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GROUNDWATER INFORMATION FROM SEISMIC SHOTHOLES IN THE CENTRAL OFFICER BASIN, SOUTH AUSTRALIA

COMPILED BY

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Environmental Geoscience and Groundwater Program

Australian Geological Survey Organisation

DEPARTMENT OF PRIMARY INDUSTRIES AND ENERGY

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Abstract

A total of 2327 shotholes was drilled in the 1993 seismic survey of the central Officer Basin by the Australian Geological Survey Organisation in a joint mapping project with the South Australian Department of Mines and Energy in the basin. Groundwater intersections were recorded in 160 holes and 45 water samples were taken, largely by the drillers of the seismic shotholes. Fresh water was sampled in only one hole and it contained nitrate and fluoride above the limits for drinking water. Brackish water was sampled in seven holes and the remaining 37 samples were saline. Preliminary plots of the data obtained show that it can be used to fill gaps between sparse waterbores to aid reconnaissance - level hydrogeological mapping of the basin.

Introduction

Between May and October 1993 the Australian Geological Survey Organisation conducted a seismic survey of part of the central Officer Basin in a joint mapping project with the South Australian Department of Mines and Energy. In a bid to increase the scarce groundwater information available in the area, drillers of the seismic shotholes were required to record the depth at which any groundwater was intersected and to take water samples for later analysis.

Drilling

The shotholes were drilled to an average depth of 40m at intervals of 240m along five surveyed lines totalling 550km in length. Four Mayhew 1000 rotary rigs were used to drill the holes with air. Water or foam was injected where necessary to stabilise the holes. Water samples were obtained by airlifting from the uncased hole and were bottled untreated by the drillers.

Drillers recorded, in specific columns on their logs, the depth at which water was intersected in each hole, whether or not water was introduced during drilling, and an estimate of the rate at which water was blown from the annulus. They did not, however, record water samples on the log or, it seems, water intersections in some of the holes sampled.

The drilling details are summarised and apparent omissions noted in Appendix 1. The locations of the seismic lines and the shotholes on them which intersected groundwater or soil moisture are shown on Figures 1 and 2. Shotholes are numbered by seismic line then by shotpoint number on the line: 1-2506 represents the hole drilled at shotpoint 2506 on seismic line 1.

Geological logging of chip samples from the shotholes was done in the field by Mark Benbow and Graham Krieg of the South Australian Department of Mines and Energy. Levelled cross-sections showing surficial geology have been prepared from these logs (Benbow and others 1995 a & b).

Twelve waterbores were drilled by the Department of Mines and Energy to supply water for the seismic survey . They are described in a report by Aldam (1994). Two other waterbores, AGSO 1 and AGSO 2, which were drilled by the Australian Geological Survey Organisation for the seismic survey, are described in a facsimile report by Barton (1993). Because they were sampled and analysed as part of the second batch of shothole samples, they have been included in Tables 1 and 2 of the current report for completeness.

Sampling and analysis

Because water samples taken were not entered on the drillers logs and because some sample numbers were hard to read in the laboratory, there is some uncertainty about sample location. It has been assumed that the sample numbers deciphered by the laboratory are accurate even when no water was recorded intersected in the corresponding shothole.

