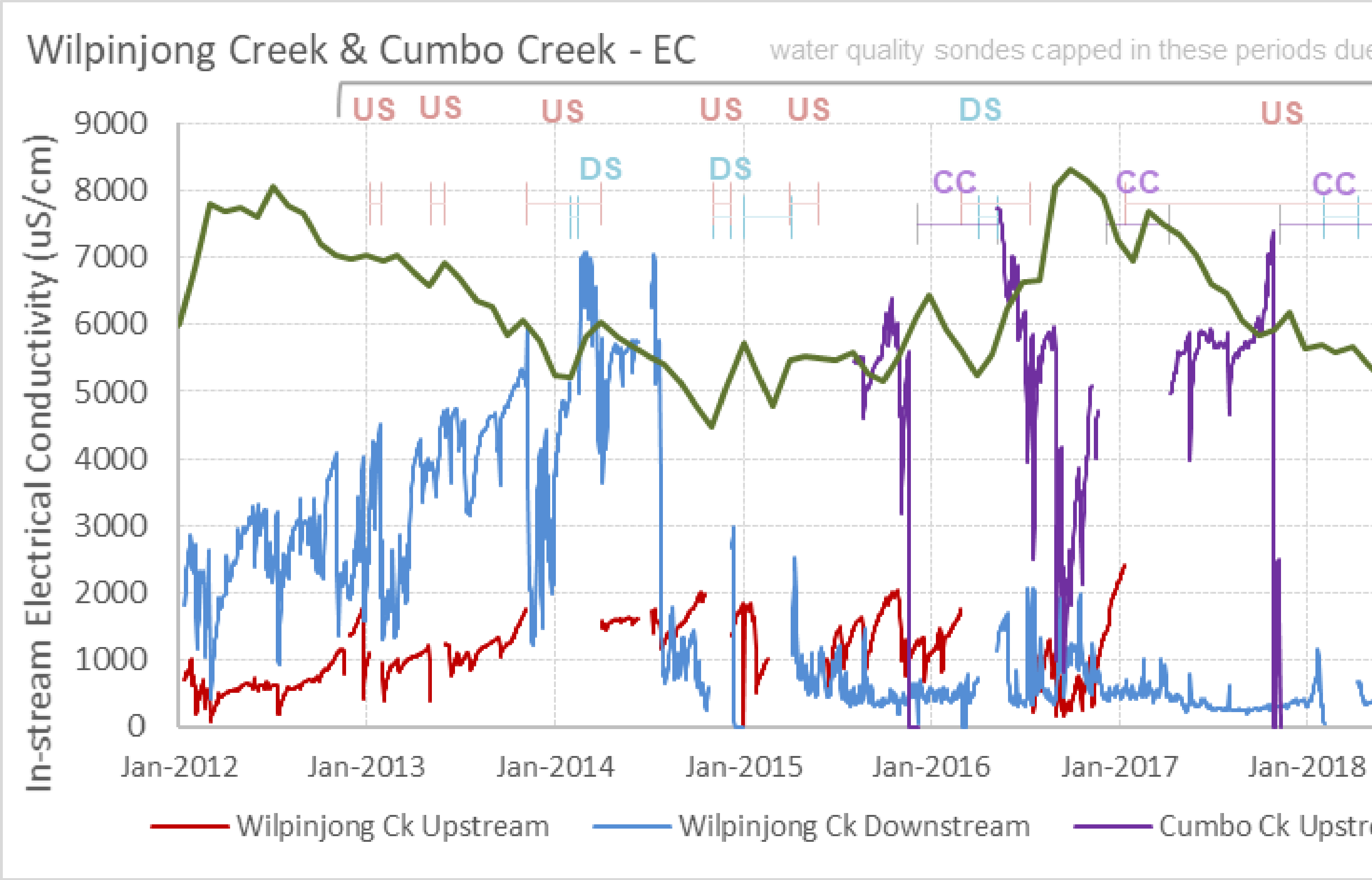
FIGURES



Source: WCPL (2017); After DIPNR (2003); DPI Water (2015); NSW Land & Property Information (2013)

Figure 1 Wilpinjong Coal Mine – Surface Water Monitoring Network (WCPL, 2017)


Wilpinjong Creek & Cumbo Creek - flow
\\au.slr.local\Corporate\Projects-SLR\660-SrvWOL\
SV
Flow (cumecs)
10.0000
1.0000
0.1000
0.0100
0.0010
0.0001
0.0000
Jan-2012
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
RO Plant discharge
Wilpinjong Ck Upstream
Wilpinjong Ck Downstream
Cumb


Wilpinjong Creek & Cumbo Creek - EC
water quality sondes capped in these periods due
US
US
US
US
US
DS
US
DS
DS
CC
CC
CC
In-stream Electrical Conductivity (uS/cm)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Jan-2012
Jan-2013
Jan-2014
Jan-2015
Jan-2016
Jan-2017
Jan-2018
Wilpinjong Ck Upstream
Wilpinjong Ck Downstream
Cumbo Ck Upstr


Wilpinjong Creek & Cumbo Creek - pH
water quality sondes capped in these periods du

Figure 2 Summary of assessed surface sites near Wilpinjong Coal Mine

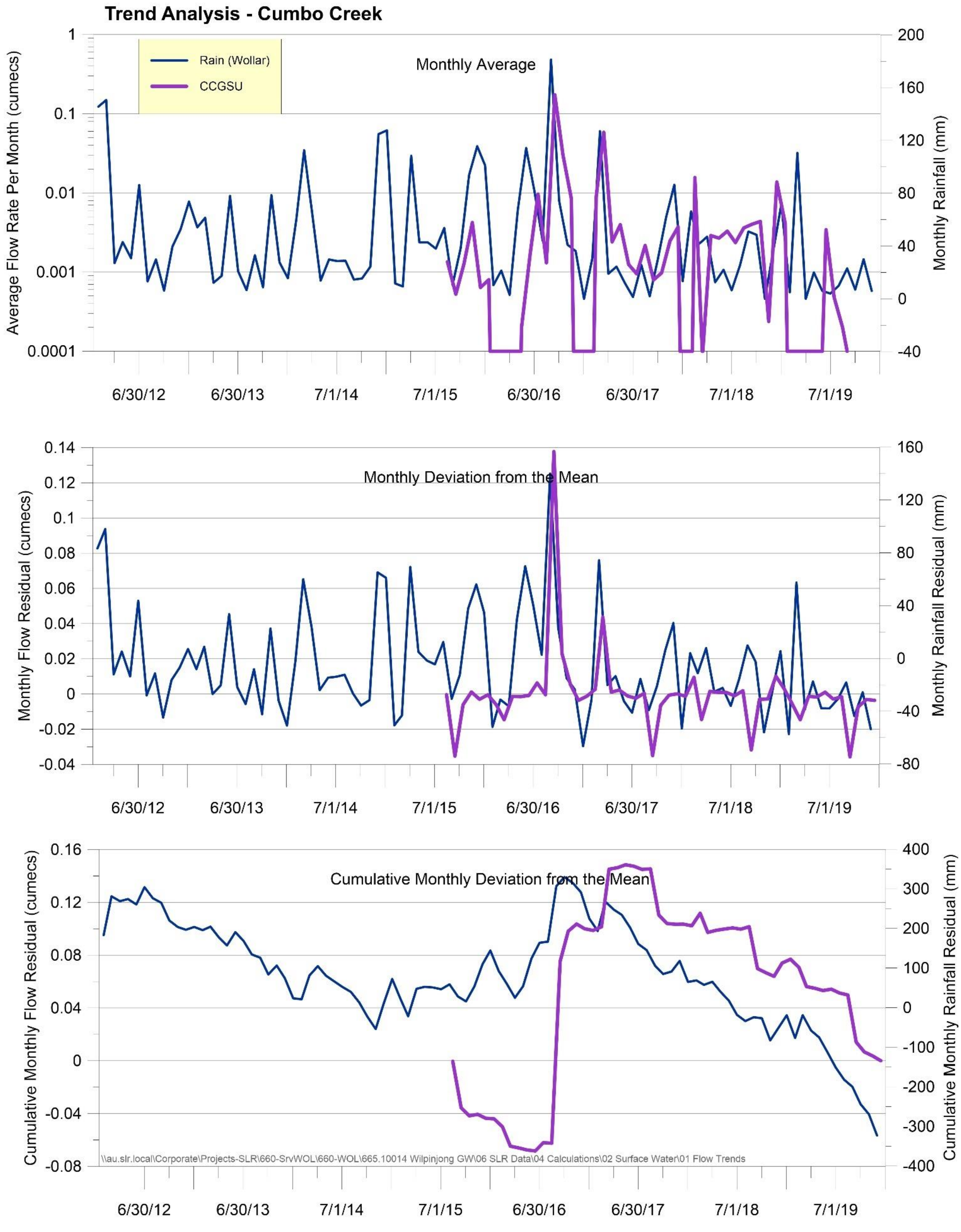


Figure 3 Summary of the Trend Analysis on Cumbo Creek Upstream gauging station (CCGSU)

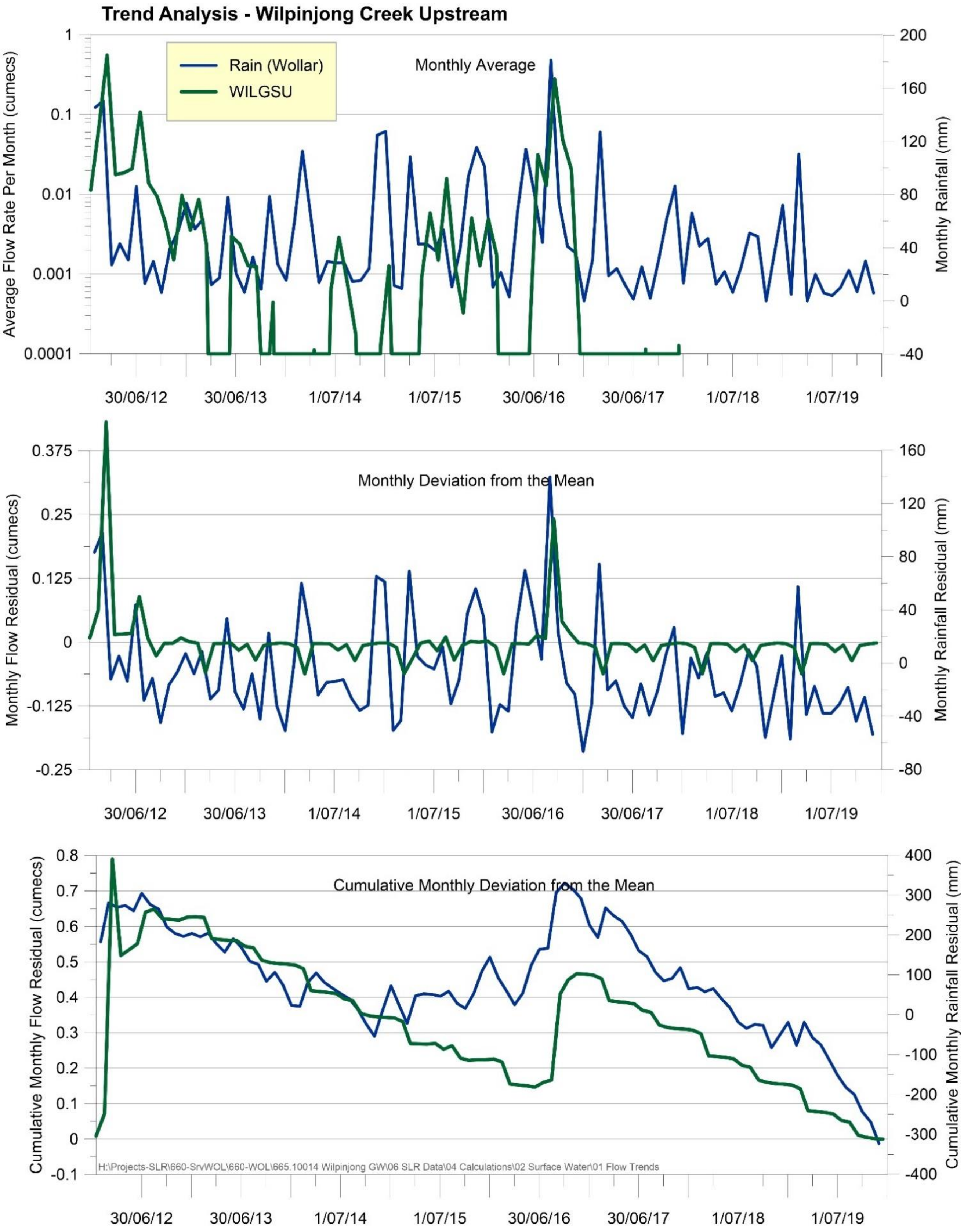


Figure 4 Summary of the Trend Analysis on Wilpinjong Creek Upstream gauging station (WILGSU)

