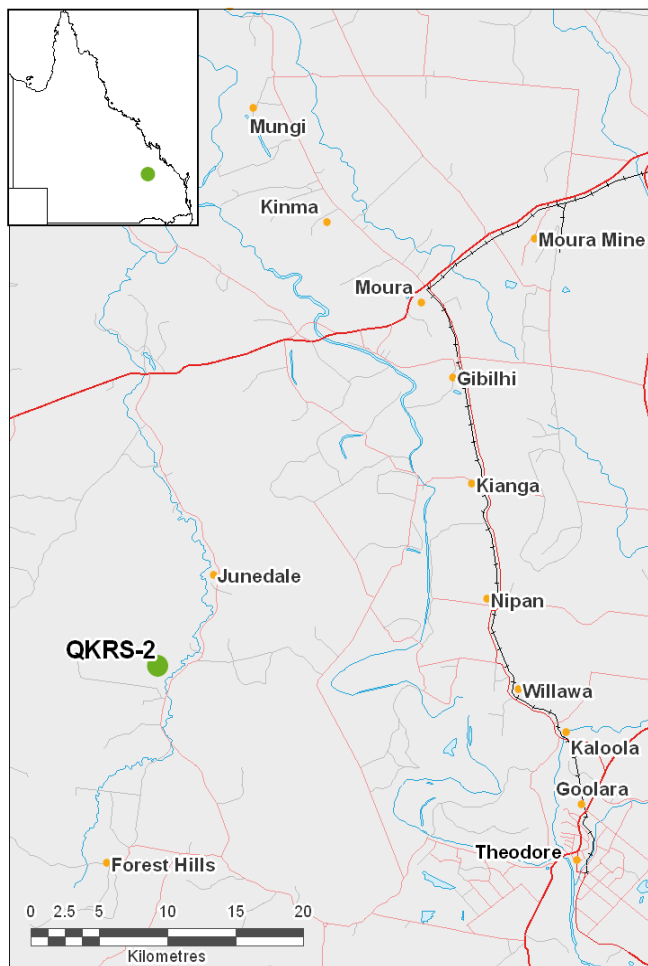


Key Reference Site 2: Brigalow Catchment Study- cropping site

Site details

MGA Coordinates:	782914 mE	7252847 mN	Zone 55
Lat/long:	-24.81309 S	149.79869 E	
Primary site:	SALTC 367		
Geology:	Cz/Rm - Undifferentiated Cainozoic sediments; Triassic shale/ siltstone/ sandstone ¹		
Vegetation:	Cleared for cropping in 1982. Originally open forest of brigalow (<i>Acacia harpophylla</i>) and belah (<i>Casurina cristata</i>) with scattered blackbutt (<i>Eucalyptus cambageana</i>).		
Land use:	Cultivation - a combination of wheat and grain sorghum crops.		

Site location



Soil and landscape correlation

	Name	Reference
Land resource area:	Mixed Brigalow Plains	Dawson/ Callide land management manual ²
Land system:	Highworth	ZDD ³
Land unit:	3: Brigalow land facet 11	ZDD ³

Site notes

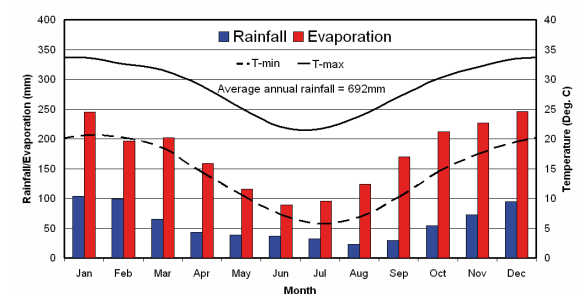
This reference site describes an upper slope position of the undulating brigalow plains of central Queensland. Across the State, the brigalow lands have largely been cleared, initially for pasture production, but since the mid 1970s much has been cropped. There is concern over soil erosion, productivity decline and salinisation associated with the cleared land. This site is the 'upper clay monitoring site' of the cultivated catchment of the Brigalow Catchment Study. It has been used for research into the effects of clearing and cultivation on the soil properties, productivity and hydrology of brigalow catchments^{4,5,6,7}.