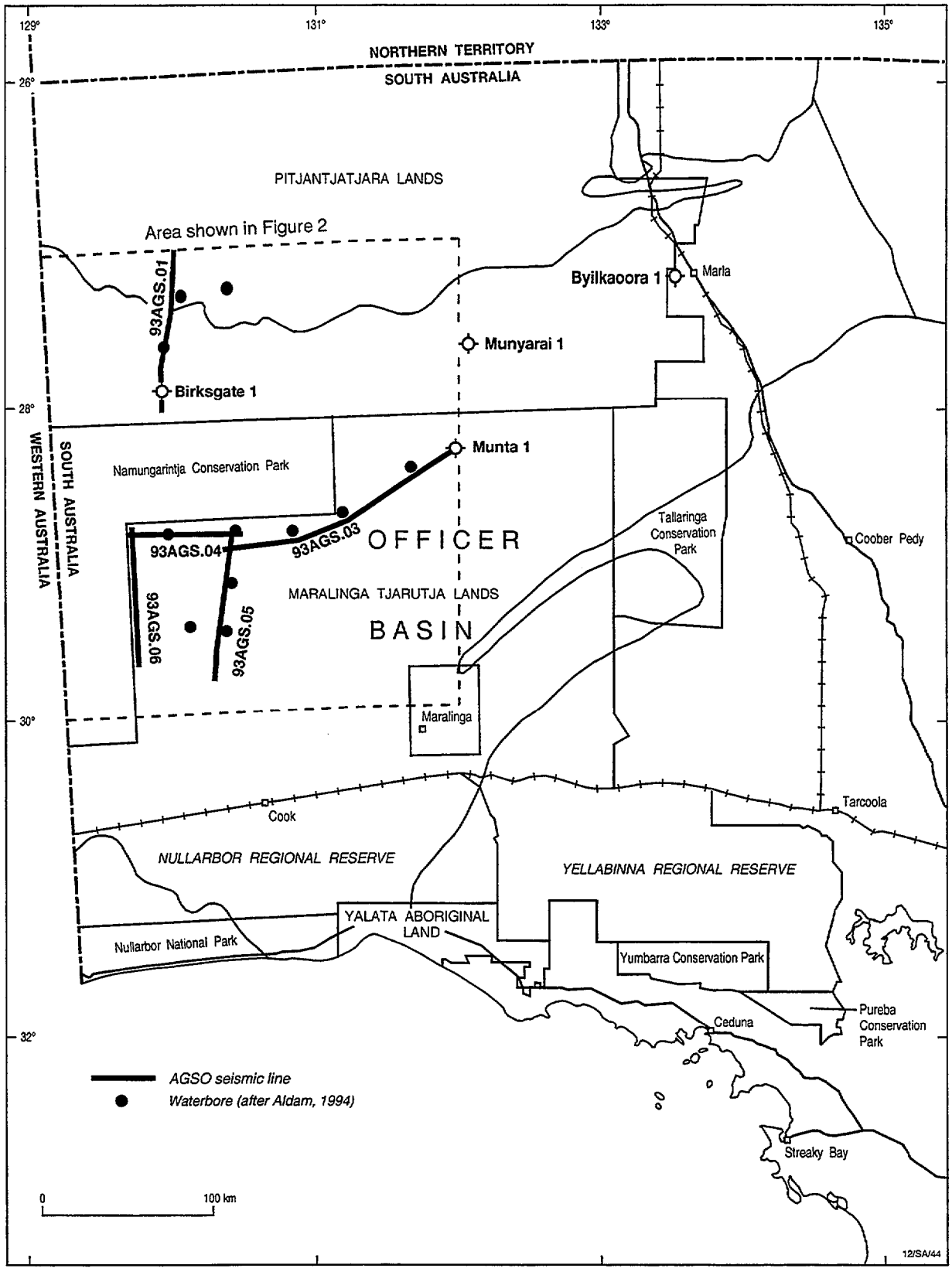

Figure 1. Location map, Officer Basin, South Australia (base map after Aldam, 1994)

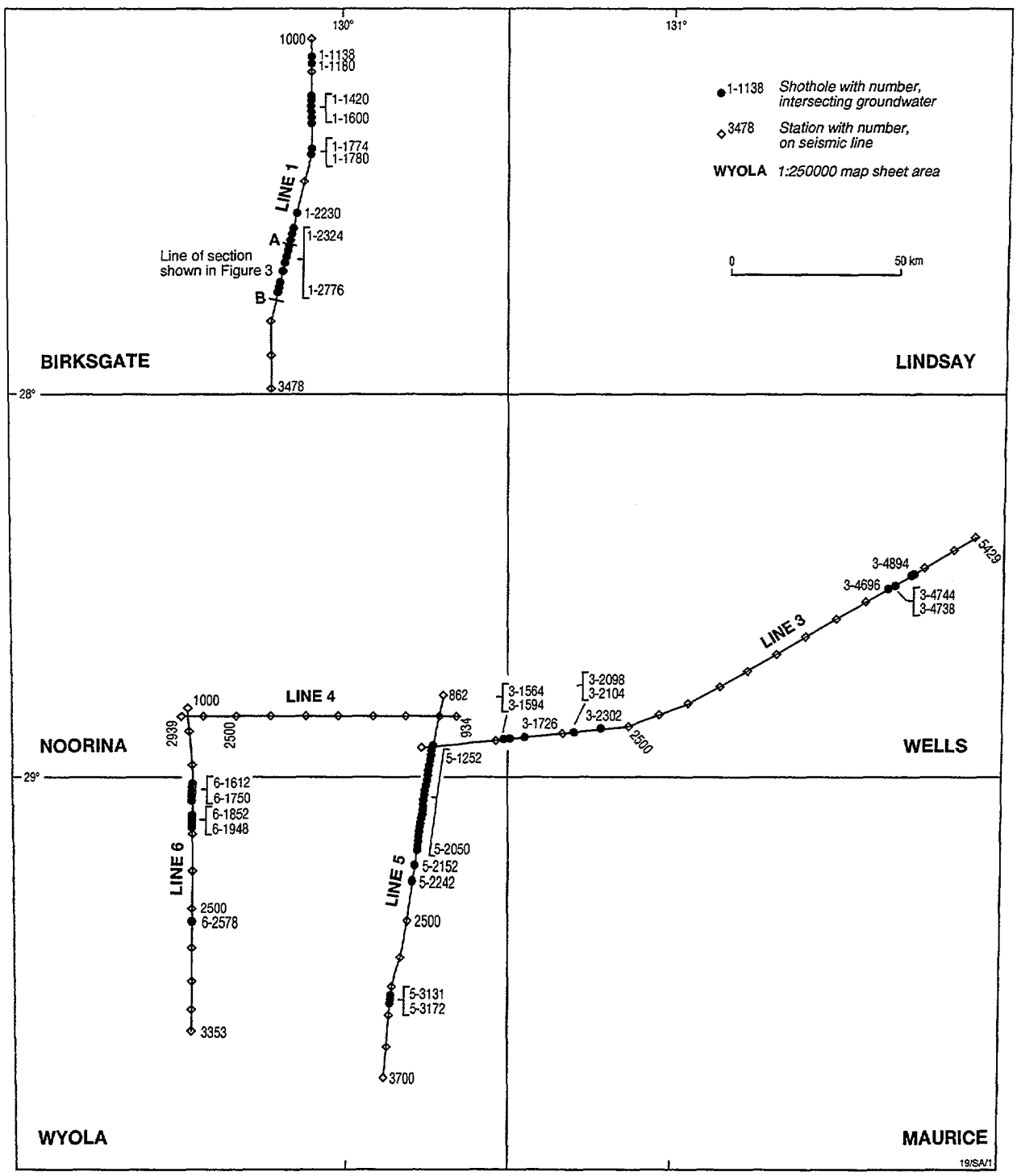

Figure 2. Location of shotholes intersecting groundwater

Three samples (1-2506, 3-2099 and 3-4896) were analysed from shotholes whose final numbers were adjusted by the seismic observer after they had been drilled and sampled. The samples have been renumbered accordingly 1-2507, 3-2098 and 3-4894 for this report. The original numbers remain in the laboratory register.