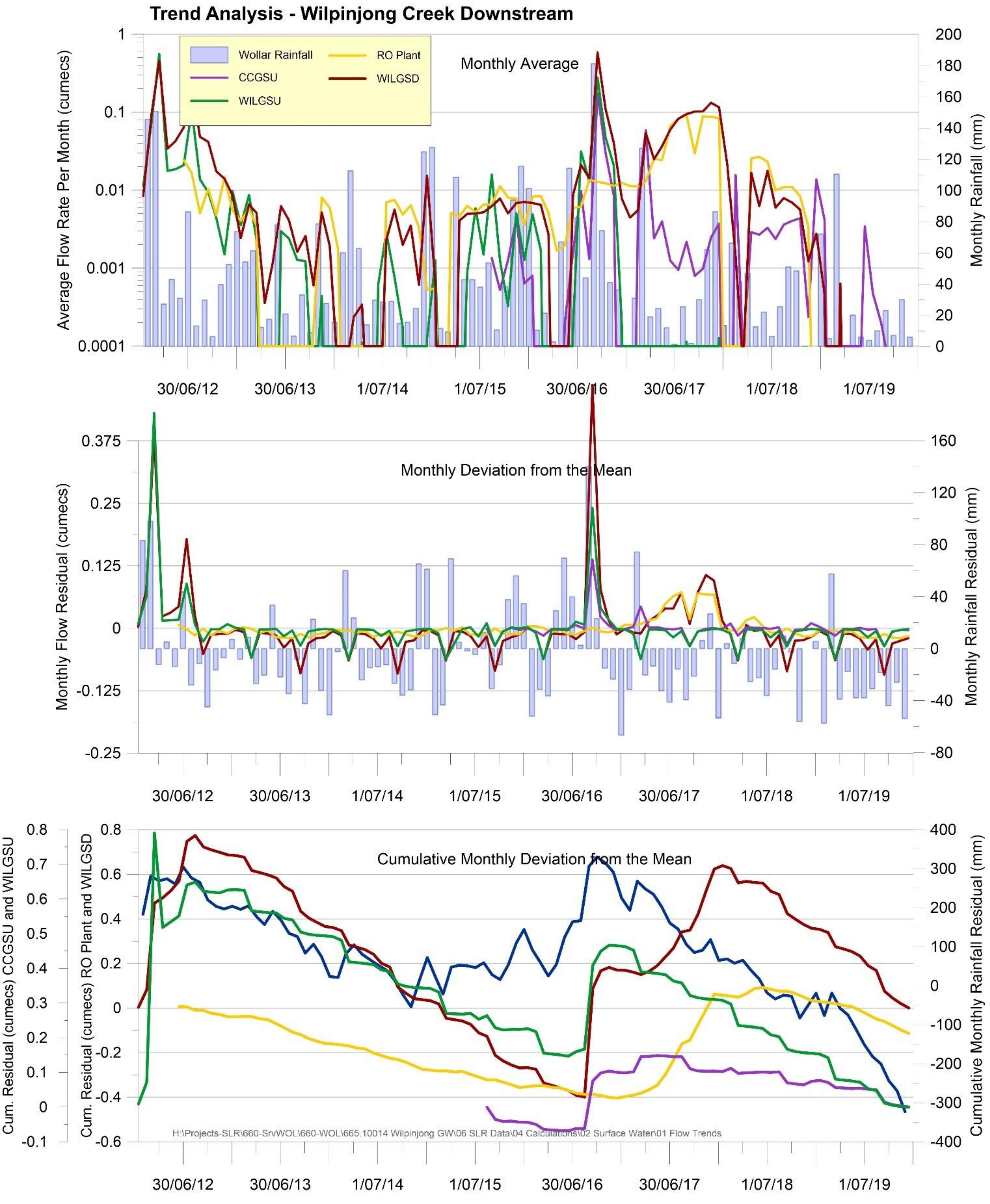


Figure 5 Summary of the Trend Analysis on Wilpinjong Creek Downstream gauging station (WILGSD)

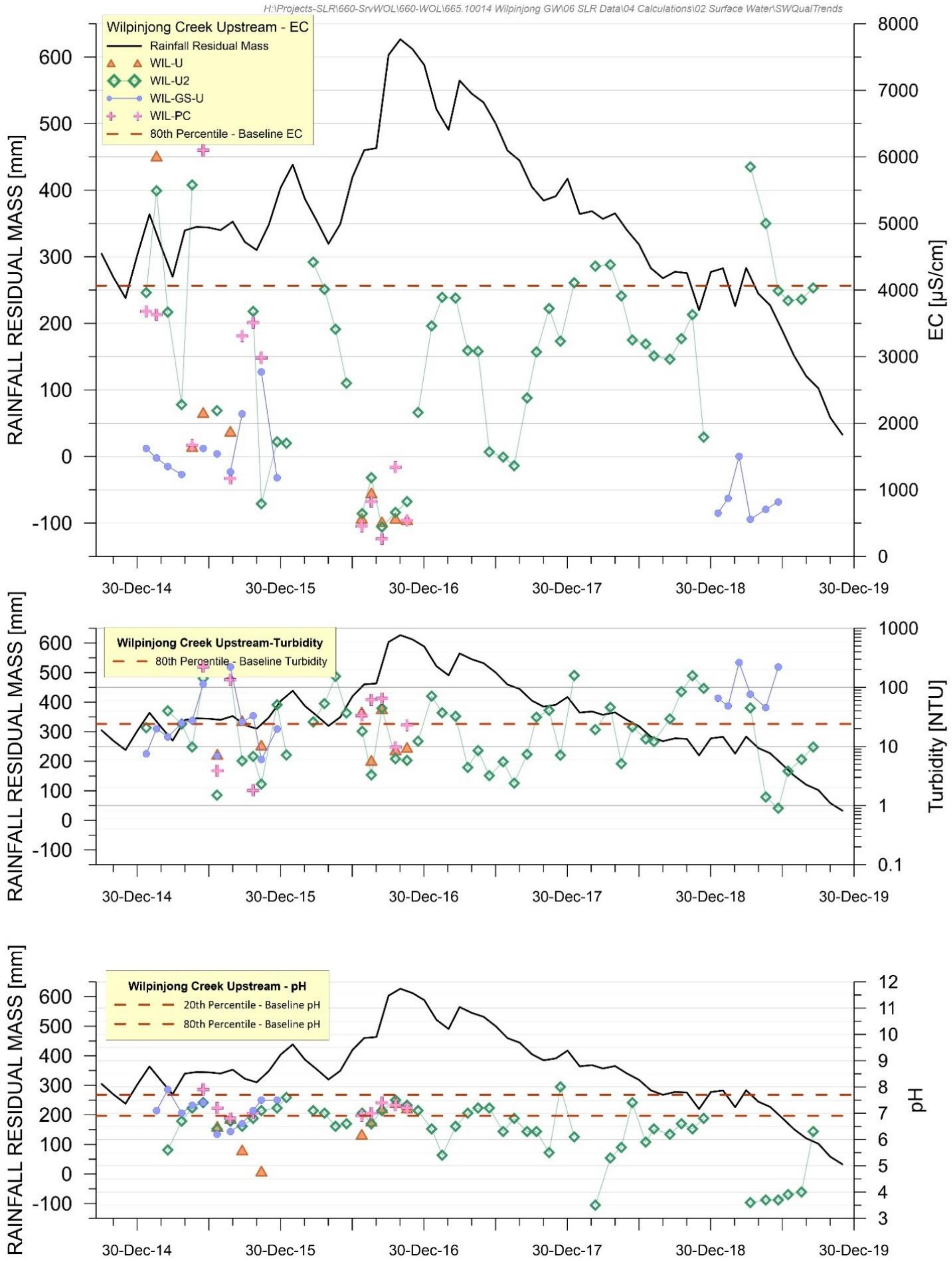
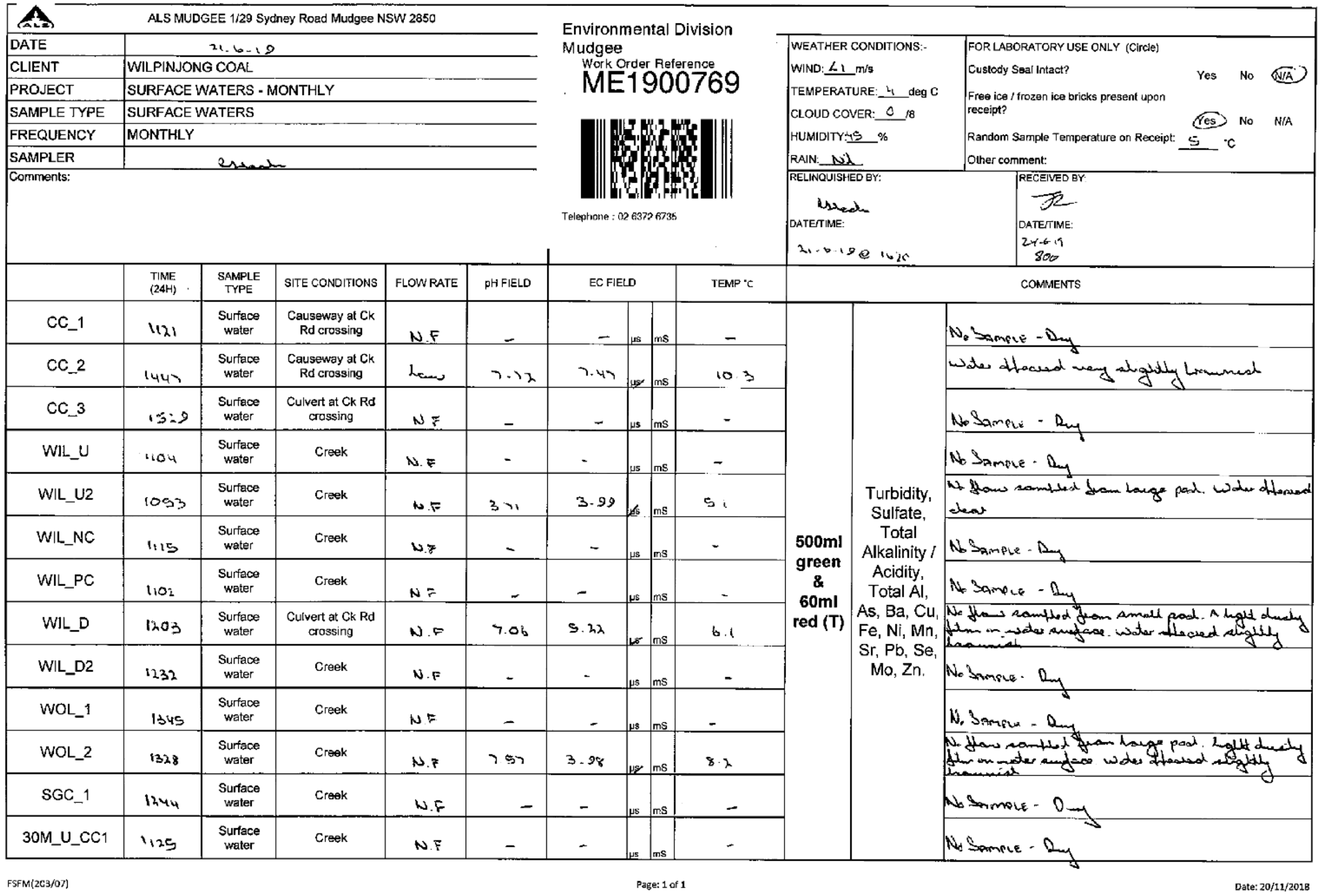