This reference site consists of:

- soil and regolith description to 6.1 m
- measured electrical conductivity (EC), soluble chloride (Cl) and soil pH.
- measured bulk density⁵ monitored over several years
- complete laboratory analysis, monitored over several years
- soil moisture monitored over time
- plant available water capacity⁵
- runoff and sediment data

QKRS 2 is therefore a key point of reference for understanding the landscapes of the brigalow lands in central Queensland.

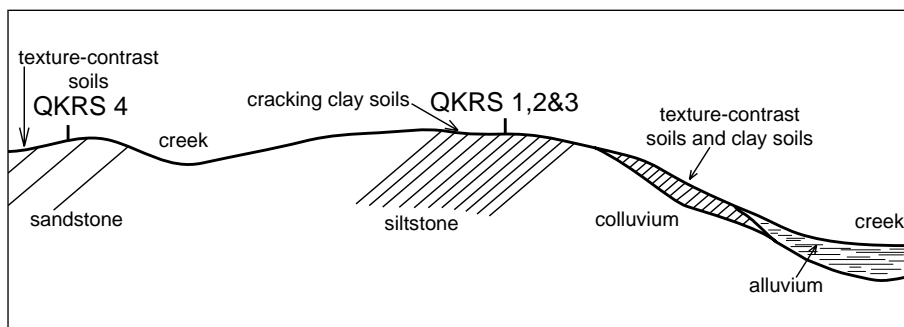
Climate⁸



Compared to evaporation, a rainfall deficit is experienced in every month of the year, and annual pan evaporation is three times the annual rainfall. 62 percent of the average annual rainfall (~430 mm) is received in the summer period (Nov – March), and this provides much of the moisture for summer and early winter cropping and pasture production. 400 mm of summer period rainfall is expected about 40% of the time (Lawrence and Thorburn, 1989)⁶. The high degree of variability in seasonal and monthly rainfall poses the biggest risk of crop failure. An average of ten days of frosts per year can be expected.

Landscape details

Landscape sketch



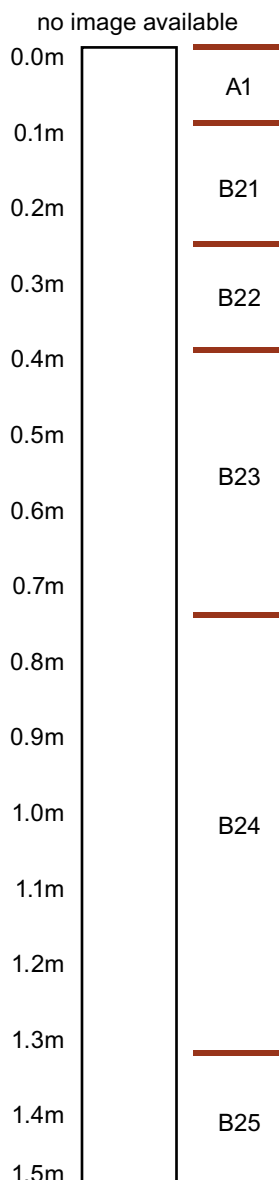
Brigalow Catchment Study aerial landscape

Soil variability in this area can be accounted for by difference in substrate lithology and the varying distribution of colluvium across the landscape. The soils have largely formed in the Triassic sedimentary rocks exposed as the old Tertiary weathered surface eroded away, however remnants of the 'old' surface may still be present. The Triassic sedimentary rocks range from labile siltstones and shale to quartzose sandstones.