One sample labelled only `from shothole 50 km from southern end of Line 6' falls close to and is more probably from the waterbore AGSO 2 (Barton, 1994). It also has been labelled as such in this report but retains its original name in the laboratory register.

The most reliable water samples are assumed to be the two from producing water bores and 18 from airlifted holes. The remaining 25 samples, taken after drilling water had been introduced to stabilise the holes, seem likely to be mixtures of drilling water and groundwater in situ. Drilling water for Line 1 came from 4843-11 (with total dissolved solids 1142 mg/L); for Lines 3 and 4 from 4940-6 (with total dissolved solids 4801 mg/L); for Line 5 from 4939-16 (with total dissolved solids 149732 mg/L), and for Line 6 from AGSO 2 (with total dissolved solids 22000 mg/L) (Barton, 1993).

However, on Line 1 north of Birksgate 1 (Figure 3), where all three sample types exist, values of total dissolved solids appear to depend more on stratigraphic unit than on sample type. In shales of the Cambrian Wirrildar Beds, total dissolved solids are consistently high in three water-drilled shotholes at the southern end of the line and they are similar for the water bore 4842-4 and its adjoining water-drilled shothole. In the adjoining Cainozoic surficial sediments, total dissolved solids determined for the only water-drilled sample fall within the range 5300 mg/L to 10111 mg/L of the otherwise air-drilled samples.

Water analysis

Most of the water samples which arrived at the AGSO water laboratory were muddy and difficult to filter. The analyses done were those that did not require more than the 50 ml of sample it was considered practical to filter. Neither total dissolved solids by evaporation nor specific conductance was measured for this reason. Total dissolved solids were measured by refractometer and by calculation (Table 2). Because the refractometer is not accurate for total dissolved solids values below 2000 mg/L, calculated values of total dissolved solids are preferred in Table 1.

Groundwater information

Appendix 1 lists the 152 shotholes and two waterbores in which groundwater was intersected. A further nine holes recorded as `damp' or `moist' are included in the listing. It also includes location, surveyed elevation, depth to aquifer (or `water cut' ), total dissolved solids of any water sampled, and whether or not drilling water was added to the hole. Shotholes for which a water sample exists but no groundwater intersection was recorded are indicated by the notation `no water cut'.

Appendix 2 contains chemical analyses for the water samples from the 43 shotholes and two waterbores drilled by the Australian Geological Survey Organisation.

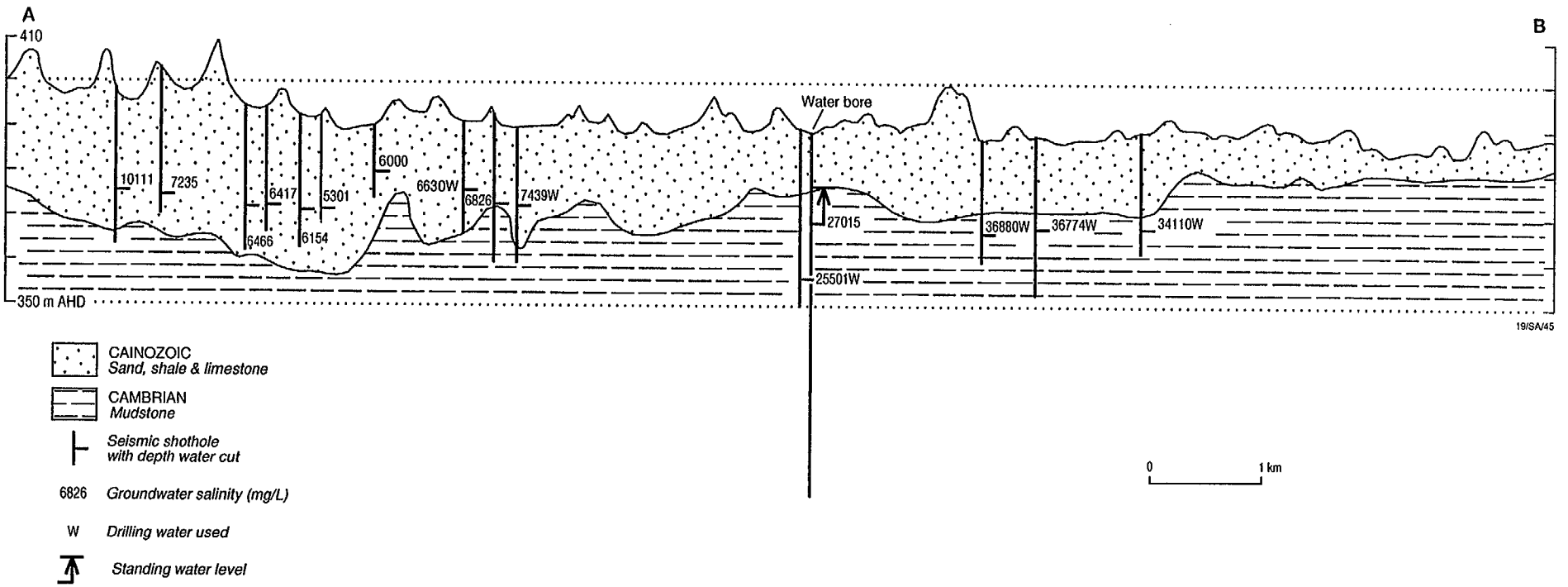

Figure 3. Cross-section showing groundwater salinity in relation to geology (after Benbow and others 1995)

Only one shothole contained `fresh' water (with total dissolved solids less than 1500 mg/L) and it was in the Birksgate Complex not in the Officer Basin. The water was not potable because its nitrate (87 mg/L) and fluoride (1.77 mg/L) values exceed the respective limits of 45 mg/L and 1.5 mg/L recommended by the National Health and Medical Research Council and the Australian Water Resources Council (1987).

