Appendices

Appendix 1: Reported water balance components in Condamine Alluvium – an extract from Dafny & Silburn (2013)

Table 1 Previous estimates of the Condamine River Alluvial Aquifer annual water balance—mega litres (*ML*), unless otherwise stated[a]

Component			Lane (1979)	Huxley (1982)	SKM(2003) Conceptual	SKM(2003) Numerical	Barnett and Muller (2008)	KCB (2011b)	Coffey (2012)
Alluvial boundaries	Upstream	Total	760	–	810	1,163	0	316	–
	Eastern tributaries	Total	280–410	1,470	250	250	2,800	705	–
	Downstream	Total	−645	–	−16,467[b]	−12,568[b]	−5,100[b]	−244.5	–
		[ML/km width][c]	129	–	567.8	433.4	175.9	48.9	–
Rivers	Streambed	Total	12,170–20,810	19,085–32,634	15,750	11,539	16,000	11,158–22,761	–
		[ML/km stream][c]	67–115	67–115	102	75	104	56–115	–
	Meanders	Total	–	2,040	2,000	–	–	–	–
Bedrock	Northeast (MRV)	Total	380–530	1,130	1,410	1,604	1,604[d]	864	–
		[ML/km length][c]	2.5	5.9	9.4	10.7	8.4	4.5	–
	Northeast (sandstones)	Total	3,230	–	–	–	–	3,742	–
	Southwest (sandstones)	Total	−8,050[e]	520	390	441	485	500	730
		[ML/km length][c]	–	2.7	2.6	2.9	2.6	2.6	3.8
	Bottom (WCM)	Total	–	35	−1,649	–	–	–	3,650
Diffuse recharge	Rainfall	Total	–	–	23,464	20,402	15,000	10,265	5,110
		[mm/year][c]	–	–	5.9	5.2	3.8	2.3	1.0
		[% of total precipitation][c]	–	–	1	0.10	0.10	0.05	–
	Deep drainage	Total	–	–	7,492	–	–	446	–
		[mm/year] on irrigated lands[c]	–	–	19.1	–	–	0.37	–
Abstraction	Metered	Total	−58,903	−61,403	−50,000	−44,379	−31,000	−46,400	–
	Unmetered	Total	–	–	–	–	–	−20,000	–
Summary:	Total in:		16,820–25,740	24,205–37,754	51,566	35,399	35,889	27,996–39,599	9,490
	Total out:		−67,598	−61,403	−68,116	−56,947	−36,100	−66,645	??

Notes:

[a] Investigated area and period of each study slightly varies

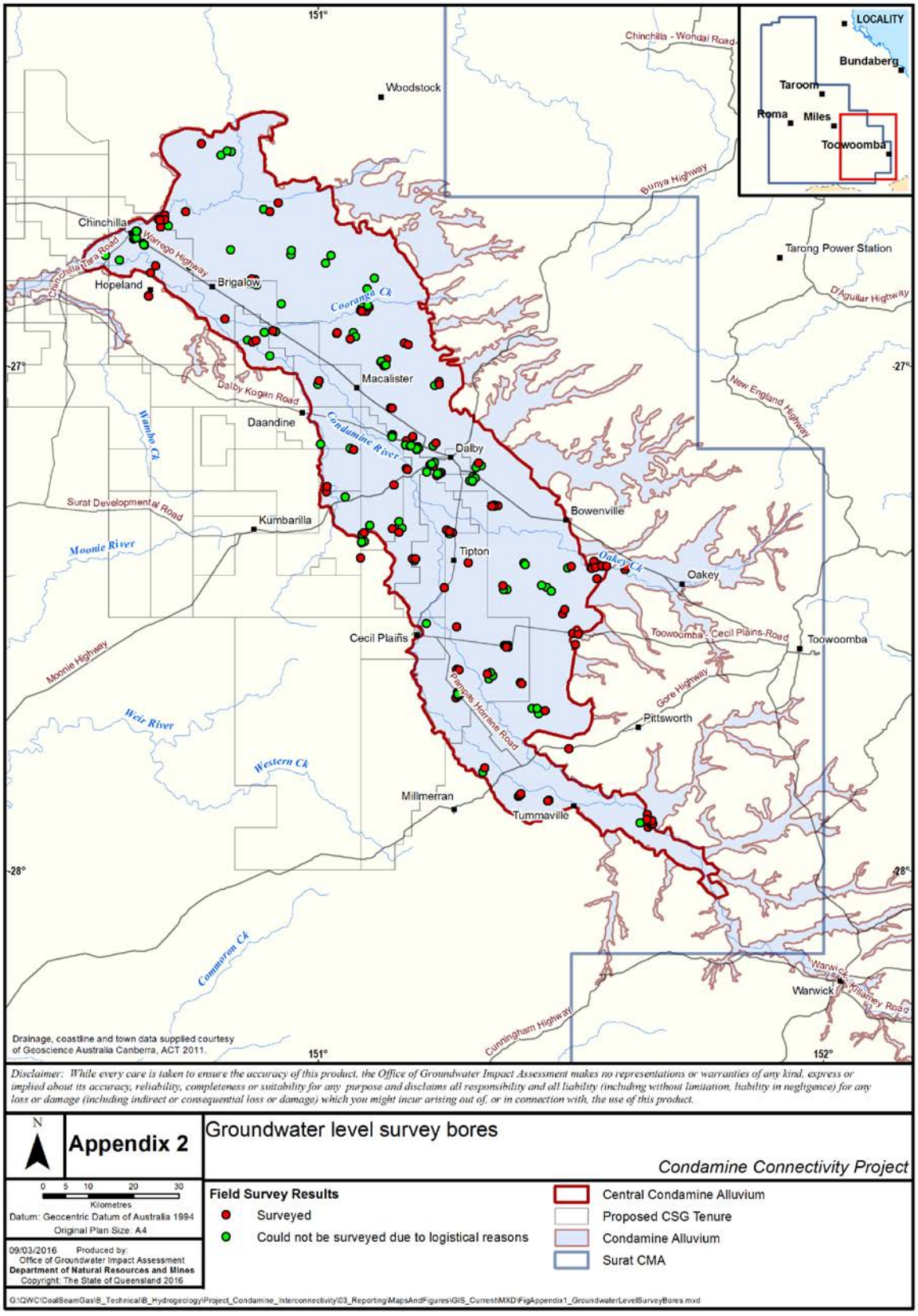
[b] Downstream boundary of this study is located in the middle of the CRAA; see text for explanation

