HYDROLOGY OF THE ADELAIDE AREA

R. G. SHEPHERD

Department of Mines
South Australia —

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by

R.G. SHEPHERD
SENIOR GEOLOGIST
HYDROGEOLOGY SECTION

PLANS

INTRODUCTION

This discussion of the hydrology of the Adelaide region is confined, in general terms, to the occurrence, availability and salinity of surface and ground waters, with particular regard to shallow groundwaters. Other phases of the hydrologic cycle including precipitation are important aspects but are not considered here. The surface drainage system which has developed on the Eden Fault Block and its escarpment has determined the form and structure of the coastal plains, (Fig. I) which in their upper sediments provide storage in shallow aquifers for considerable bodies of ground water. The three streams traversing the plains add a material annual quota of intake to the aquifers but in addition intake from the short consequent streams in the vicinity the Eden and Burnside faults is probably large, although there is little quantitative data available.

The drainage pattern and the distribution of groundwaters according to salinities is shown in Figure II.

SURFACE WATERS

Almost all streams entering the Adelaide Plains are ephemeral and, even the larger ones, the Torrens and Sturt Rivers, have only very small summer flows and there is generally little or no flow across the Adelaide Plains. Flood flows in the Sturt River are controlled by a dam, designed to alleviate flooding in the south western suburbs.

In the Torrens River a small flow usually continues during the summer. Part of this water was used for irrigation of market gardens but the demand for this purpose is now very minor, as these activities have practically ceased in the western suburbs of Adelaide. However, the waters of Torrens Lake in the Adelaide area are used for some of the city gardens and lawns and to fill and maintain the level of artificial lakes in the east parklands.

Several of the larger stream channels are now concrete lined in the western part of the Adelaide Plains and in these most surface water flows to the sea or to the Torrens River, the only loss being through evaporation. Included in these is the Sturt River, and Brownhill Creek, which have now been straightened and the channels concrete lined.

All of the smaller escarpments consequent streams cease to flow shortly after rain ceases and their waters are lost by recharge to shallow groundwater or by transpiration. In some areas the waters of these streams are directed into larger streams or artificial drainage channels.

Salinity

Generally, salinities of surface waters are low, less than 500 milligrams per litre (m.g./l) but there are three main factors which may combine to cause its increase. These are:-

Time of Sampling - Water collected during late spring and summer or the first flows of winter are likely to have a higher salinity than in winter or early spring.

<u>Place of Sampling</u> - Salinity of surface streams generally increases in the direction of flow and those traversing the Adelaide Plains show such an increase from their hills catchment to the sea. However, the rate of increase would vary widely from stream to stream and would depend to a large extent on their flow and the geology of the catchment area. Table I shows a selection of sampling sites and the salinity of free flowing water in the various streams.

<u>Origin of Water</u> - At times, depending on local distribution of rainfall, a larger proportion of run-off may come from certain parts of the catchment area in the Adelaide Hills, possibly where weathering of the rocks is well advanced. Rocks which are strongly weathered or decomposed yield soluble products which may increase the salinity of streams traversing them.

Generally, salinity of surface water remains low until it reaches the low lying coastal fringe. In this area the waters are tidal and mingle with sea water, for example, where the Sturt River enters the Patawalonga Creek. The latter has a controlled outlet to the sea and salinity in the lower reaches normally approaches that of sea water; but may be considerably lower during periods of heavy winter flow in the Sturt River.

UNDERGROUND WATERS

General

Groundwater occurs as both pressure and non-pressure water within Tertiary to Recent sediments of the Adelaide Plains and also within Precambrian basement rocks in the Adelaide Hills. Small quantities of groundwater also occur in thin alluvial sand and gravel beds along the larger streams within the hills.

Adelaide Plains Basin

The Adelaide Plains basin which is part of the much larger St. Vincent basin occupies the greater part of the Metropolitan Area. It extends northward from Marino over the surface of the Para Block to the Torrens River, bounded on the east by the Burnside and Eden Faults. The basin continues north of the Torrens River between the coast and the Para Fault, and the area of interest, extends to beyond the Gawler River.