Landscape description

Landform	undulating rises
Runoff	slow
Microrelief	none observed
Drainage	imperfectly drained
Rock outcrops	no bedrock exposed
Surface coarse fragments	very few <2% large pebbles 20-60mm unconsolidated material (unidentified)
Permeability	slowly permeable

Soil details



Brief description	Very deep, grey cracking clay. Strong to moderately structured throughout, alkaline grading to acid at depth.	
Classification	Australian Soil Classification ⁹ Great Soil Group ¹⁰ Principal Profile Form ¹¹	Epihypersodic, Epipedal, Black Vertosol No suitable group Ug5.15
Description site	SALTC 367	
Matching sites	Upper clay monitoring site - cultivated catchment, Brigalow Catchment Study (BCS 64) ⁴	

Soil morphology - (SALTC 367, Obs 2)

Name	Depth (m)	Colour	Mottles	Texture	Structure			Consistence	Coarse Fragments	Segregations	Boundary
					Grade	Type	Size				
A1p	0.00-0.10	black (10YR 2/1)	-	light medium clay	moderate	subangular blocky	5-10 mm	-	none	none	clear
B21	0.10-0.26	very dark grey (10YR 3/1)	-	fine sandy light clay	strong	lenticular	5-10 mm	-	none	10-20% calcareous soft segregations (2-6 mm)	gradual
						angular blocky	5-10 mm	-	none	<2% manganiferous soft segregations (2-6 mm)	
B22	0.26-0.40	dark grey (10YR 4/1)	-	medium clay	strong	lenticular	10-20 mm	-	none	2-10% manganiferous soft segregations (6-20 mm)	gradual
						angular blocky	5-10 mm	-	none	2-10% calcareous nodules (6-20 mm)	
B23	0.40-0.75	brown (10YR 5/3)	<2% faint orange (5-15 mm)	medium heavy clay	strong	lenticular	10-20 mm	-	none	<2% manganiferous soft segregations (6-20 mm)	diffuse
					moderate	angular blocky	10-20 mm	-	-		
B24	0.75-1.32	pale brown (10YR 6/3)	-	fine sandy medium clay	moderate	subangular blocky	10-20 mm	-	-	none	diffuse
B25	1.32-3.10	light reddish brown (2.5YR 6/3)	-	fine sandy medium clay	moderate	subangular blocky	10-20 mm	-	none	none	diffuse
B26	3.10-3.28	greyish brown (2.5Y 5/2)	10-20% distinct orange (5-15 mm)	medium clay	moderate	lenticular	20-50 mm	-	none	none	diffuse
B31	3.28-3.60	light brownish grey (2.5Y 6/2)	10-20% distinct orange (5-15 mm)	medium clay	moderate	subangular blocky	10-20 mm	-	none	-	abrupt
			2-10% distinct red (<5 mm)								

Chemical analysis

Surface chemistry - Brigalow catchment study, upper clay monitoring site; Catchment 2 - cropped⁵

Depth (m)	pH	EC (1:5 H ₂ O) mS/cm	Cl mg/kg	NO ₃ -N mg/kg	P (bicarb) [#] mg/kg	Extr. K [#] (HCl) meq 100g	Org.C* (W&B) %	Total N* %	SO ₄ -S* mg/kg	DTPA extractable trace elements (mg/kg) [#]			
										Cu	Zn	Mn	Fe
										0-0.10	8.3	0.14	44
0.10-0.20							0.77	0.08					
0.20-0.30							0.56	0.06					

Sampling 1 (1981) unless specified * 1985 (Sampling 5) # 1983 (sampling 3)

1:5 soil/water analysis - Brigalow catchment study, upper clay monitoring site; Catchment 2 - cropped (unpublished data, Cowie - personal comm.). All results are from a bulked sample obtained from several replicate soil cores.