Seven shotholes contained 'brackish' water (with total dissolved solids between 1500 mg/L and 3000 mg/L). All of these were in the Birksgate Complex.

`Saline' waters (with total dissolved solids greater than 3000 mg/L) occur in 37 holes. The highest salinity intersected measured 146 000 mg/L total dissolved solids in Palaeozoic sandstone near Wyola Lake.

Hydrogeological interpretation

The detailed levelled geological cross-sections on which Figure 3 is based allow water intersections and chemical analyses to be related to geology. The resulting composite sections (Benbow and others,1995) underpin the maps of groundwater availability and salinity prepared for the Officer Basin atlas (Lau and others,1995 a&b).

Conclusions

The shothole water data together with the detailed levelled geological sections is a valuable addition to the scarce waterbore data in the region.

Recommendations

Water samples need to be identified both in drillers logs and on separate laboratory submission sheets. Water intersections need to be noted in the drillers log whether or not water samples are taken.

Acknowledgments

John Lindsay and Gerry Jacobson (AGSO) initiated water sampling and recording in the seismic survey. Jim Leven (AGSO) provided drillers logs of shotholes and surveying details. Chris Parvey (AGSO) produced the computer plot on which Figure 2 is based. John Spring and Peter Ryan (AGSO) provided details of water analysis procedure. Geoff Lau set up the databases on which Appendices 1 and 2 are based.

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Appendix 1

Groundwater occurrence in shotholes and two water bores

Groundwater occurrence in Officer Basin shotholes

Shot hole	Map sheet (1:250 000)	Latitude (DMS)	Longitude (DMS)	Elevation (m)	Tot depth (m)	Aq depth (m)	TDS (mg/L)	Comment
1-1138	BIRKSGATE	270805	1295445	565.50	40.00			AW: MOIST
1-1180	BIRKSGATE	270900	1295443	566.60	40.00			AW MOIST
1-1420	BIRKSGATE	271411	1295450	541.90	40.00	36.00	1863	W
1-1426	BIRKSGATE	271419	1295450	540.50	40.00	36.00	2874	AW;SEEP
1-1438	BIRKSGATE	271435	1295451	536.10	40.00		1661	W:NO WATER CUT
1-1456	BIRKSGATE	271458	1295452	528.50	40.00	21.00	2523	A
1-1474	BIRKSGATE	271521	1295453	521.40	34.00	31.00	4000	A
1-1522	BIRKSGATE	271623	1295500	507.80	31.00	6.00		A
1-1540	BIRKSGATE	271647	1295500	504.90	36.00	22.00	1493	A
1-1558	BIRKSGATE	271710	1295459	500.40	18.00	14.00		A
1-1564	BIRKSGATE	271718	1295458	499.20	30.00	18.00		A
1-1570	BIRKSGATE	271726	1295458	498.30	23.00	8.00		A
1-1576	BIRKSGATE	271734	1295457	497.60	13.00	8.00	1573	A
1-1582	BIRKSGATE	271741	1295457	497.60	25.00		1592	A:NO WATER CUT
1-1594	BIRKSGATE	271757	1295456	497.70	18.00	13.00	1859	A
1-1600	BIRKSGATE	271805	1295456	498.80	13.00	13.00		A
1-1774	BIRKSGATE	272149	1295436	474.60	40.00	36.00		A :MOIST
1-1780	BIRKSGATE	272157	1295435	472.00	40.00	13.00		A
1-2230	BIRKSGATE	273124	1295202	417.00	40.00	36.00	22607	AW
1-2324	BIRKSGATE	273322	1295127	408.83	60.00	37.00		AW
1-2333	BIRKSGATE	273333	1295123	404.19	40.00	32.00		AW
1-2348	BIRKSGATE	273352	1295118	402.30	40.00	35.00		AW
1-2368	BIRKSGATE	273417	1295110	399.39	40.00	32.00	4525	AW
1-2377	BIRKSGATE	273428	1295107	401.06	40.00	32.00		AW
1-2410	BIRKSGATE	273510	1295055	397.34	36.00		4556	AW:NO WATER CUT
1-2424	BIRKSGATE	273527	1295050	397.80	32.00	22.00	10111	A
1-2428	BIRKSGATE	273532	1295048	395.58	40.00	26.00	8048	A
1-2434	BIRKSGATE	273540	1295046	402.07	32.00	28.00	7235	A
1-2440	BIRKSGATE	273547	1295044	397.72	28.60		6954	NO WATER CUT
1-2452	BIRKSGATE	273602	1295039	394.29	32.00	21.00	6466	A
1-2458	BIRKSGATE	273610	1295037	394.27	28.00	21.00	6417	A
1-2464	BIRKSGATE	273617	1295035	393.38	28.00	21.00	6154	A
1-2469	BIRKSGATE	273624	1295033	391.39	23.00	22.00	5301	A
1-2476	BIRKSGATE	273632	1295030	389.89	31.00	21.00		AW
1-2482	BIRKSGATE	273640	1295028	390.50	17.00	13.00	6000	A
1-2492	BIRKSGATE	273653	1295024	392.40	27.00			AW
1-2500	BIRKSGATE	273703	1295021	391.13	24.00	16.00	6630	AW
1-2507	BIRKSGATE	273711	1295018	394.89	31.00	20.00	6826	A