TABLE 1

Composition of Surface Waters

No.	Stream	Location	Total Soluble Salts mgm/litre	Sodium chloride mgm/litre
1	Torrens River	Kangaroo Creek	421	203
2	Torrens River	Weir (overflowing)	287	180
3	Torrens River	Below weir (drought)	888	490
4	Torrens River	Welland	1171	613
5	Millbrook Reservoir	Chain of Ponds	303	161
6	Hope Valley Reservoir	Hope Valley Hope Valley	305	125
7	Sturt River	Sturt	700	411
8	Fifth Creek	Lower gorge	321	138
9	Fourth Creek	Rostrevor	262	150
10	Third Creek	Magill	460	172
11	Second Creek	Burnside	259	162
12	First Creek	Burnside	391	142
13	Brownhill Creek	Mitcham	524	204

Sediments forming the basin are essentially flat lying, although there is a dip of about 1 in 350 towards the south and the beds thicken in that direction. The maximum thickness of all beds occurs beneath the western suburbs of Adelaide in the vicinity of Adelaide Airport, to the north, or downthrow side, of the Para Fault.

On the Para Fault Block the Tertiary sediments are much reduced in thickness. To the north-east of the city Tertiary marine sediments thin out and disappear with lower Tertiary non-marine lignitic sediments occurring near Hope Valley.

Details of the stratigraphy and aquifers of the Adelaide Plains Basin are given in Table II.

Pressure Aquifers

Within the Adelaide Plains there are three main pressure aquifers, which in their continuation northward into the Salisbury-Virginia area have been designated A, B and C in order of increasing depth. These aquifers are continuous throughout the Adelaide Plains west of the Para Fault. On the Para Fault Block all aquifers are thinner with aquifers A and B wedging out northeast of the city.

Aquifer A consists of Pliocene Dry Creek Sands together with the upper part of the Pt. Willunga beds above the Munno Para Clay. The latter is a semi-confining bed within the Port Willunga beds, with a maximum known thickness of 12 m. Aquifer B underlies this in the lower Pt. Willunga Beds. These two deep aquifers provide the irrigation supply for an extensive vegetable growing area on the Northern Adelaide Plains.

Aquifer C, comprised of sands of Lower Tertiary age, is not important west of the Para Fault because of its very considerable depth below the surface (488 metres at Grange). However, on the Para Fault Block, particularly east and north east of the city water supplies have been developed from Aquifer C. This is in areas where Aquifers A and B are missing or are negligible in thickness.

TABLE II

STRATIGRAPHIC SUMMARY OF TERTIARY - QUARTERNARY SUCCESSION, ADELAIDE PLAINS

GEOLOGICAL UNIT NAME	AGE	ENVIRONMENT OF DEPOSITION	OCCURRENCE	DESCRIPTION	MAX. THICKNESS	REMARKS
St. Kilda Formation	Recent	MARINE	Adjacent to present coast.	Stranded shell beds.	4 m	
Pooraka Clay	Pleistocene	ALLUVIAL	Whole of plains.	Sand, silt and clay.	3 m	
Glanville Formation	Pleistocene	MARINE	Adjacent to present coast.	Shell beds.	3 m	
Hindmarsh Clay	Pleistocene	FLUVIATILE, ALLUVIAL.	Whole of plains.	Clay, silt sand and gravel.	107 m	Thin aquifer[s] common.
Carisbrooke Sand.	Pliocene-Pleistocene	FLUVIATILE, ALLUVIAL.	Vicinity of rivers and Para Fault.	Yellow silt and sand.	52 m	Continuous with Aquifer "A" in some areas.
Hallett Cove Sandstone and Dry Creek Sand	Pliocene	MARINE	Mainly North West of Para fault. Restricted elsewhere.	Calcareous sandstone, limestone and sand fossiliferous.	68 m	Aquifer "A"