Figure 6 Time-series water quality for Wilpinjong Creek Upstream



ALS MUDGEE 1/29 Sydney Road Mudgee NSW 2850

Environmental Division
Mudgee
Work Order Reference
ME1900769

Telephone : 02 6372 6735

DATE	21-6-19
CLIENT	WILPINJONG COAL
PROJECT	SURFACE WATERS - MONTHLY
SAMPLE TYPE	SURFACE WATERS
FREQUENCY	MONTHLY
SAMPLER	

Comments:

WEATHER CONDITIONS:-
WIND: <1 m/s
TEMPERATURE: 4 deg C
CLOUD COVER: 0 /8
HUMIDITY: 45 %
RAIN: Nil

FOR LABORATORY USE ONLY (Circle)
Custody Seal Intact? Yes No [✓ N/A]
Free ice / frozen ice bricks present upon receipt? [✓ Yes] No N/A
Random Sample Temperature on Receipt: 5 °C
Other comment:

RELINQUISHED BY:
DATE/TIME: 21-6-19 @ 1620

RECEIVED BY:
DATE/TIME: 24-6-19 800

	TIME (24H)	SAMPLE TYPE	SITE CONDITIONS	FLOW RATE	pH FIELD	EC FIELD			TEMP °c			COMMENTS
CC_1	1121	Surface water	Causeway at Ck Rd crossing	N.F	-	-	µs	mS	-	500ml green & 60ml red (T)	Turbidity, Sulfate, Total Alkalinity / Acidity, Total Al, As, Ba, Cu, Fe, Ni, Mn, Sr, Pb, Se, Mo, Zn.	No Sample - Dry
CC_2	1447	Surface water	Causeway at Ck Rd crossing	Low	7.12	7.47	µs	mS	10.3			Water appeared very slightly brownish
CC_3	1529	Surface water	Culvert at Ck Rd crossing	N.F	-	-	µs	mS	-			No Sample - Dry
WIL_U	1104	Surface water	Creek	N.F	-	-	µs	mS	-			No Sample - Dry
WIL_U2	1053	Surface water	Creek	N.F	3.71	3.99	µs	mS	5.1			No flow sampled from large pool. Water appeared clear
WIL_NC	1115	Surface water	Creek	N.F	-	-	µs	mS	-			No Sample - Dry
WIL_PC	1102	Surface water	Creek	N.F	-	-	µs	mS	-			No Sample - Dry
WIL_D	1203	Surface water	Culvert at Ck Rd crossing	N.F	7.06	5.22	µs	mS	6.1			No flow sampled from small pool. A light dusty film on water surface. Water appeared slightly brownish
WIL_D2	1232	Surface water	Creek	N.F	-	-	µs	mS	-			No Sample - Dry
WOL_1	1345	Surface water	Creek	N.F	-	-	µs	mS	-			No Sample - Dry
WOL_2	1328	Surface water	Creek	N.F	7.57	3.98	µs	mS	8.2			No flow sampled from large pool. Light dusty film on water surface. Water appeared slightly brownish
SGC_1	1244	Surface water	Creek	N.F	-	-	µs	mS	-			No Sample - Dry
30M_U_CC1	1125	Surface water	Creek	N.F	-	-	µs	mS	-			No Sample - Dry

FSFM(203/07)