[c] Normalized values, in equivalent units, display to overcome the differences between study areas' dimensions (area, width, length, stream length)

[d] Influx from main range volcanics (MRV) of 1,304 ML/year and from Walloon Coal Measures (WCM) of 300 ML/year (B. Barnett, SKM, personal communication, 2013)

[e] Include influx from the southwest bedrock (sandstones) and the bottom bedrock (WCM); see text for explanation.

Appendix 2: Bores surveyed for mapping groundwater levels in the Condamine Alluvium footprint (2013)



Appendix 3: A list of Walloon Coal Measures bores used for groundwater level mapping

Bore ID	Easting (m)	Northing (m)	Surface Elevation (m)	Groundwater Elevation (m)
12360	318402	7017180	349	323
15457	350219	6958197	379	363
15757	277666	7060355	322	286
17631	316631	6976432	342	319
64264	356690	6969605	382	367
71134	286133	7031656	321	298
83068	287643	7029772	321	292
83118	293046	7047622	328	289
86828	296182	7005725	339	297
147679	320127	6916565	431	382
42230204	268175	7031791	300	288
42231213	324206	6961996	353	335
42231216	316929	6962269	355	331
42231254	310458	6969894	345	323
42231256	300018	7001662	326	305
42231257	296318	7002795	348	300
42231260	307708	7017950	329	301
42231390	323098	6994023	339	317
42231548	351102	6999900	419	376
Carn Brea 18	338673	6953465	363	343
Daandine 164	309292	6998809	328	314
Lone Pine 14	337977	6951056	364	334
Lone Pine 16	337958	6951057	364	327

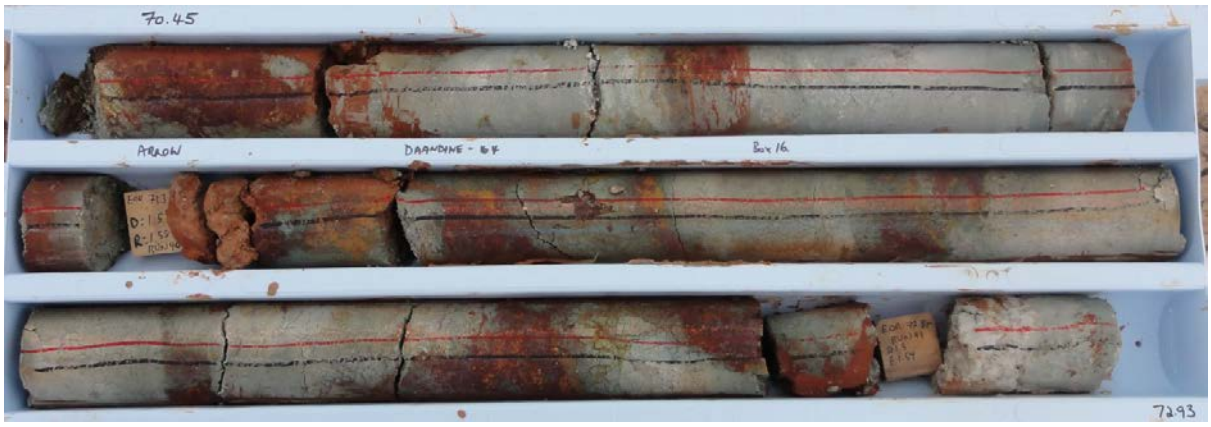
Appendix 4: Images of core samples from selected depths at Daleglade and Cecil Plains