a) 1981: pre-clearing

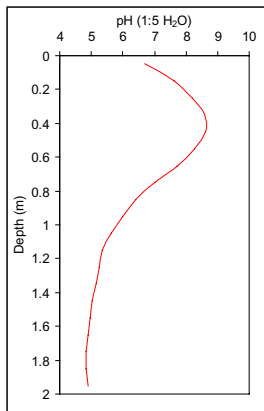
Depth	pH	EC	Cl
(m)		mS/cm	mg/kg
0.00-0.10 B*	6.71	0.1	24.5
0.10-0.20	7.64	0.21	179
0.20-0.30	8.2	0.35	392
0.30-0.40	8.6	0.55	669
0.40-0.50	8.62	0.66	837
0.50-0.60	8.28	0.68	921
0.60-0.70	7.72	0.66	937
0.70-0.80	7	0.66	942
0.80-0.90	6.42	0.64	905
0.90-1.00	5.98	0.61	887
1.00-1.10	5.64	0.60	861
1.10-1.20	5.36	0.58	832
1.20-1.30	5.24	0.56	802
1.30-1.40	5.16	0.55	782
1.40-1.50	5.04	0.59	845
1.50-1.60	4.96	0.60	859
1.60-1.70	4.9	0.64	905
1.70-1.80	4.83	0.66	934
1.80-1.90	4.83	0.61	871
1.90-2.00	4.9	0.55	783

b) 2000 - 2003: after 20 years of pasture

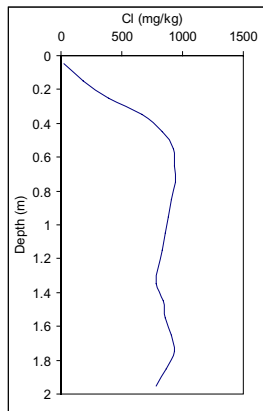
Depth	pH	EC	Cl
(m)		mS/cm	mg/kg
0.00-0.10	7.21	0.07	<10
0.10-0.20	8.61	0.12	15.47
0.20-0.30	8.96	0.15	31.44
0.30-0.40	9.19	0.17	23.39
0.40-0.50	9.25	0.20	39.52
0.50-0.60	9.02	0.14	60.62
0.60-0.70	8.79	0.16	83.03
0.70-0.80	8.37	0.20	115.53
0.80-0.90	7.43	0.22	164.06
0.90-1.00	6.50	0.25	230.66
1.00-1.10	5.67	0.26	293.81
1.10-1.20	5.4	0.30	365.66
1.20-1.30	5.19	0.36	468.04
1.30-1.40	5.00	0.39	546.76
1.40-1.50			
1.50-1.60			
1.60-1.70			
1.70-1.80			
1.80-1.90			
1.90-2.00			

a) 1981: pre-clearing

pH

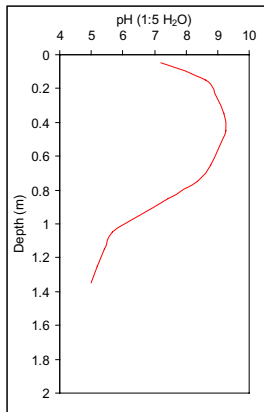


Chloride

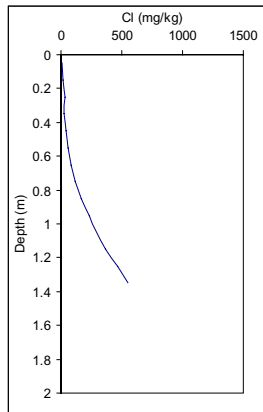


b) 2000 - 2003: after 20 years of pasture

pH



Chloride



Soil profile analysis - Brigalow catchment study, upper clay monitoring site; Catchment 2 - cropped (unpublished data, Cowie - personal comm.)