Page: 1 of 1

Date: 20/11/2018

Figure 7 June 2019 Surface Water Sampling Field notes

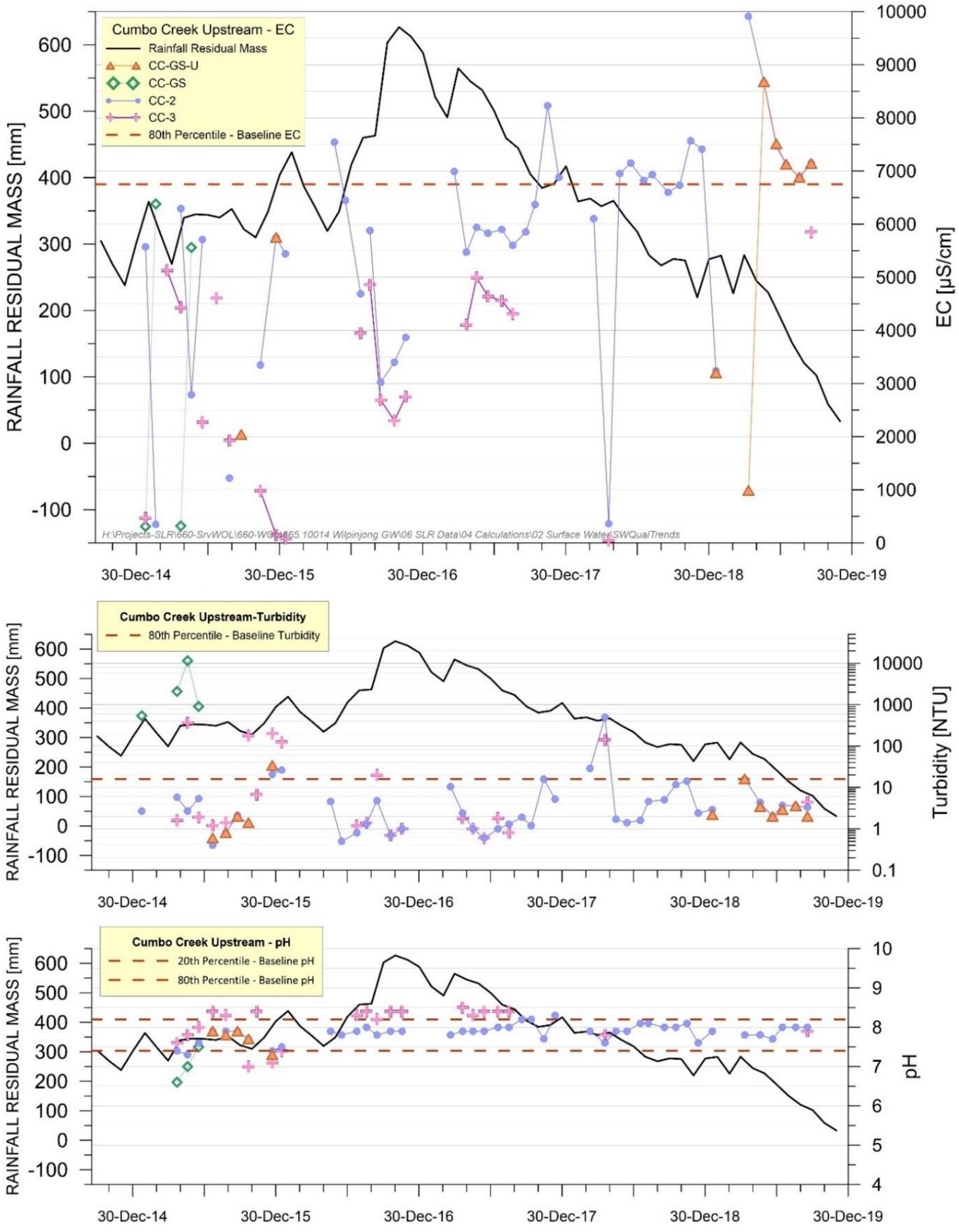


Figure 8 Time-series water quality for Cumbo Creek Upstream

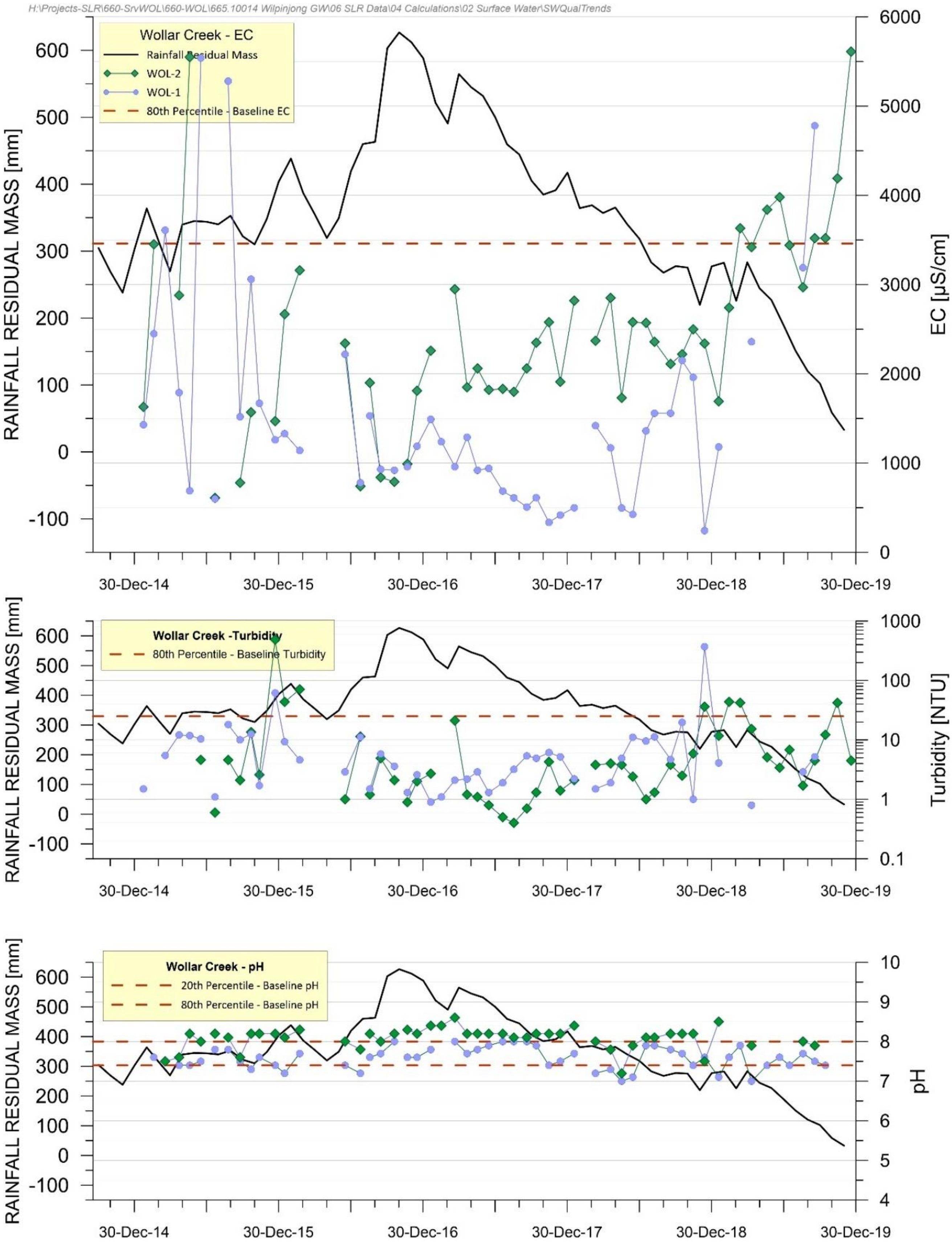


Figure 9 Time-series water quality for Wollar Creek

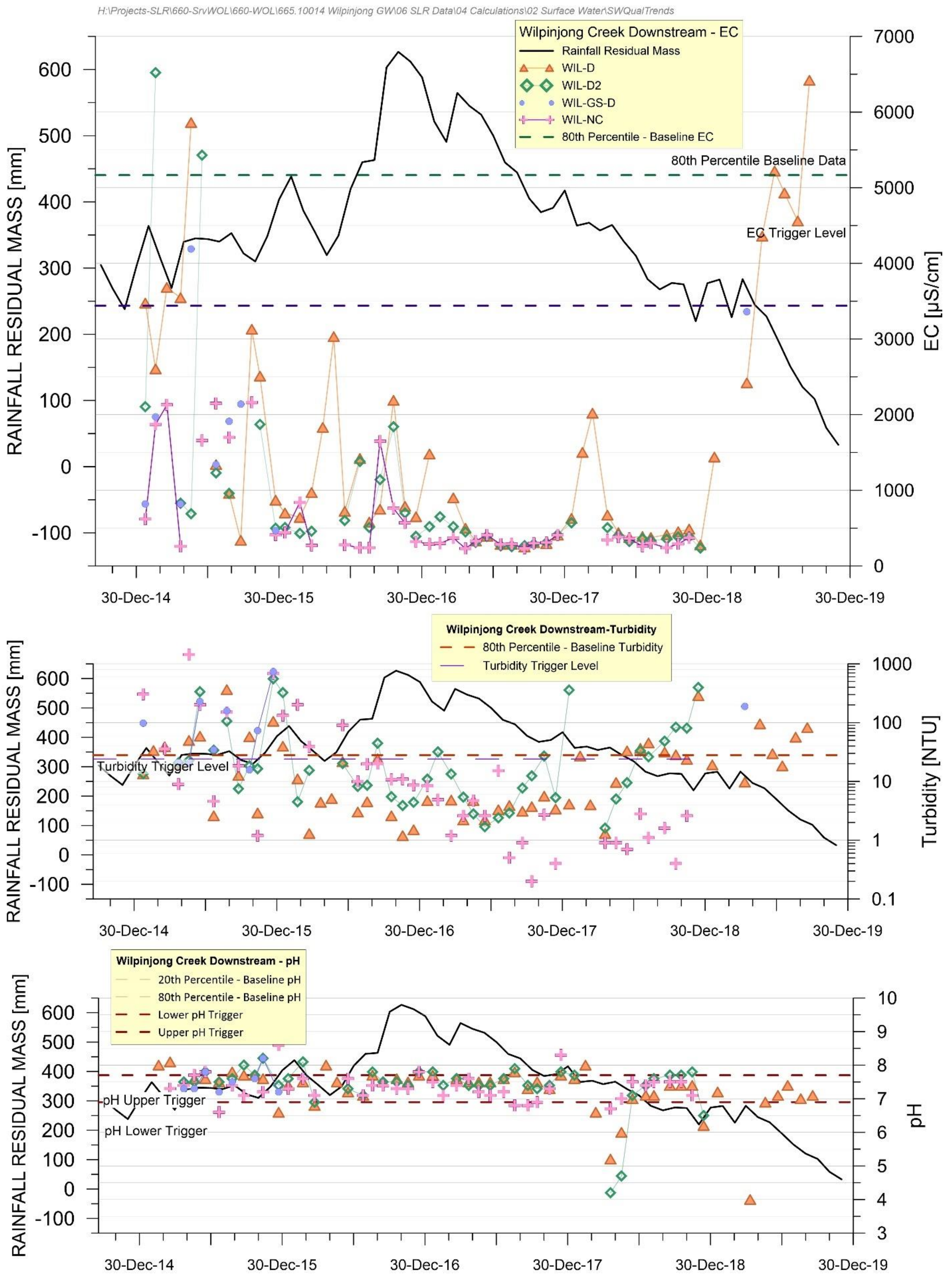


Figure 10 Time-series water quality for Wilpinjong Creek Downstream

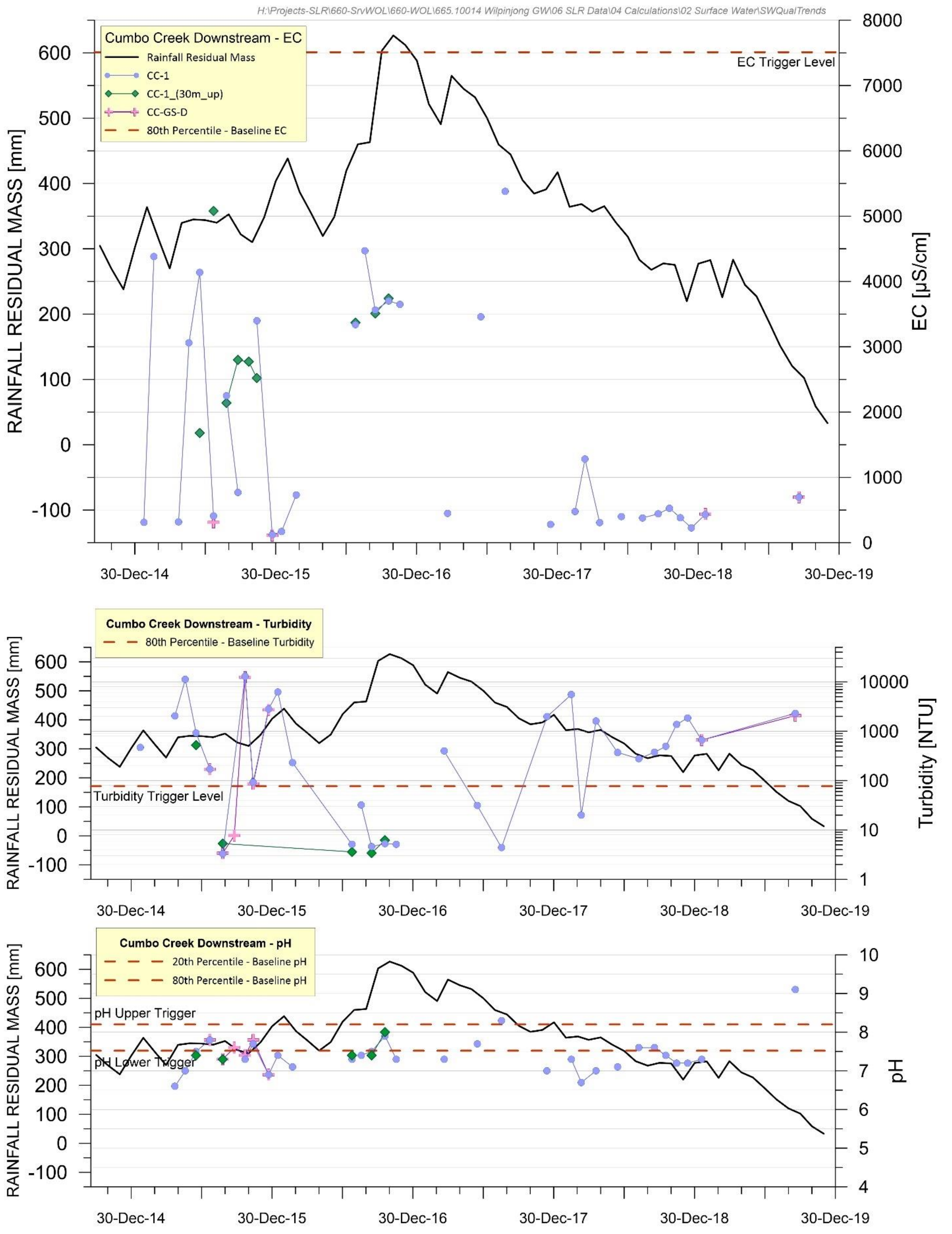


Figure 11 Time-series water quality for Cumbo Creek Downstream

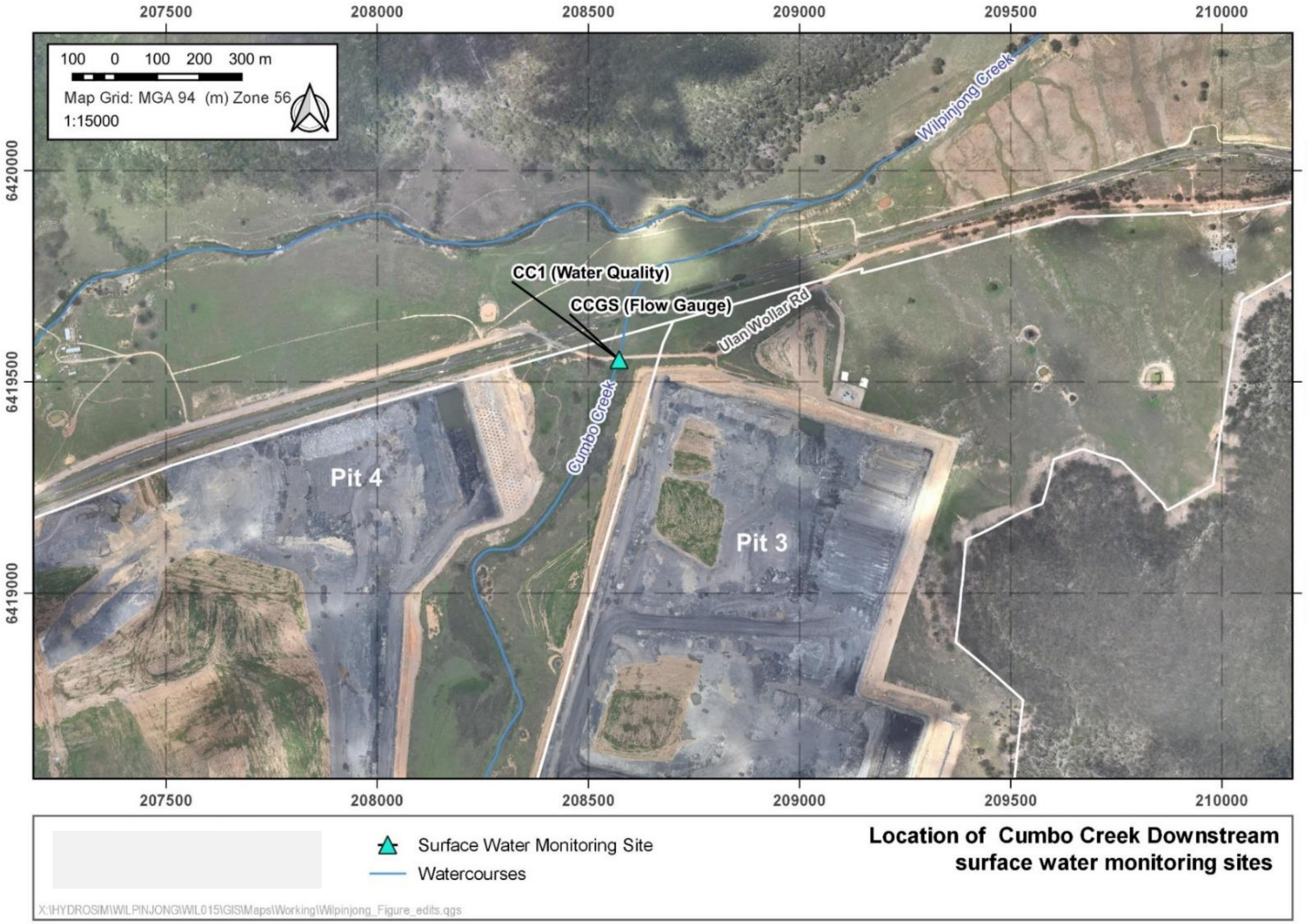


Figure 12 Location of Cumbo Creek Downstream surface water monitoring sites

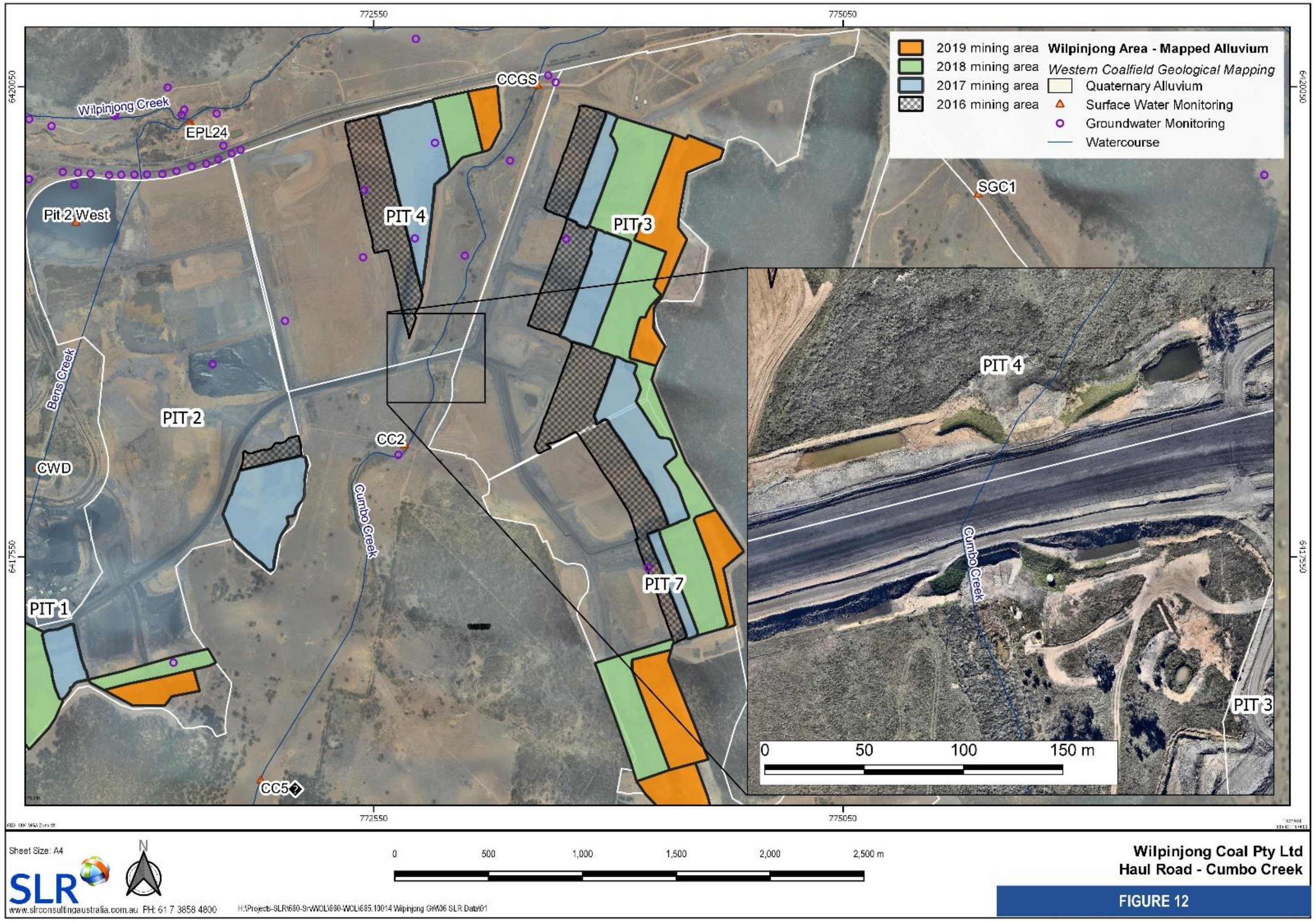


Figure 13 Location of haul road constructed across Cumbo Creek

wrm
water + environment

Memorandum

Date	17 October 2019	Pages	9
Attention	James Heesterman		
Company	Wilpinjong Coal Pty Ltd		
Job No.	1052-10-E		
Subject	Wilpinjong Mine – 2019 site water balance addendum		

As requested by Wilpinjong Coal Pty Ltd (WCPL), WRM Water & Environment Pty Ltd (WRM) has prepared an addendum to the 2019 site water balance for the Wilpinjong Mine which investigates the behaviour of the site water inventory for the period between 1 August 2019 and 31 December 2021.

Two scenarios were assessed for the reporting period:

- Scenario 1: the Water Treatment Facility (WTF) will operate when the total inventory exceeds ~3,000 ML at a maximum discharge rate of 3 ML/d.
- Scenario 2: the WTF will be offline for the duration of the reporting period.

Figure 1 shows the forecasted total site water inventory for the period between 1 August 2019 and 31 December 2021 for WTF Scenario 1. The following is of note:

- For the 1%ile results (very wet climatic conditions), the total site water inventory increases by 3,629 ML, to reach a volume of 5,353 ML by 31 December 2021.
- For the 50%ile results (median climatic conditions), the total site water inventory increases by 932 ML, to reach a volume of 2,657 ML by 31 December 2021.
- For the 99%ile results (very dry climatic conditions), the total site water inventory decreases by 347 ML, to reach a volume of 1,377 ML by 31 December 2021.

Figure 2 shows the forecasted total site water inventory for the period between 1 August 2019 and 31 December 2021 for WTF Scenario 2. The following is of note:

- For the 1%ile results (very wet climatic conditions), the total site water inventory increases by 4,450 ML, to reach a volume of 6,175 ML by 31 December 2021.
- For the 50%ile results (median climatic conditions), the total site water inventory increases by 1,472 ML, to reach a volume of 3,197 ML by 31 December 2021.
- For the 99%ile results (very dry climatic conditions), the total site water inventory decreases by 347 ML, to reach a volume of 1,377 ML by 31 December 2021.

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ABN 96 107 404 544

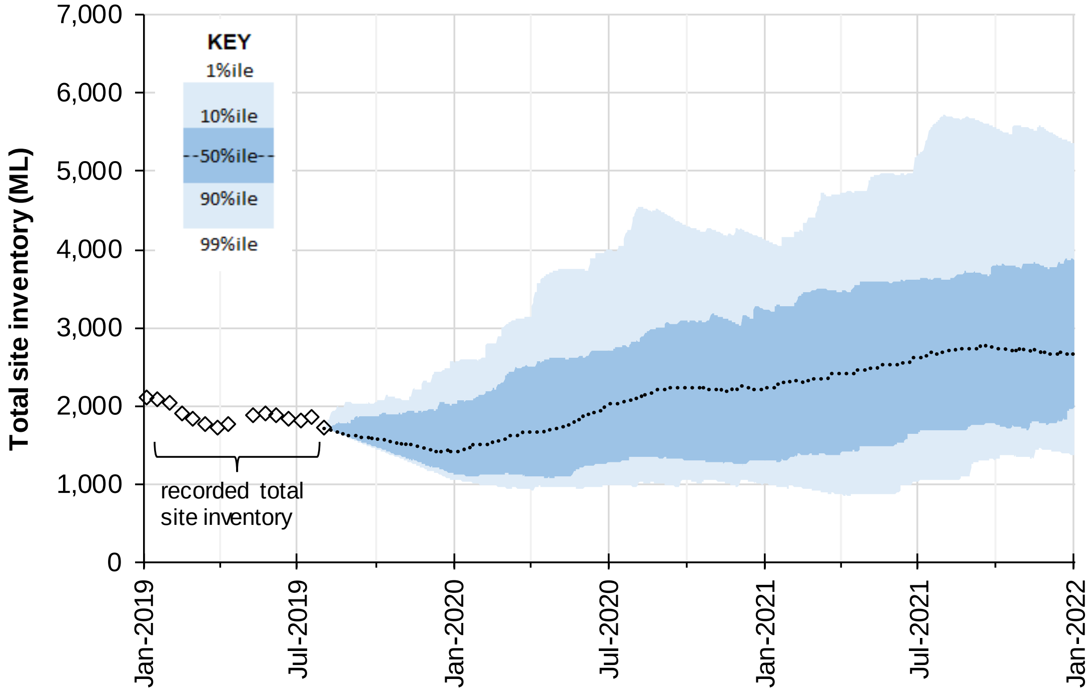


Figure 1 - Forecasted total site water inventory (WTF Scenario 1)

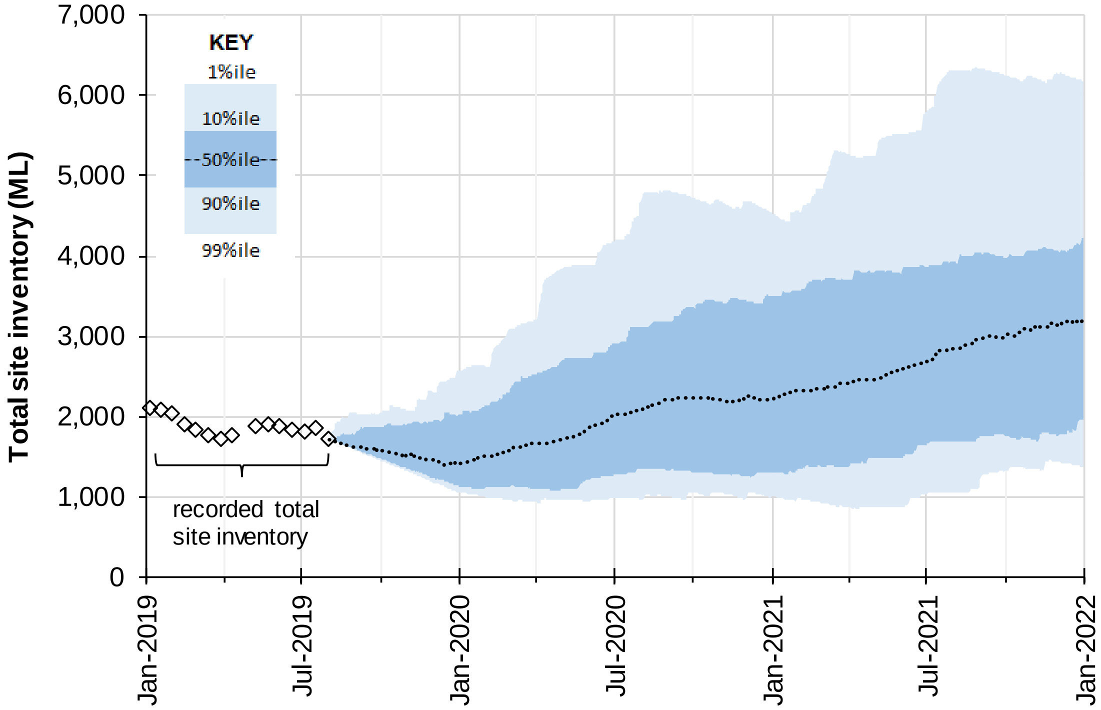


Figure 2 - Forecasted total site water inventory (WTF Scenario 2)

Closing

We trust that this advice satisfies WCPL's immediate requirements. Please do not hesitate to contact WRM if you have any questions or comments in relation to the content of this document.