Daleglade (DA-164


62.3
ARROW
DAANDINE- 164
Box 13.
65.08


65.08
ARROW
DAANDINE- 164
Box 14
67.70


67.70m
ARROW
DAANDINE- 164
Box 15
70.45


70.45
ARROW
DAANDINE - 164
Box 16
7293


72.93
ARROW
DRAINLINE - 164
Box 17
75.8
75.8
ARROW
DRAINLINE - 164
Box 18
78.44
78.44
ARROW
DRAINLINE - 164
Box 19
81.06

Cecil Plains (LP-17)


86.53
ARROW ENERGY LONE PINE 17 Box 14
89.10
93.09
ARROW ENERGY LONE PINE 17 Box 16
96.09
89.10
ARROW ENERGY LONE ANE 17 BOX 15
93.09

Appendix 5: Laboratory test results of core permeability at Daleglade and Cecil Plains

Daleglade (DA-164)

Sample ID	Depth (m) (BGL)	Description	N	W_R	W_F	ρ_R kg/m³	ρ_D kg/m³	ρ_S kg/m³	Φ	Apparent Hydraulic Conductivity (m/s)		
										K_A	K_L	K_U
DA164-S01	50.82 - 51.03	Non-indurated stiff clay with weathering alteration occuring vertically down the core	2	*30.61*	*32.5*	*1892*	*1313*	*2730*	*47*	*$>1x10^{-10}$*	*$7x10^{-11}$*	*$1x10^{-8}$*
DA164-S02	59.65 - 59.85	Fine silt to medium grained noncemented clayey sands with irregular clayey layers	2	*15.72*	*20.8*	*2054*	*1731*	*2820*	*37*	*$>3x10^{-10}$*	*$3x10^{-10}$*	*$1x10^{-9}$*
				15.72	*18.9*	*2054*	*1731*	*2670*	*34*	*$>3x10^{-9}$*	*$2x10^{-9}$*	*$3x10^{-9}$*
DA164-S03	64.45 - 64.65	Non-indurated stiff clay	2	*31.54*	*33.3*	*1945*	*1332*	*2910*	*49*	*$>6x10^{-10}$*	*$6x10^{-10}$*	*$1x10^{-9}$*
DA164-S04	78.22 - 78.44	Non-indurated stiff clay with no visible cracks	2	*19.36*	*26.8*	*2171*	*1751*	*3370*	*46*	*$>4x10^{-11}$*	*$4x10^{-11}$*	*$1x10^{-10}$*
DA164-S05	85.05 - 85.25	Fine to medium grained sandstone with a thin veneer of clay on a small section of the vertical axis	2	*8.87*	*11.7*	*2188*	*1994*	*2620*	*23*	*$>3x10^{-9}$*	*$3x10^{-9}$*	*$5x10^{-9}$*

N *– Number of sub-samples* ***W_R*** *– Received Moisture Content* ***K_L*** *– Lower bound of apparent K*
ρ_R *– Received Density* ***W_F*** *– Final Moisture Content* ***K_U*** *– Upper bound of apparent K*
ρ_D *– Dry Density* ***Φ*** *– Estimated Porosity* ***K_A*** *– Minimum apparent hydraulic conductivity (K) at sample depth*

Cecil Plains (LP-17)