A = Air drilling, W = Drilling with water injection, NO WATER CUT = No water recorded in hole by driller, TDS = Total dissolved solids in water sample sent for analysis

Groundwater occurrence in Officer Basin shotholes

Shot hole	Map sheet (1:250 000)	Latitude (DMS)	Longitude (DMS)	Elevation (m)	Tot depth (m)	Aq depth (m)	TDS (mg/L)	Comment
1-2512	BIRKSGATE	273718	1295017	390.17	30.00	18.00	7439	AW
1-2524	BIRKSGATE	273733	1295012	393.40	36.00	18.00		AW
1-2554	BIRKSGATE	273810	1295001	390.45	40.00			AW:MOIST
1-2578	BIRKSGATE	273840	1294952	389.07	40.00	32.00	25501	AW
1-2584	BIRKSGATE	273848	1294949	390.68	31.00	18.00		AW
1-2601	BIRKSGATE	273909	1294943	389.91	40.00	24.00		AW
1-2606	BIRKSGATE	273915	1294941	391.16	40.00		31116	AW:NO WATER CUT
1-2620	BIRKSGATE	273933	1294936	387.59	27.00	22.00	36880	AW:1.05L/s
1-2632	BIRKSGATE	273948	1294931	388.30	36.00	22.00	36774	AW
1-2638	BIRKSGATE	273955	1294929	386.96	32.00	27.00		AW
1-2644	BIRKSGATE	274003	1294927	387.53	40.00	24.00		AW
1-2656	BIRKSGATE	274018	1294922	388.72	27.00	22.00	34110	AW
1-2716	BIRKSGATE	274133	1294859	385.70	40.00	32.00		AW
1-2720	BIRKSGATE	274138	1294858	384.52	40.00	34.00		AW
1-2740	BIRKSGATE	274203	1294850	387.18	32.00	30.00		AW
1-2752	BIRKSGATE	274218	1294846	388.45	32.00	24.00		AW
1-2770	BIRKSGATE	274241	1294839	390.62	34.00		8772	AW:NO WATER CUT
1-2776	BIRKSGATE	274249	1294837	391.55	32.00	21.00		A
3-1564	NOORINA	285341	1302923	262.90	40.00	32.00		AW:DAMP ONLY
3-1588	NOORINA	285338	1302958	259.10	40.00	30.00		AW
3-1594	NOORINA	285337	1303007	259.60	40.00	27.00		AW:DAMP
3-1726	WELLS	285319	1303321	253.50	40.00	36.00		AW
3-2098	WELLS	285227	1304229	252.40	40.00	34.00	17365	
3-2104	WELLS	285226	1304236	257.10	40.00	32.00		W
3-2302	WELLS	285158	1304727	261.70	40.00	36.00	18908	AW
3-4696	WELLS	282857	1313924	289.00	40.00	36.00		AW
3-4738	WELLS	282830	1314017	285.20	40.00		19802	W:NO WATER CUT
3-4744	WELLS	282826	1314025	286.20	40.00	33.00	12974	AW
3-4894	WELLS	282647	1314338	328.60	40.00		13499	A:NO WATER CUT
5-1252	NOORINA	285422	1301640	287.94	45.00	36.00		AW:LOW YIELD
5-1277	NOORINA	285455	1301634	273.39	60.00	35.00		AW
5-1285	NOORINA	285505	1301632	270.80	40.00	36.00		AW
5-1292	NOORINA	285514	1301631	268.98	40.00	33.00		AW
5-1295	NOORINA	285518	1301630	270.32	60.00	40.00		AW
5-1308	NOORINA	285534	1301627	268.41	40.00	37.00		AW
5-1315	NOORINA	285543	1301625	267.13	40.00	35.00		AW
5-1318	NOORINA	285547	1301624	262.50	40.00	34.00		AW
5-1324	NOORINA	285555	1301623	262.45	40.00	27.00		AW

A = Air drilling, W = Drilling with water injection, NO WATER CUT = No water recorded in hole by driller, TDS = Total dissolved solids in water sample sent for analysis