For and on behalf of

WRM Water & Environment Pty Ltd

Michael Batchelor

Director

Supporting information

Section 1: Wilpinjong OPSIM model

Background*:* WCPL maintain a water balance simulation model for the Wilpinjong Mine using the OPSIM simulation software. Prior to this study, the Wilpinjong OPSIM model was most recently updated in early 2019 (WRM, 2019) based on 2018 site conditions.

Model Schematic: An indicative schematic of the Wilpinjong water management system, as modelled in OPSIM, has been provided for reference in Attachment A.

Simulation methodology*:* The water balance model was run on a daily time step for period between 1 August 2019 and 31 December 2021. The model was run for 128 climate sequences, each referred to as a “realisation”. Each realisation is based on a 2.5 year sequence extracted from the historical rainfall data. The first realisation is based on rainfall data from 1889 to 1892. The second uses data from 1890 to 1893 and so on. This approach provides the widest possible range of climate scenarios covering the full range of climatic conditions represented in the historical rainfall record. Statistical analysis of the results from all realisations provides a probability distribution of key hydrologic parameters, such as storage inventories.

Key flow streams, or model parameters, inferred or adjusted as part of this exercise include: 1) groundwater inflow rates; 2) catchment yield parameters and 3) spoil aquifer porosities. These are discussed further in following sections.

Section 2: Groundwater and seepage

Net groundwater inflow rates to the mining pits were adopted as per the WEP surface water assessment (WRM, 2015) and were derived by applying highwall evaporative losses to gross inflow rates determined through hydrogeological modelling as part of the groundwater assessment undertaken by HydroSimulations in 2015 (shown in Table 1). Based on advice from WPCL, an additional 3 ML/d of groundwater will be extracted via two bores that will be commissioned on 1 January 2020.

Table 1 – Adopted groundwater inflows – combined pits

Project Year	Total groundwater intercepted (ML/year)	Estimated evaporative losses (ML/year)	Net groundwater inflows (ML/year)
2019	816	188	628
2020	858	254	604
2021	706	254	452

Seepage losses: Unmetered steady-state loss streams in any water balance model typically include evaporation, groundwater inflow and seepage. In the Wilpinjong OPSIM model, evaporation is accounted for (see Section 3), and the combined influence of groundwater inflow and seepage (i.e. the net groundwater inflow) was inferred as part of the model calibration exercise. The calibration inferred a positive net groundwater inflow to the water management system, which is consistent with groundwater modelling predictions documented in the 2017

Wilpinjong Annual Review Groundwater Analysis (Hydrosimulations, 2017). The water balance assumes that the net groundwater inflow stream is comprised wholly of groundwater interception in the open cut voids, with no seepage outflow. The rationale supporting this assumption is as follows: 1) aquifers adjacent to open cut voids are understood to have been depressurised and as such any flow should be toward the voids; 2) seepage from pits or dams holding water is expected to drain back toward the mine water management system via preferential pathways (e.g. Pit 2W seepage will flow toward the depressurised Pit 4 void, Pit 1S seepage will flow towards the depressurised Pit 5 void).

Spoil aquifers: In-pit spoil dumps are porous and may transmit or store water under certain conditions. Spoil aquifer storage is modelled adjacent to Pit 5N, and between Pit 2W and Pit 4. These areas are recharged or drained depending on the water level in the adjacent open cut void. Spoil aquifer storage capacities were estimated based on dump geometry and assuming a nominal spoil porosity of 20% for Pit 2W and Pit 4 spoil aquifers and 10% for Pit 5N spoil aquifer (iteratively adjusted as part of the current model calibration). The model also simulates drainage of water from upslope pits to their respective downslope pits (i.e. Pit 5S to Pit 5N) through the interconnecting spoil aquifer (see Attachment A).

Section 3: Rainfall, runoff and evaporation

Rainfall: Rainfall and evaporation data for the Wilpinjong site (latitude -32.35, longitude 149.9) was sourced from the SILO Data Drill service (Queensland Government Department of Science, Information Technology and Innovation) for the 130-year period 1889 to present. Figure 3 shows a statistical variation of monthly rainfall at the Wilpinjong site.

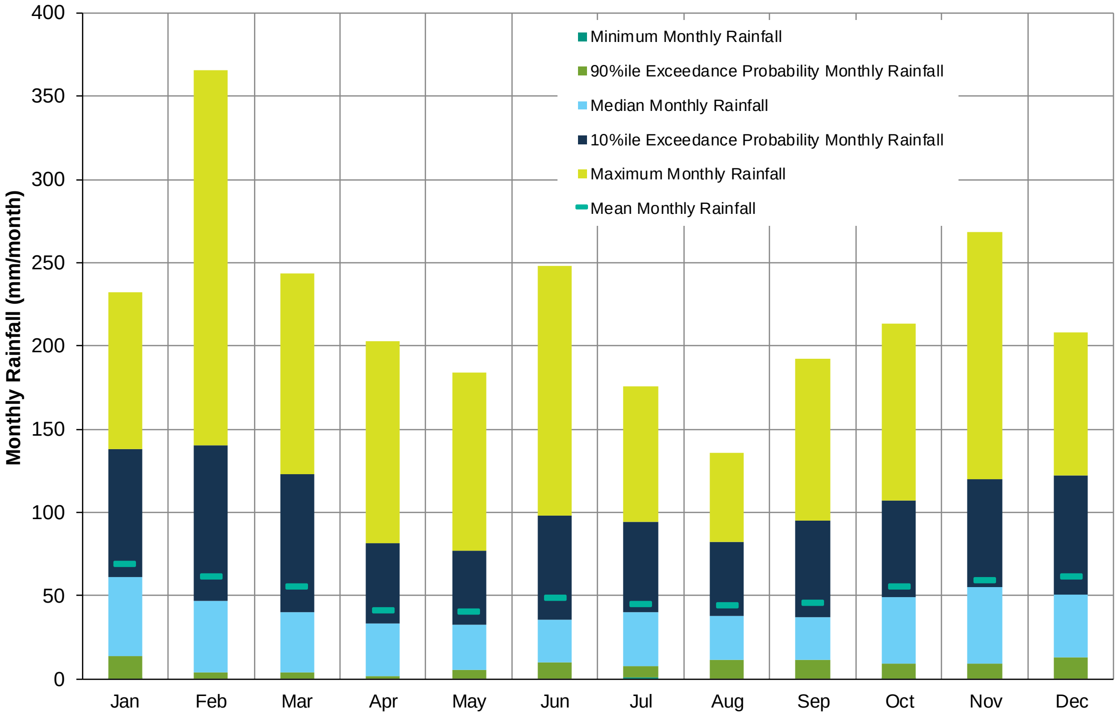


Figure 3 - Monthly and cumulative monthly rainfall at Wilpinjong based on 130 years of SILO Data Drill data

Evaporation (atmospheric): Evaporative losses from storages within the water balance model have been estimated based on daily evaporation depths and wetted surface areas. Evaporation depths have been sourced from the SILO Data Drill service (Morton Lake Evaporation) for the 130-year period 1889 to present. No adjustment factors have been applied to open cut pits (which are relatively shallow). Wetted surface areas are calculated for each storage within the OPSIM model on a daily basis, using level-area-volume tables based on bathymetric survey or computer analysis of topographic survey data. Figure 4 shows the variation of mean monthly Morton Lake evaporation at the Wilpinjong site.

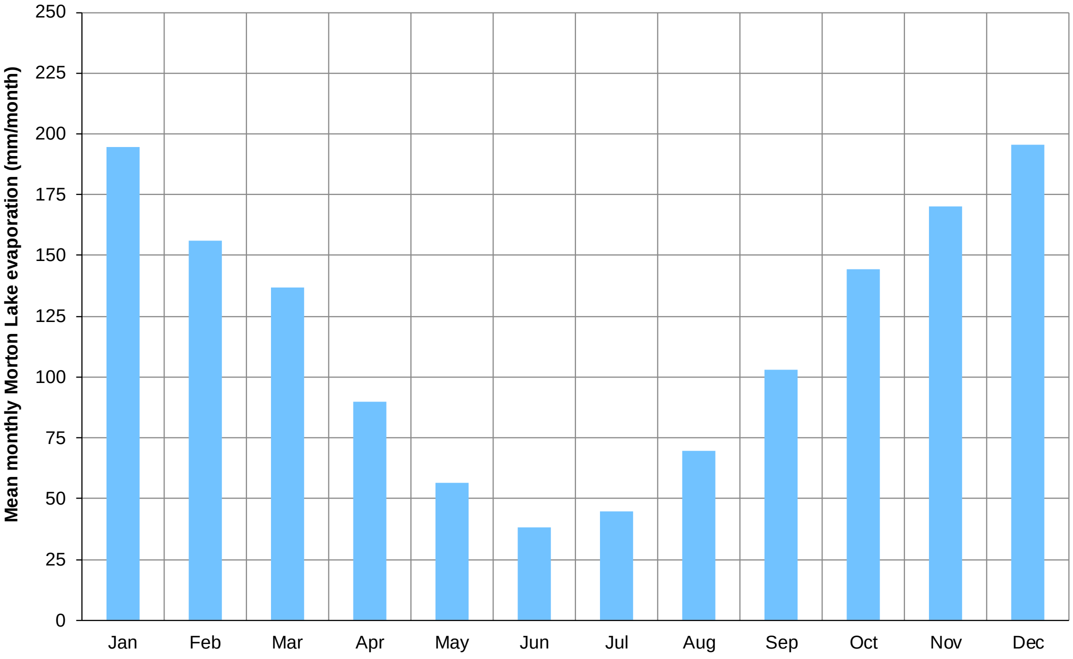


Figure 4 - Mean monthly Morton Lake evaporation at Wilpinjong based on 130 years of SILO Data Drill data

Evaporation (forced): WCPL operate a system of spray fans along the eastern bank of the Pit 2W water storage. The sprays were not assumed to be operational during the reporting period.

Runoff: Catchment runoff is estimated within the Wilpinjong OPSIM using the Australian Water Balance Model (AWBM). The AWBM is a saturation overflow flow model which uses daily rainfalls and estimates of catchment evapotranspiration to calculate daily values of runoff using a water balance approach. Different AWBM parameters are defined for each land use type within the mine catchment. Catchment and Land Use maps are provided in Attachment B. The AWBM parameters were recalibrated as part of the main 2019 water balance update, thereby extending the calibration period for the adopted AWBM parameters to five years. Calibrated AWBM parameters are summarised in Table 2. Refer to Boughton (2003) for additional information regarding the AWBM.