a) 1981: pre-clearing

b) 2000 - 2003: after 20 years of pasture

Depth (m)	Total element %				P(A) mg/kg			P(B) mg/kg			NO3-N (KCl extract) mg/kg			NH4-N mg/kg			Exchangeable cations (aqueous) m.eq/100g			CEC	ESP	Particle size %			BD	Moistures @ 105°C		Disp. ratio
	OC (W&B) %	N	P	K	S	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	Ca	Mg	Na	K	Ca	Mg	Na			K	CS	FS		S	C	
0.00-0.10 B*	2.16	0.22	0.04	0.12	0.03	11.8	10.2	3.11	5.68	12.77	5.33	0.56	0.39	27.9	2	42.8	18	8.7	28.2	1.35	20.8	12.5	3.69	0.25				
0.10-0.20	0.67	0.07	0.02	0.1	0.02	3	5	0.7	1.7	10.7	9.3	1.86	0.17	27	7	28	27	5	38	1.60	28	14	4.38					
0.20-0.30	0.52	0.06	0.02	0.08	0.02	3	4	0.4	1.4	9.5	9.9	2.6	0.17	27	10	27	30	7	38	1.69	27	13	4.01					
0.30-0.40																				1.77			3.94					
0.40-0.50																				1.76			3.81					
0.50-0.60						2	2	0.2	1.3	5.9	10.3	3.55	0.1	25	14	28	31	8	34	1.76	27	13	3.74					
0.60-0.70																				1.77			3.63					
0.70-0.80																				1.80			3.40					
0.80-0.90						1	2	0.1	1.8	3.6	8.2	3.15	0.07	20	16	27	31	9	28	1.81	26	12	3.32					
0.90-1.00																				1.83			3.33					
1.00-1.10																				1.82			3.26					
1.10-1.20						1	2	0.1	1.3	2.2	6.6	2.91	0.1	19	15	31	30	6	28	1.82	24	11	3.08					
1.20-1.30																				1.84			3					
1.30-1.40																				1.81			2.93					
1.40-1.50						1	2	0.1	1.8	2.1	6.9	3.37	0.09	21	16	30	30	7	29	1.82	24	11	3.24					
1.50-1.60																				1.85			3.15					
1.60-1.70																				1.86			3.33					
1.70-1.80								0.1	1.6	2.2	7.4	3.82	0.11	22	17					1.85	27	13	3.43					
1.80-1.90																				1.86			3.26					
1.90-2.00																				1.86			3.04					

Depth (m)	Total element %				P(A) mg/kg			P(B) mg/kg			NO3-N (KCl extract) mg/kg			NH4-N mg/kg			Exchangeable cations (aqueous) m.eq/100g			CEC	ESP	Particle size %			BD#	Moistures @ 105°C		Disp. ratio
	OC (W&B) %	N	P	K	S	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	Ca	Mg	Na	K	Ca	Mg	Na			K	CS	FS		S	C	
0.00-0.10 B*	0.96	0.09				15.8	11	13.7	7.3	0.55	0.29	22	3	3	1.34					3.13								
0.10-0.20	0.5	0.05				3.21	11.4	14	9.75	1.45	0.11	24	6	6	1.70					4.30								
0.20-0.30	0.34	0.04				1.63	9.6	10.5	9.62	1.95	0.09	22	9	9	1.71					3.57								
0.50-0.60								6.2	9.96	3.76	0.28	21	18	18	1.82													
0.80-0.90								3.28	9.01	4.78	0.11	20	24	24	1.86													
1.10-1.20								1.37	7.73	4.03	0.06	19	21	21	1.89													
1.40-1.50								0.83	7.68	4.07	0.06	18	23	23	2.01													
1.70-1.80								0.61	8	4.27	0.06	21	20	20														