Groundwater occurrence in Officer Basin shotholes

Shot hole	Map sheet (1:250 000)	Latitude (DMS)	Longitude (DMS)	Elevation (m)	Tot depth (m)	Aq depth (m)	TDS (mg/L)	Comment
5-1331	NOORINA	285604	1301622	261.31	40.00	33.00		AW
5-1338	NOORINA	285613	1301620	264.91	40.00	34.00		AW
5-1343	NOORINA	285619	1301619	257.91	40.00	35.00		AW
5-1347	NOORINA	285625	1301618	255.40	40.00	20.00		AW
5-1353	NOORINA	285632	1301617	251.33	40.00	18.00		AW
5-1361	NOORINA	285642	1301615	248.61	40.00	18.00		AW;YIELD 0.2 L/s
5-1365	NOORINA	285648	1301614	249.14	45.00	38.00		AW
5-1372	NOORINA	285657	1301612	254.19	45.00	33.00		AW
5-1380	NOORINA	285707	1301610	262.32	45.00	35.00		AW
5-1387	NOORINA	285716	1301609	253.82	45.00	34.00		AW
5-1390	NOORINA	285720	1301608	251.30	45.00	34.00		AW
5-1397	NOORINA	285729	1301607	255.42	45.00	38.00		AW
5-1402	NOORINA	285735	1301605	251.48	45.00	33.00		AW
5-1410	NOORINA	285745	1301604	252.90	45.00	32.00		AW
5-1416	NOORINA	285753	1301602	252.37	45.00	33.00		AW
5-1420	NOORINA	285758	1301601	254.29	34.00	27.00		AW
5-1429	NOORINA	285810	1301559	255.48	45.00	33.00		AW
5-1432	NOORINA	285814	1301559	257.18	45.00	33.00		AW
5-1443	NOORINA	285828	1301556	251.45	45.00	27.00		AW
5-1444	NOORINA	285829	1301556	251.14	45.00	37.00		AW
5-1456	NOORINA	285844	1301553	251.67	45.00	32.00		AW;LARGE YIELD
5-1465	NOORINA	285856	1301551	249.66	45.00	34.00		AW
5-1468	NOORINA	285900	1301550	249.90	38.00	27.00		AW
5-1486	NOORINA	285923	1301546	247.28	45.00	32.00		AW
5-1491	NOORINA	285929	1301544	246.09	45.00	36.00		AW
5-1497	NOORINA	285937	1301542	246.91	45.00	36.00		AW
5-1505	NOORINA	285947	1301539	245.65	45.00	36.00		AW
5-1516	NOORINA	290001	1301537	243.65	45.00			AW;MOIST
5-1528	WYOLA	290017	1301534	243.96	45.00	38.00		AW
5-1546	WYOLA	290040	1301530	242.55	45.00	36.00		AW;LOW YIELD
5-1552	WYOLA	290047	1301529	243.25	45.00	32.00		AW
5-1559	WYOLA	290056	1301527	243.49	45.00	36.00		AW
5-1570	WYOLA	290110	1301525	242.83	45.00	40.00		AW
5-1576	WYOLA	290118	1301523	242.80	45.00	35.00		AW
5-1594	WYOLA	290141	1301519	252.79	45.00			AW;MOIST
5-1606	WYOLA	290157	1301516	254.46	45.00	38.00		AW;MOIST
5-1614	WYOLA	290207	1301515	246.42	45.00	33.00		AW
5-1621	WYOLA	290216	1301513	240.50	40.00	32.00		AW

A = Air drilling. W = Drilling with water injection. NO WATER CUT = No water recorded in hole by driller. TDS = Total dissolved solids in water sample sent for analysis

Groundwater occurrence in Officer Basin shotholes

Shot hole	Map sheet (1:250 000)	Latitude (DMS)	Longitude (DMS)	Elevation (m)	Tot depth (m)	Aq depth (m)	TDS (mg/L)	Comment
5-1623	WYOLA	290218	1301513	240.63	40.00	32.00		AW
5-1624	WYOLA	290220	1301512	241.02	45.00	27.00		AW
5-1636	WYOLA	290235	1301509	245.49	45.00	40.00		AW;SEEP
5-1639	WYOLA	290239	1301509	242.75	45.00	32.00		AW
5-1654	WYOLA	290258	1301505	240.22	45.00	34.00		AW
5-1672	WYOLA	290321	1301501	237.31	45.00	24.00		AW
5-1685	WYOLA	290338	1301458	242.59	45.00	30.00	15779	AW;1.05 L/s
5-1698	WYOLA	290355	1301455	242.48	45.00	26.00		AW
5-1714	WYOLA	290415	1301452	240.89	45.00	32.00	20000	AW
5-1729	WYOLA	290435	1301448	240.08	45.00	26.00		AW
5-1738	WYOLA	290446	1301446	241.05	45.00	34.00		AW
5-1770	WYOLA	290527	1301438	242.44	45.00	27.00		AW
5-1780	WYOLA	290540	1301436	246.82	45.00	40.00		AW
5-1802	WYOLA	290608	1301430	239.16	45.00	40.00		AW
5-1810	WYOLA	290618	1301429	245.77	45.00	40.00		AW
5-1834	WYOLA	290649	1301422	241.35	45.00	40.00		AW
5-1851	WYOLA	290711	1301420	238.67	45.00	36.00		AW
5-1906	WYOLA	290818	1301353	239.95	45.00	33.00		AW
5-1925	WYOLA	290841	1301344	239.76	45.00	35.00		AW
5-1936	WYOLA	290855	1301343	237.95	45.00	37.00		AW
5-1954	WYOLA	290919	1301343	235.70	45.00	35.00		AW
5-1978	WYOLA	290949	1301338	229.20	36.00	30.00		AW
5-1990	WYOLA	291004	1301334	233.15	45.00	36.00		AW
5-2008	WYOLA	291027	1301333	239.89	45.00	40.00		AW
5-2032	WYOLA	291058	1301329	236.49	45.00	36.00		AW
5-2050	WYOLA	291120	1301321	231.70	45.00	37.00		AW
5-2152	WYOLA	291329	1301303	238.09	45.00	36.00		AW
5-2242	WYOLA	291524	1301246	236.16	45.00	36.00		AW
5-3131	WYOLA	293313	1300820	177.76	40.00	36.00		AW
5-3149	WYOLA	293335	1300821	168.04	30.00	26.00		AW
5-3160	WYOLA	293348	1300824	164.45	40.00	27.00	41000	AW
5-3172	WYOLA	293402	1300815	164.02	40.00	27.00		AW
6-1612	WYOLA	290040	1293232	290.40	45.00	40.00		AW
6-1654	WYOLA	290135	1293232	283.00	45.00	40.00		AW
6-1690	WYOLA	290222	1293232	278.80	45.00	36.00	13026	A;YIELD 0.3 L/s
6-1708	WYOLA	290245	1293231	280.70	45.00	38.00	12987	A;YIELD 0.4 L/s
6-1720	WYOLA	290301	1293231	279.00	45.00	32.00		AW
6-1726	WYOLA	290308	1293231	283.90	45.00	38.00		A