Table 2 - Calibrated AWBM parameters

‘		Natural	Rehab	Spoil	High Runoff[1]
Partial Areas	A1	0.134	0.134	0.134	1.0
	A2	0.433	0.433	0.433	-
	A3	0.433	0.433	0.433	-
Soil Storage Capacity (mm)	C1	17.6	14.7	11.0	17.0
	C2	182.6	153.2	114.1	-
	C3	366.2	306.9	228.8	-
Baseflow Index	BFI	0.50	0.50	0.50	0.00
Surface flow recession constant	Ks	0.80	0.97	0.97	0.00
Base flow recession constant	Kb	0.97	0.80	0.80	0.00
Avg. Storage (mm)	Savg	239.9	201.2	150.0	17.0

Notes:

1. Hardstand, roads, pits, cleared, coal stockpiles and tailings all use this parameter set

Section 4: Discharge from WTF

Description: The WTF comprises two separate reverse osmosis (RO) treatment plants located immediately east of Pit 2W. Both plants receive a feed water stream from Pit 2W, and produce a low salinity permeate stream and a concentrate stream. The permeate stream is blended with small quantities of Pit 2W water and then discharged into Wilpinjong Creek in accordance with the site’s environmental protection license (EPL No. 12425). The concentrate stream is recirculated into the water management system (either Pit 2W, Pit 1S or the RWD).

Two scenarios were assessed for the operation of the WTF during the simulation period, which are as follows:

- Scenario 1: the WTF will operate when the total inventory exceeds ~3,000 ML at a maximum discharge rate of 3 ML/d.
- Scenario 2: the WTF will be offline for the duration of the three year period.

Section 5: Dust suppression on haul roads

Description: A fleet of water carts extract water from the mine water management system via one of three fill points and apply to heavy and light vehicle roads to minimise dust lift-off. Fill points are located at Pit 2W, Pit 5, and the RWD.

Measurement: Haul road dust suppression water usage is estimated for each of the 128 climatic realisations using the dust suppression sub-model detailed in Section 5.2.2 of WRM (2019). The sub-model accounts for the seasonal variation and sensitivity to rainfall observed in the metered usage data. Daily water application is calculated as a function of wetted haul road area, evaporation, and rainfall. Water is applied to offset daily evaporation from the wetted area. Evaporation rates are subject to monthly adjustment factors. Application is cancelled if rainfall exceeds a nominated minimum threshold. A distribution of the monthly modelled dust suppression rates based on the current haul road configuration is shown in Figure 5.

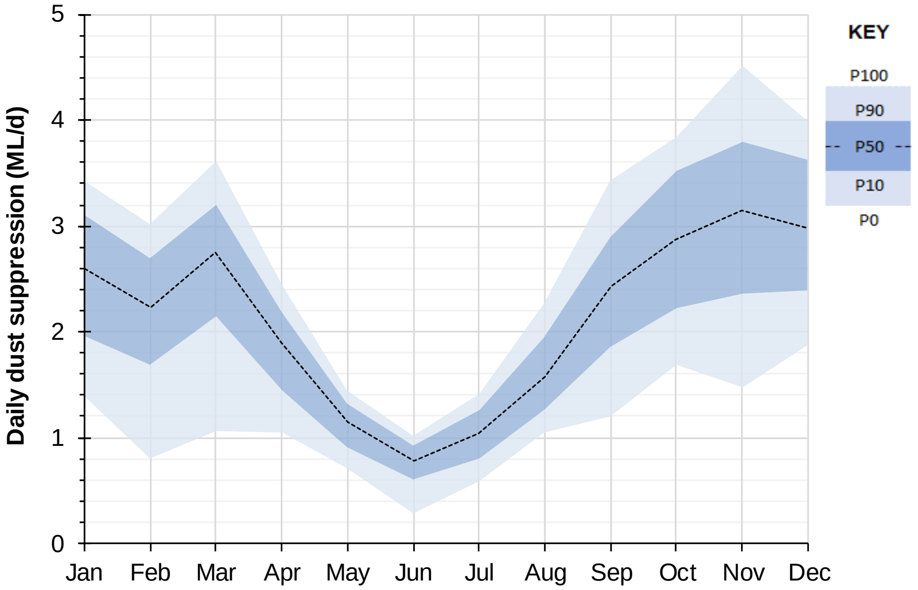


Figure 5 - Modelled monthly dust suppression rates at Wilpinjong based on 130 years of SILO Data Drill data

Section 6: CHPP and MIA losses

CHPP water usage: Water is used in the CHPP to separate saleable coal from ROM impurities. The CHPP is supplied with mine water extracted from the CWD and RWD. Loss streams include moisture entrained within the product coal (railed offsite) and reject material stream (dumped in-pit). It is noted that the CHPP process was modified in 2015 to include a tailings belt filter press, which considerably reduced the plant's net water makeup requirement.

Estimation of net losses: Net CHPP water losses were estimated through a water and solids mass balance, based on the proposed CHPP production schedule and moisture contents documented in WRM (2015). The water balance has allowed for a nominal loss of 65 ML/a for miscellaneous losses, selected based on past experience at similar operations. The assumed net CHPP losses are shown in Table 1. Based on metered data from 2017 to 2019, approximately 68% of the net CHPP loss will be sourced from CWD. The remaining loss (32%) will be sourced from RWD.

Table 1 - Assumed net CHPP losses and proposed CHPP production schedule

Year	CHPP Feed (Mt*)	CHPP Product (Mt*)	Coarse Reject (Mt*)	Tailings (Mt*)	Assumed net CHPP losses (ML)
2019	8.35	5.57	2.28	0.50	1,399
2020	8.25	5.02	2.74	0.49	1,502
2021	6.50	4.26	1.85	0.39	1,198

*Note: * For ease of comparison, tabulated tonnages are total tonnes at the CHPP feed moisture content (7.5%). Actual wet tonnages will differ depending on the applied moisture content.*
Mt = million tonnes.

MIA water usage: Heavy and light vehicle wash bays, and washdown pads are located within the mine industrial area, adjacent to the CHPP. These areas are supplied with water extracted from the CWD and RWD, using the same infrastructure used to supply the CHPP. It is understood that excess water recovered from these activities is collected in drains which convey water back to the mine water management system (i.e. Pit 2W).

Section 7: Recorded site water volumes

The stored volumes prior to the reporting period (to 31 July 2019) were estimated based on historical water level data recorded by WCPL. Water levels have been converted to estimates of volume, using level-area-volume tables derived based on bathymetric survey or computer analysis of topographic survey data. The combined site volume on 31 July 2019 was 1,725 ML.

Closing

We trust that this advice satisfies WCPL's immediate requirements. Please do not hesitate to contact WRM if you have any questions or comments in relation to the content of this document.