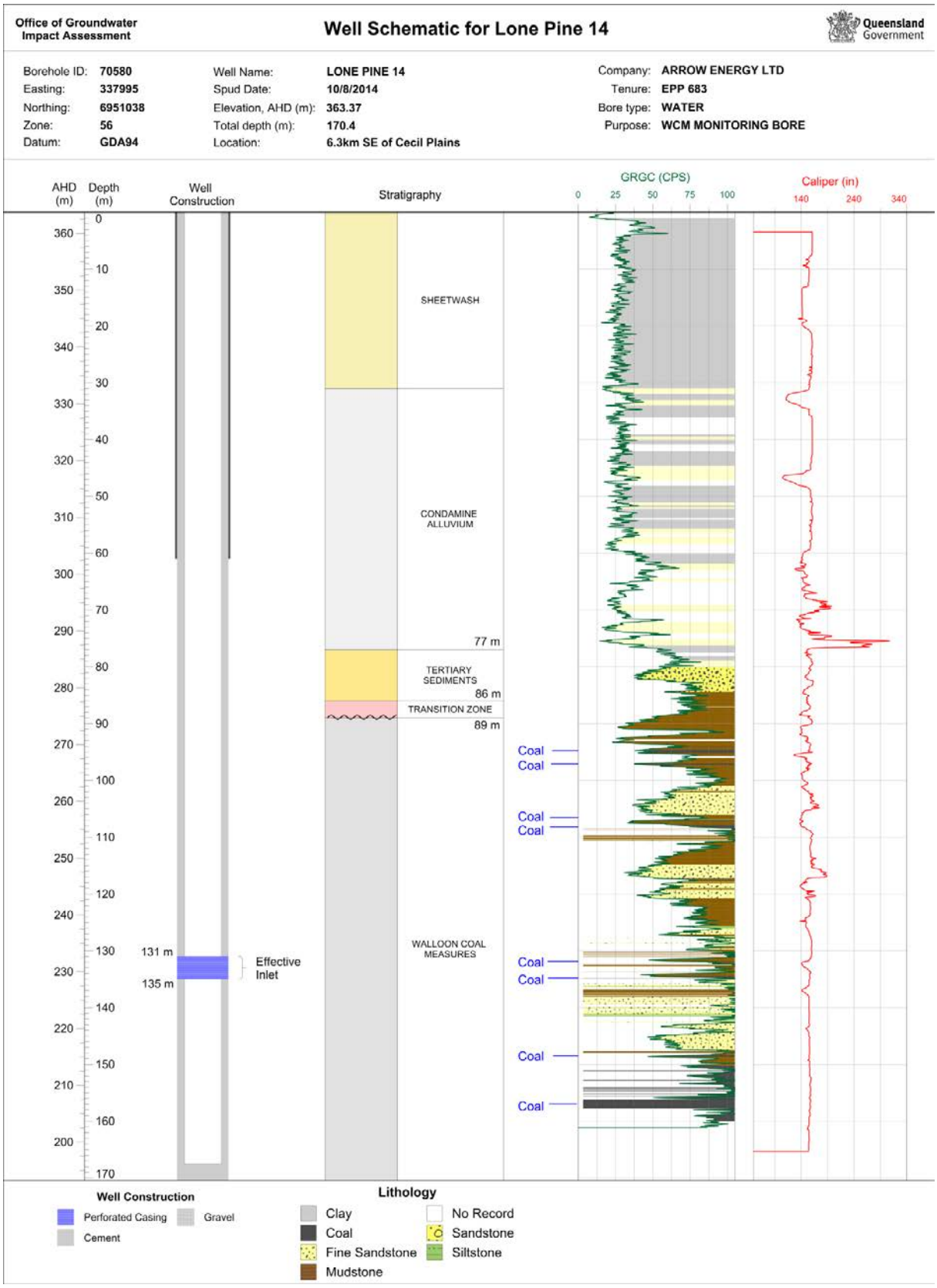
BRINE PERMEABILITY - SINGLE PHASE
(As-Received)

Weatherford LABORATORIES

Client	Arrow Energy Pty. Ltd.	**Saturant**	Complex Brine
Well	Lone Pine-17	**Overburden**	400 psi

Sample Number	Dir	Depth (metres)	Permeability to Air (milliDarcy's)	Porosity (percent)	Liquid Permeability (milliDarcy's)	Liquid Permeability (m/s)
Perm-005	V	81.00	3.21	N/D	0.0022	2.45E-11
Perm-006	V	85.38	0.0014	N/D	0.0043	4.80E-11
Perm-007	V	89.53	0.0014	N/D	0.0002	2.23E-12
Perm-008	V	93.47	<0.0001	N/D	0.0021	2.34E-11
Perm-012	V	117.40	0.0051	N/D	<0.0001	<1.10E-12
Perm-014	V	124.94	0.0006	N/D	<0.0001	<1.10E-12
Perm-017	V	75.11	18.7	N/D	3.94	4.40E-08
Perm-019	V	79.61	0.0008	N/D	0.0057	6.36E-11
Perm-020	V	82.27	0.76	N/D	0.16	1.78E-09
Perm-020H	H	82.39	0.20	N/D	0.0043	4.80E-11
Perm-024	V	96.52	<0.0001	N/D	0.013	1.43E-10
Perm-025	V	104.70	<0.0001	N/D	<0.0001	<1.10E-12
Perm-025H	H	104.85	0.0024	N/D	0.0038	4.24E-11
Perm-026	V	127.46	0.0015	N/D	<0.0001	<1.10E-12