* Surface Bulked

* Surface Bulked
BD is 1987 sampling

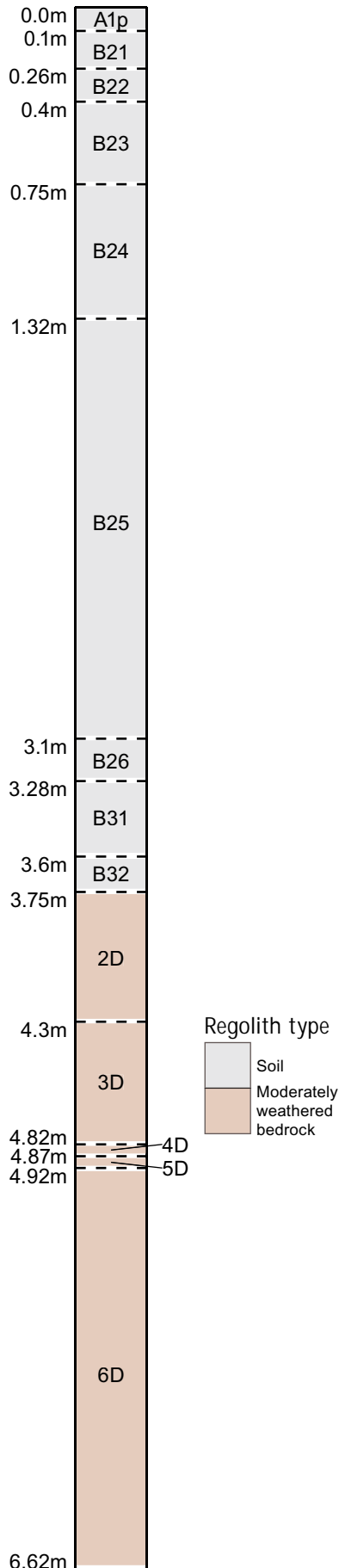
Regolith details

Regolith morphology - (SALTC 367, Obs 2)

Zone	Depth (m)	Colour	Mottles	Texture	Boundary	Grain Size	Grain Shape	Grain Sorting	Mineralogy	Lithology	Degree of Weathering	Regolith Type	Strength
A1p	0.00-0.10	black (10YR 2/1)	-	light medium clay									
B21	0.10-0.26	very dark grey (10YR 3/1)	-	fine sandy light clay									
B22	0.26-0.40	dark grey (10YR 4/1)	-	medium clay									
B23	0.40-0.75	brown (10YR 5/3)	<2% faint orange (5-15 mm)	medium heavy clay									
B24	0.75-1.32	pale brown (10YR 6/3)	-	fine sandy medium clay									
B25	1.32-3.10	light reddish brown (2.5YR 6/3)	-	fine sandy medium clay									
B26	3.10-3.28	greyish brown (2.5Y 5/2)	10-20% distinct orange (5-15 mm)	medium clay									
B31	3.28-3.60	light brownish grey (2.5Y 6/2)	10-20% distinct orange (5-15 mm)	medium clay									
			2-10% distinct red (<5 mm)										
B32	3.60-3.75	-	-	-									
2D	3.75-4.30	grey	20-50% distinct orange (30-100mm)		abrupt	fine sand (0.125-0.25mm)	angular	poorly sorted	clay, feldspar	sandstone	moderately weathered	moderately weathered bedrock	weak rock
			10-20% distinct red (15-30mm)						quartz				
3D	4.30-4.82	grey	2-10% distinct orange (5-15mm)			clay (<0.002mm)		poorly sorted	clay, quartz	sandstone	moderately weathered	moderately weathered bedrock	weak rock
			<2% distinct red (5-15mm)						feldspar				
4D	4.82-4.87	grey	-			pebble				sandstone	moderately weathered	moderately weathered bedrock	strong siliceous pebbles
5D	4.87-4.92	grey	20-50% distinct orange (30-100mm)		abrupt	fine sand (0.125-0.25mm)	angular	poorly sorted	clay, feldspar	sandstone	moderately weathered	moderately weathered bedrock	weak rock
			10-20% distinct red (15-30mm)						quartz				
6D	4.92-6.62	orange/brown	-			fine sand (0.125-0.25mm)	angular	moderately sorted	quartz, feldspar	sandstone	moderately weathered	moderately weathered bedrock	weak rock
									mica, clay				

Moderately weathered sandstone; grey sandy clay with distinct orange to red mottling, over orange/brown micaceous clayey sand

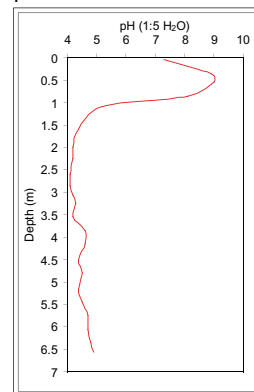
Regolith profile - (SALTC 367, Obs 2)