For and on behalf of

WRM Water & Environment Pty Ltd

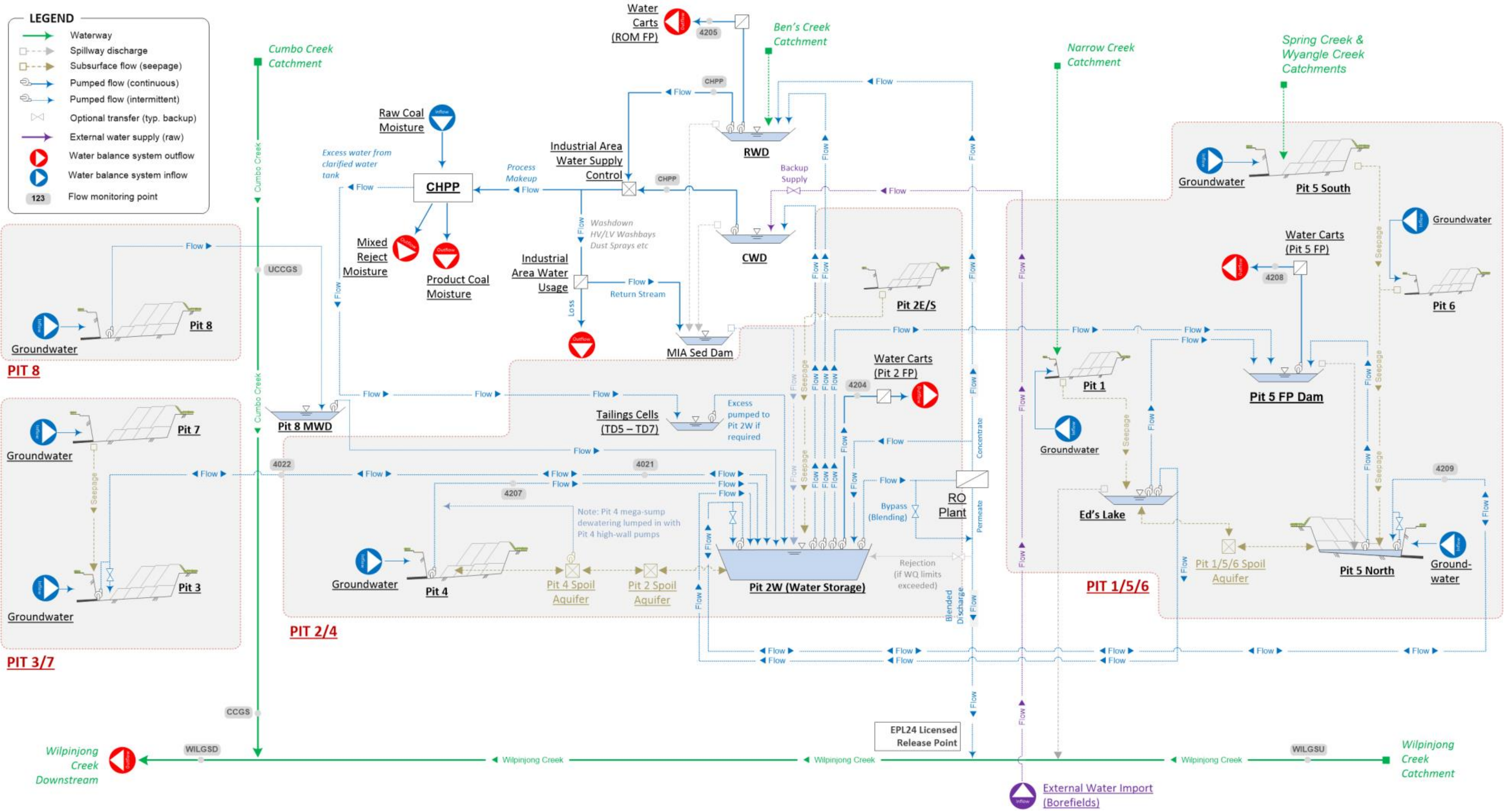
Michael Batchelor

Director

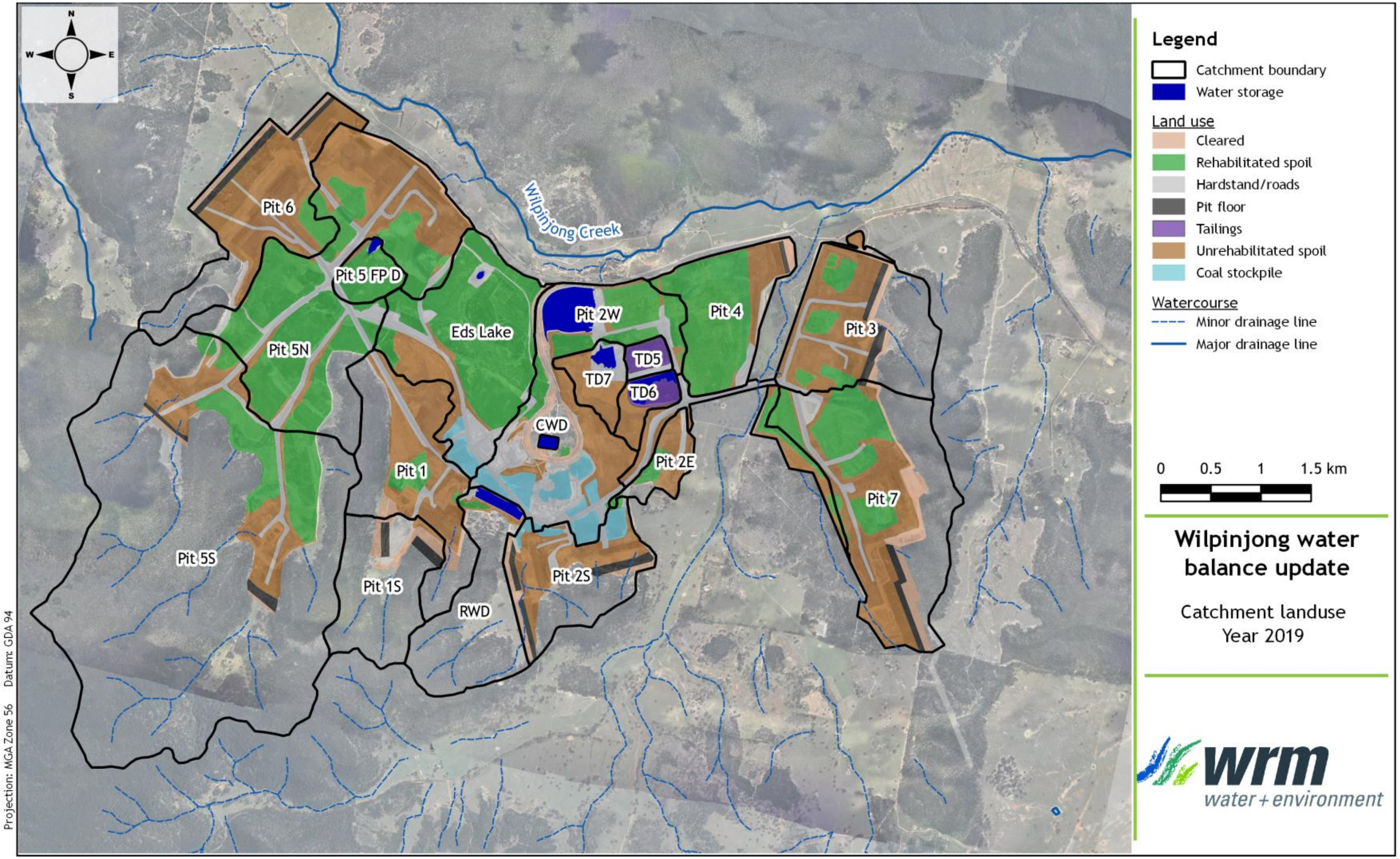
References:

Boughton, 2003	*'The Australian water balance model'*, October 2003.
Hatch, 2017	*'Report – Baseline OPSIM Model Setup'* H352411-00000-228-230-0001 Rev 0, Hatch Pty Ltd, April 2017.
EPA, 2017	*'Environmental Protection License – License 12425'*, New South Wales Environmental Protection Agency, January 2017.
Hydrosimulations, 2017	*'Wilpinjong Annual Review Groundwater Analysis'* WIL012 – Report HS2017/12, NPM Technical Pty Ltd (trading as HydroSimulations), March 2017.
WRM, 2015	*'Wilpinjong Extension Project – Surface Water Assessment'*, WRM Water & Environment Pty Ltd, November 2015
WRM, 2018	*'Wilpinjong Mine – Site Water Balance for 2018 Annual Review'*, WRM Water & Environment Pty Ltd, March 2018
WRM, 2019	*'Wilpinjong Mine – Site Water Balance for 2019 Annual Review'*, WRM Water & Environment Pty Ltd, May 2019

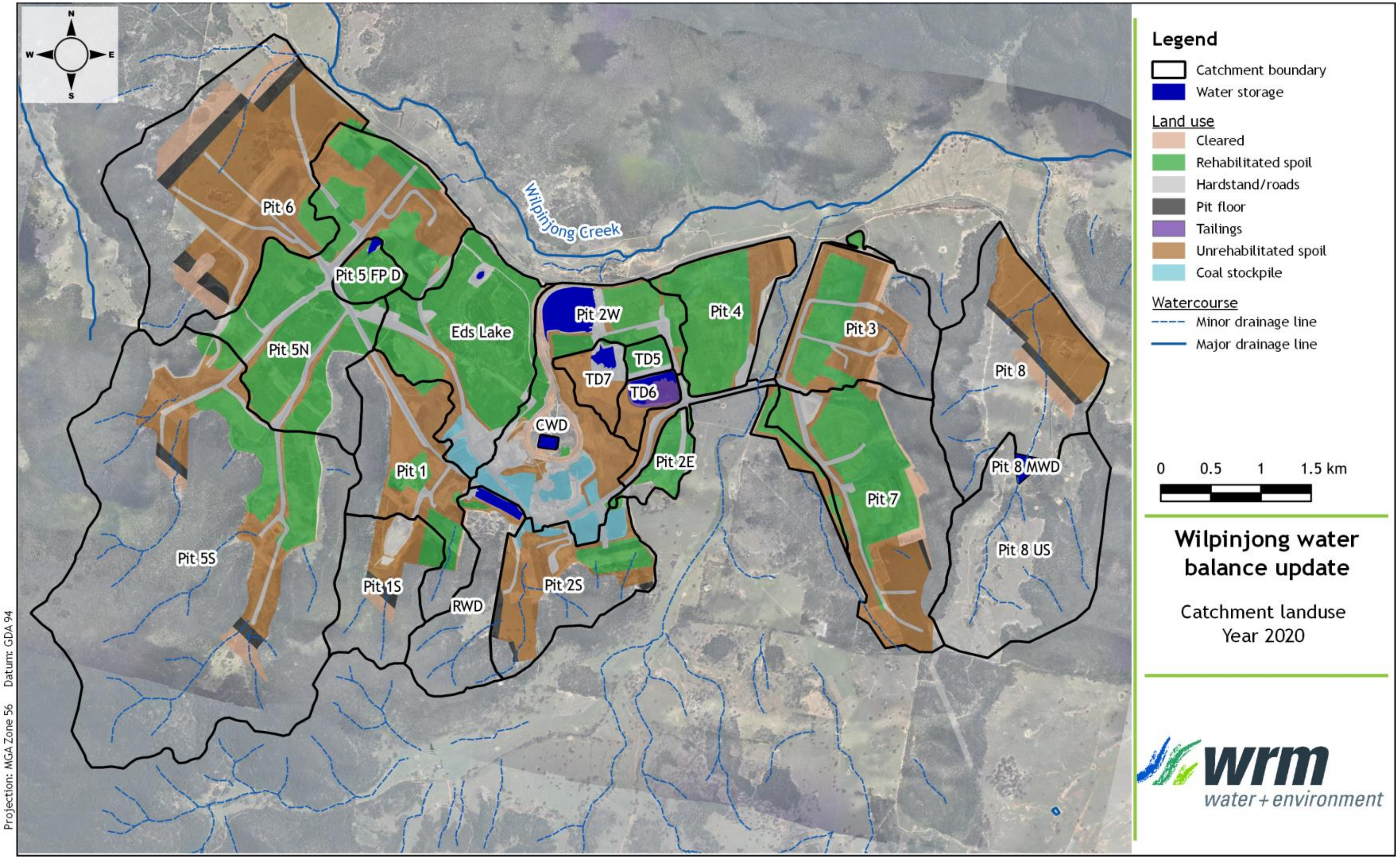
Memorandum



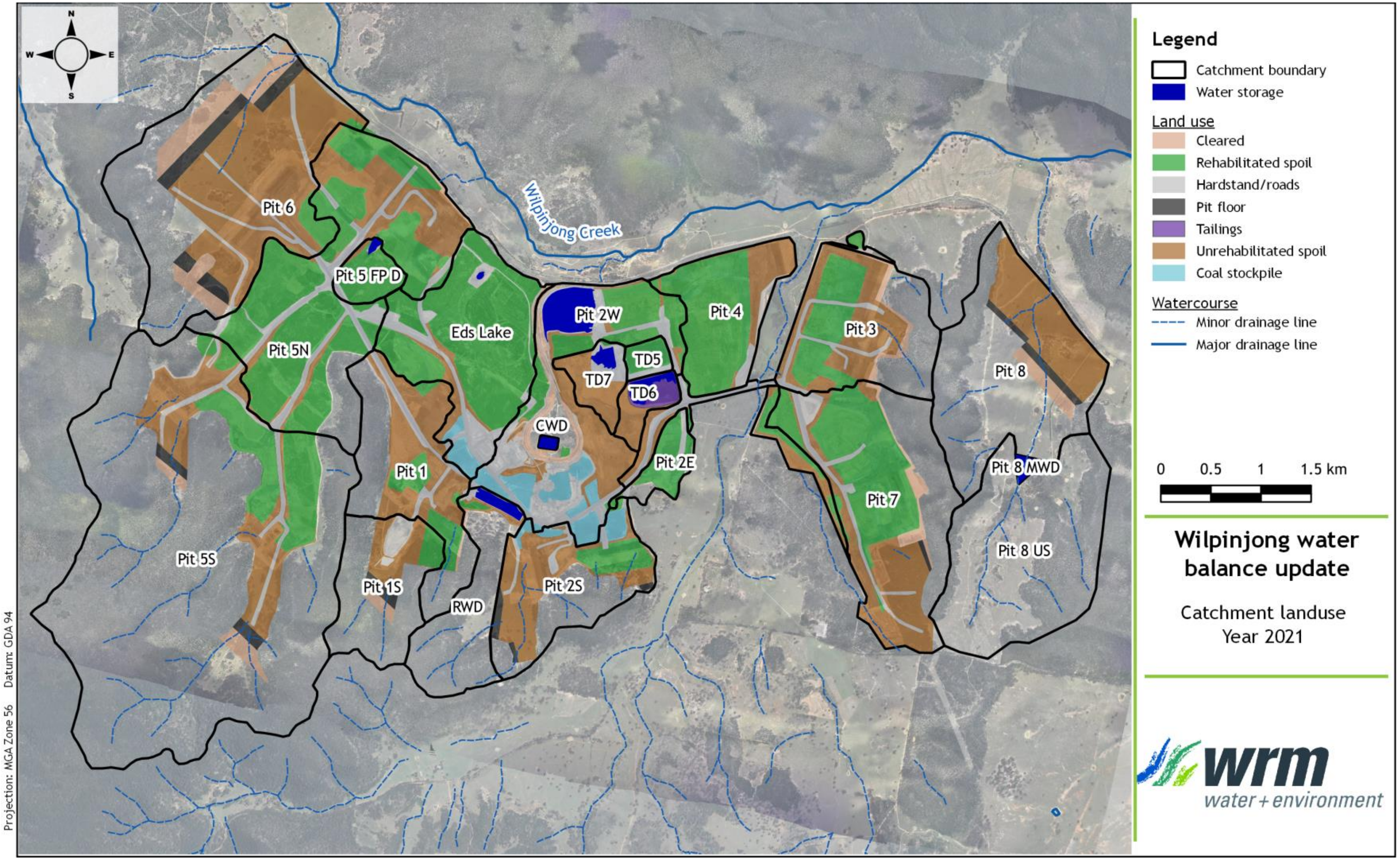
Attachment A: Wilpinjong OPSIM Model Schematic



Attachment B1: Wilpinjong Catchment and Land Use Plan (2019 Site Conditions)



Attachment B2: Wilpinjong Catchment and Land Use Plan (2020 Site Conditions)



Attachment B3: Wilpinjong Catchment and Land Use Plan (2021 Site Conditions)