A = Air drilling, W = Drilling with water injection, NO WATER CUT = No water recorded in hole by driller, TDS = Total dissolved solids in water sample sent for analysis

Groundwater occurrence in Officer Basin shotholes

Shot hole	Map sheet (1:250 000)	Latitude (DMS)	Longitude (DMS)	Elevation (m)	Tot depth (m)	Aq depth (m)	TDS (mg/L)	Comment
6-1738	WYOLA	290324	1293230	284.90	45.00	42.00		AW;YIELD 0.5L/s
6-1750	WYOLA	290340	1293229	289.50	45.00	44.00		AW
6-1852	WYOLA	290052	1293225	272.30	45.00	30.00		AW
6-1882	WYOLA	290631	1293224	269.80	45.00	30.00		AW
6-1894	WYOLA	290646	1293224	267.30	45.00		12585	AW;NO WATER CUT
6-1900	WYOLA	290654	1293223	267.40	45.00	30.00		AW
6-1924	WYOLA	290725	1293223	269.00	45.00	40.00	12422	AW;YIELD 0.4 L/s
6-1948	WYOLA	290757	1293222	270.90	45.00	42.00	14127	AW
6-2578	WYOLA	292134	1293206	222.80	45.00	30.00		AW
AGSO 1	WELLS	284633	1310456		66.00	44.00		CASING 66M;YIELD2.5L/S
AGSO 2	WYOLA	291145	1293218		50.00	36.00	21590	CASING 50M;YIELD 0.5L/S
4939-16	WYOLA	290929	1301342		115.40	38.00		

A = Air drilling, W = Drilling with water injection, NO WATER CUT = No water recorded in hole by driller, TDS = Total dissolved solids in water sample sent for analysis

Appendix 2

Officer Basin shothole groundwater chemistry

Officer Basin shothole groundwater chemistry

Shot hole	Sample depth	Lab pH	TDS meas	TDS calc	Total alk	Na	K	Ca	Mg	Cl	F	SO4	CO3	HCO3	NO3	Si	B	Br	Total Fe
1-1420	36.0	7.90	500	1863	168.75	448	76.8	90.1	88.6	727	2.75	262	0	168.75	62.5	21.20	0.84	4.32	0.02
1-1426	40.0	7.79	2000	2874	250.00	707	110.0	123.0	119.0	1160	1.81	461	0	250.00	35.1	24.80	1.06	7.23	0.03
1-1438	16.0	7.72	1000	1661	200.00	418	52.8	76.0	64.2	637	1.31	244	0	200.00	49.3	14.10	0.96	3.93	0.01
1-1456	21.0	8.40	2200	2523	175.00	592	94.3	101.0	107.0	1030	1.73	421			58.1	24.50	0.99	5.81	0.03
1-1474	31.0		4000			924	143.0	201.0	222.0	1840	2.20	525			51.6	22.50	0.89	10.60	0.06
1-1540	21.0	8.03	200	1493	168.75	342	49.6	86.5	60.2	542	1.77	219	0	168.75	87.2	13.70	0.83	3.30	0.02
1-1576	8.0	7.82	1000	1573	168.75	358	62.5	104.0	62.8	564	1.53	248	0	168.75	84.3		0.92	3.61	0.02
1-1582	13.0	8.07	1000	1592	181.25	362	66.2	81.8	58.9	595	1.81	245	0	181.25	74.1	11.10	0.90	4.66	0.02
1-1594	9.0	7.68	1000	1859	243.75	416	67.7	127.0	64.4	680	0.56	284	0	243.75	74.1	17.90	0.82	4.41	0.02
1-2230	40.0	7.43	22200	22607	275.00	5150	379.0	845.0	1310.0	10300	0.91	4340	0	275.00	96.0	5.26	3.43	51.10	0.05
1-2368	32.0	7.63	4000	4525	87.50	1030	84.4	274.0	243.0	2000	0.91	761	0	87.50	65.0	13.50	1.00	10.80	0.05
1-2410	32.0	7.35	4000	4556	168.75	1200	52.7	264.0	166.0	1930	0.28	812	0	168.75	17.3	16.50	0.90	10.60	0.04
1-2424	22.0	7.59	10000	10111	225.00	2700	162.0	534.0	404.0	4340	0.56	1770	0	225.00	39.3	25.10	2.43	23.50	0.12
1-2428	26.0	7.51	8000	8048	200.00	2130	152.0	405.0	309.0	3400	0.56	1460	0	200.00	46.9	25.20	2.16	18.50	0.06
1-2434	28.0	7.83	6200	7235	193.75	1900	147.0	338.0	291.0	3040	1.11	1320	0	193.75	55.6	23.40	2.16	15.90	0.05
1-2440	12.0	7.61	6000	6952	215.00	1820	127.0	378.0	274.0	2900	0.22	1260	0	215.00	44.2	27.70	1.64	11.60	0.05
1-2452	21.0	7.31	6000	6466	250.00	1690	145.0	337.0	257.0	2670	0.83	1150	0	250.00	41.0	32.00	1.75	14.00	0.05
1-2458	21.0	7.71	6000	6417	225.00	1680	131.0	319.0	256.0	2690	1.59	1120	0	225.00	52.8	35.00	1.77	14.60	0.05
1-2464	28.0	7.71	6000	6154	231.25	1640	142.0	306.0	230.0	2560	1.07	1050	0	231.25	60.9	35.00	1.85	13.60	0.04
1-2469	22.0	7.81	2200	5301	187.50	1340	102.0	286.0	207.0	2220	0.32	974	0	187.50	52.4	10.60	1.30	11.80	0.04
1-2482	13.0	7.93	6000	6000	231.25	1550	131.0	353.0	245.0	2440	0.44	1050	0	231.25	63.1	35.00	1.51	13.00	0.05
1-2500	16.0	7.77	6000	6630	243.75	1720	148.0	375.0	276.0	2730	1.56	1130	0	243.75	75.6	38.00	1.67	14.50	0.05
1-2507	25.0	8.17	6000	6826	175.00	1750	137.0			2840	1.02	1220	0	175.00	78.7	27.90	1.58	14.90	0.05
1-2512	10.0	8.10	7000	7439	181.25	1900	146.0	405.0	302.0	3150	0.58	1330	0	181.25	77.7	17.30	2.03	16.00	0.06