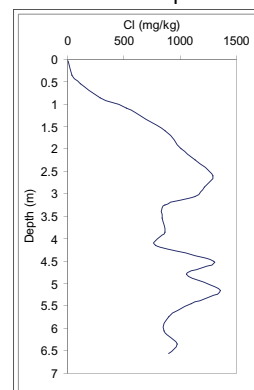
1:5 soil/water analysis - (SALTC 367, Obs 2)

Depth (m)	pH	EC (dS/m)	Cl (mg/kg)	NO3-N (mg/kg)
0-0.1	7.3	0.05	6	2
0.3-0.4	8.9	0.22	42	2
0.5-0.6	9	0.29	113	1
0.8-0.9	8.1	0.26	288	1
1.05-1.15	5.2	0.38	524	2
1.55-1.65	4.4	0.6	869	3
1.95-2.05	4.2	0.72	1010	2
2.20-2.30	4.2	0.81	1130	1
2.55-2.65	4.1	0.92	1290	1
2.80-2.90	4.1	0.9	1220	<1
3.00-3.10	4.2	0.8	1130	<1
3.20-3.30	4.3	0.67	868	<1
3.50-3.60	4.2	0.65	838	<1
3.80-3.90	4.6	0.55	863	<1
4.10-4.20	4.6	0.51	780	<1
4.45-4.55	4.4	0.94	1300	<1
4.75-4.85	4.5	0.8	1060	<1
5.10-5.20	4.4	0.95	1360	<1
5.40-5.50	4.5	0.79	1100	<1
5.70-5.80	4.7	0.65	896	<1
6.00-6.10	4.7	0.65	855	<1
6.30-6.40	4.8	0.61	972	<1
6.50-6.60	4.9	0.56	904	<1

pH



Chloride - sampled in February 2005



References

1. Olgers F (1966). Baralaba, Queensland, Australia 1:250 000 geological series. Bureau of Mineral Resources, Geology and Geophysics, Canberra.
 2. Gillespie, RL, Shields PG and Cannon RS (1991). Land management manual: Dawson/ Callide districts. Queensland Department of Primary Industries.
 3. Speck NH, Sweeney FC, Fitzpatrick EA, Gunn RH, Wright RL, Perry RA, Nix HA and Wilson IB (1968). Lands of the Dawson-Fitzroy Area, Queensland. CSIRO Land Research Series No 21 [Project Code: ZDD].
 4. Hunter HM, Cowie BA (1987a). Brigalow Catchment Study 1981-1987. Part One: A report on the effects of land clearing for cropping and grazing on soils in the Brigalow Catchment Study.
 5. Hunter HM, Cowie BA (1987a). Brigalow Catchment Study 1981-1987. Part Two: A complete data set.
 6. Lawrence PA and Thorburn PJ (eds) (1989). Changes in hydrology, soil fertility and productivity of brigalow catchments following clearing. Research Bulletin RQR89002, Queensland Department of Primary Industries.
 7. Thorburn PJ, Cowie BA, Lawrence PA (1991). Effect of land development on groundwater recharge determined from non-steady chloride profiles. *Journal of Hydrology* **124**: 43-58.
 8. Queensland Department of Natural Resources, Mines and Water (2006). SILO, <http://www.nrm.qld.gov.au/silo/datadrill/>
 9. Isbell RF (2002). 'The Australian Soil Classification' (CSIRO: Melbourne).
 10. Stace HTC, Hubble GD, Brewer R, Northcote KH, Sleeman JR, Mulcahy MJ and Hallsworth EG (1968). 'A Hand book of Australian Soils' (Rellim Technical Publications, Glenside, South Australia).
 11. Northcote KH (1979). 'A Factual Key for the Recognition of Australian Soils' 4th Edition (Rellim Technical Publications, Glenside, South Australia).
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