Appendix 6: Composite bore log for LP-14 (Cecil Plains)



Appendix 7: Summary of hydraulic parameters from pump testing at Daleglade and Cecil Plains

Hydrostrat. Unit	Sub-unit	K_h (m/d)				K_v (m/d)			S_s			
		Hantush-Jacob	Cooper-Jacob	MLU	MODFLOW	MLU	MODFLOW	Core Testing	Hantush-Jacob	Cooper-Jacob	MLU	MODFLOW
Daleglade Site												
Condamine Alluvium	Sheetwash	8×10^{-4} to 1×10^{-2}	-	-	-	3×10^{-3}	-	-	-	-	4×10^{-7}	-
	Condamine Alluvium	5.3 to 7.9	8.0 to 11.5	0.3 to 25	0.63 to 75	-	0.03 to 1.0	-	2.5×10^{-4}	4.4×10^{-2} to 8×10^{-6}	6×10^{-5} to 4×10^{-6}	6.25×10^{-4} to 3.3×10^{-3}
	Tertiary sediments	0.8	-	3×10^{-3} to 0.1	0.19 to 0.40	-	0.04 to 0.09	-	-	-	3×10^{-4}	8.8×10^{-4} to 4.1×10^{-3}
Transition Zone	Undifferentiated clay	-	-	-	2.5×10^{-5} to 5.4×10^{-3}	1×10^{-5} to 3×10^{-4}	2.9×10^{-6} to 6.2×10^{-4}	3×10^{-6} to 4×10^{-4}	-	-	5×10^{-4}	4.7×10^{-5}
Walloon Coal Measures	Upper Walloon Coal Measures	-	-	-					-	-		
	Coal Seam	-	-	1	3.3×10^{-3}	-	3.2×10^{-4}		-	-	5×10^{-6}	6.1×10^{-4}
	Underlying Walloon Coal Measures (Interburden)	-	-	-	7.5×10^{-6}	2×10^{-6} to 4×10^{-5}	7.3×10^{-7}		-	-	4×10^{-7}	4.8×10^{-5}

Hydrostrat. Unit	Sub-unit	K_h (m/d)				K_v (m/d)			S_s			
		Theis	Cooper-Jacob	MLU	MODFLOW	MLU	MODFLOW	Core Testing	Theis	Cooper-Jacob	MLU	MODFLOW
Cecil Plains Site												
Condamine Alluvium	Sheetwash		-	-	-	1×10^{-6}	-	-	-	-	1×10^{-4}	-
	Condamine Alluvium		16.6	4.7	1.4 to 40	-	0.1 to 1.4	-	0.12		5×10^{-5}	$8.9\text{x}10^{-5}$ to $1.8\text{x}10^{-3}$
	Tertiary sediments		5.0	1.0	$6.3\text{x}10^{-4}$ to $6.5\text{x}10^{-2}$	1.2×10^{-4}	$7\text{x}10^{-5}$ to 0.1	-	0.15	5×10^{-2}	6×10^{-5}	$1.2\text{x}10^{-7}$ to $4.3\text{x}10^{-5}$
Transition Zone	Undifferentiated clay	-	-	5.0	$4.9\text{x}10^{-7}$ to $2\text{x}10^{-2}$	5×10^{-7}	5.7×10^{-10} to 7×10^{-7}	2×10^{-7} to 1.5×10^{-4}	-	-	4×10^{-5} to 1×10^{-6}	$9.2\text{x}10^{-9}$ to $2.9\text{x}10^{-4}$
Walloon Coal Measures	Upper Walloon Coal Measures	-	-	-		1×10^{-7}			-	-	1×10^{-6}	
	Coal Seam	-	-	0.1	$2.9\text{x}10^{-4}$ to 0.1	-	$7.3\text{x}10^{-5}$ to $7.1\text{x}10^{-3}$		-	-	1×10^{-6}	$1.9\text{x}10^{-5}$ to $1.1\text{x}10^{-2}$
	Underlying Walloon Coal Measures (Interburden)	-	-	-	$6.5\text{x}10^{-5}$ to $1\text{x}10^{-2}$	1×10^{-7}	$3.8\text{x}10^{-9}$ to $5.8\text{x}10^{-6}$		-	-	1×10^{-6}	$2.2\text{x}10^{-4}$ to $3.5\text{x}10^{-4}$