Officer Basin shothole groundwater chemistry

Shot hole	Sample depth	Lab pH	TDS meas	TDS calc	Total alk	Na	K	Ca	Mg	Cl	F	SO4	CO3	HCO3	NO3	Si	B	Br	Total Fe
1-2578	32.0	7.92	24200	25501	325.00	7280	503.0	791.0	1030.0	11000	1.52	4580	0	325.00	73.3	9.09	5.34	60.80	0.06
1-2606	20.0	7.71	29000	31116	325.00	9030	716.0	756.0	1170.0	13100	1.17	6050	0	325.00	37.2	4.14	6.17	70.70	0.09
1-2620	22.0	7.60	35000	36880	268.75	10200	1070.0	975.0	1680.0	16000	3.40	6670	0	268.75	30.2	11.30	6.85	88.80	0.04
1-2632	20.0	7.65	34200	36774	331.25	10200	883.0	908.0	1660.0	15500	2.08	7320	0	331.25	21.7	10.40	6.61	83.60	0.02
1-2656	22.0	7.65	32200	34110	331.25	9350	466.0	958.0	1850.0	15100	2.90	6090	0	331.25	19.3	12.10	4.57	75.70	0.03
1-2770	34.0	7.80	8000	8772	212.50	2150	183.0	354.0	500.0	3490	1.27	1740	0	212.50	209.0	19.20	3.73	19.60	0.13
3-2098	40.0	8.36	17000	17365	193.75	5010	287.0	425.0	672.0	7920	0.75	2910			0.0	9.23	3.97	36.60	0.15
3-2302	36.0	8.29	18000	18908	189.38	5480	466.0	402.0	702.0	9390	3.73	2310	0	189.38	0.0	11.60	6.87	44.40	0.16
3-4738		8.34	18000	19802	519.40	5630	507.0	327.0	799.0	8630	4.75	3570			0.0	12.20	7.60	46.80	0.18
3-4744	33.0	8.40	13000	12974	331.25	3560	321.0	272.0	570.0	5560	3.25	2480			0.0	9.03	5.11	29.70	0.18
3-4894	36.0	8.42	13000	13499	332.50	3600	336.0	275.0	592.0	5940	2.68	2540			0.0	17.30	5.31	30.80	0.18
5-1685	30.0	7.90	16000	15779	122.50	4500	259.0	326.0	647.0	7660	1.15	2270	0	122.50	0.0	10.20	6.09	34.20	0.19
5-1714	22.0	9.11	20000			4120	814.0	6.3	292.0	8100	1.78	1050			0.0		3.86	28.70	0.32
5-3160	27.0		41000			10900	636.0	590.0	1700.0	22200		4500			0.0	2.99	3.12	64.10	0.09
6-1690	35.0	8.35	13000	13026	108.75	3600	455.0	222.0	554.0	6450		1660			0.0	5.92	3.31	27.80	0.11
6-1708	36.0	7.88	12000	12987	187.50	3500	381.0	327.0	551.0	6360	1.53	1740	0	187.50	0.0	8.25	3.37	27.70	0.12
6-1894	40.0	7.79	13000	12585	167.50	3400	343.0	308.0	546.0	6140	1.87	1720	0	167.50	0.0	6.85	3.35	27.70	0.12
6-1924	36.0	7.49	12000	12422	117.50	3400	324.0	267.0	530.0	6220	1.27	1580	0	117.50	0.0	6.98	3.23	26.80	0.12
6-1948	40.0	7.82	14000	14127	116.25	3930	356.0	281.0	596.0	7060	1.43	1800	0	116.25	0.0	7.81	3.70	31.10	0.14
AGSO 2		6.62	22000	21590	64.38	5800	463.0	371.0	977.0	11100	1.17		0	64.37	0.0	11.20	6.00	46.50	0.13
4939-16		4.09	146000			42000	1960.0	353.0	9940.0	76200	0.79	29200			0.0	1.81	3.29	167.00	32.00