Pt. Willunga beds(upper)	Middle-Lower Miocene	MARINE	Plains south of Gawler River.	Fossiliferous sandy limestone.	38 m	
Munno Para Clay	Middle-Lower-Miocene	MARINE	Plains south of Gawler River.	Blue grey clay.	12 m	Semi-confining bed.
Pt. Willunga Beds(Lower)	Lower Miocene-Oligocene	MARINE	Whole of plains.	Fossiliferous sandy limestone.	171 m	Aquifer B
Blance Pt. Marls	Upper Eocene	MARINE	Whole of plains.	Marl, siltstone limestone.	119 m	Confining bed.
South Maslin Sands	Upper Eocene	Restricted Marine.	Whole of plains.	Poorly fossiliferous sands.	38 m)	Confining bed where present. Aquifer "C
Muloowurtie Clay	Middle-Upper-Eocene	Restricted Marine and non-Marine.	Missing in some areas. Penetrated in only 3 bores.	Silty calcareous clay. Confining bed where present.	40 m)	
North Maslin Sands.	Middle Eocene	Fluviatile estuarine.	Whole of plains. Penetrated in only 3 bores.	Sand and gravel.	31 m)	

Shallow Aquifers

These aquifers occur commonly in the Adelaide Plains, mainly within the Hindmarsh Clay formation and possibly also at higher stratigraphic levels, such as the Pooraka Clay. The aquifers are usually non-pressure and the water they contain is derived from local sources.

West of the Para Fault the shallow aquifers are well developed, particularly over a broad strip in the vicinity of the Torrens River and following the courses of other main streams. They consist essentially of fine to coarse sand and occasional gravel beds. In other areas, particularly in and near the city of Adelaide, the shallow aquifers are poorly developed and where sand beds occur they usually contain a considerable proportion of clay. This is because deposition of coarser materials normally occurred much closer to the Adelaide Hills.

Sand dunes (Semaphore Sands) in the coastal area northward from Grange contain small quantities of groundwater, which has been developed in the Semaphore area as a useful supplementary supply for garden watering. In the area east of the coastal dunes the groundwater table is at shallow depth, often less than 3 metres. In the more low lying areas in the vicinity of Port Reach the water table may be less than 1 metre and corresponds closely to surface water level in the channel. In general, with the exception of the coastal sand dunes, groundwater occurring in the area below the 8 metre contour is at a depth of 3 metres or less, and, in fact, in the more low lying areas it occurs very close to natural surface.

On the Para Fault Block shallow aquifers are well developed in the vicinity of the larger streams, including the Torrens and Sturt Rivers. Adjacent to these streams the aquifers consist of coarse sand, grading to gravel toward the Burnside escarpment. Sand and gravel have also been deposited along the courses of the smaller streams, including the numerous short, consequent streams which are generally less than 2.5 kilometres in length. Thin sand or coarse gravel beds, with an irregular distribution, occur along the foothills zone. Some of these contain water for short periods following rain, drying out each summer, while others contain permanent water.

Adjacent to the streams groundwater may occur at depths of 4.5-6 metres and occasionally at 1.5-3 metres. Perched water tables occur in several areas, particularly North Adelaide, where it is saline and commonly less than 3 metres from the surface.

Salinity of Pressure Aquifers

For Aquifers A and B, salinity in the area south of Port Road and west of the Para Fault is less than 1 000 m.g./l. For this reason these aquifers have been pumped extensively in the past to augment the water supply for Adelaide. The best quality groundwater of approximately 700 m.g./l occurs west of Adelaide where the Torrens River crosses the Para Fault. The Para Fault zone is apparently where much of the intake to the Tertiary aquifers occurs. Salinity increases markedly north of Port Road; within 1.5 kilometres it increases to approximately 3 000 m.g./l, reflecting lower permeability of the sediments and greater distance from intake areas.

A similar pattern has been observed in the Northern Adelaide Plains where water of less than 700 m.g./l occurs in the pressure aquifers in the vicinity of the Gawler and Little Para Rivers. Dry Creek, where it crosses the Para Fault apparently has not resulted in intake to the pressure aquifers, because salinity of the pressure aquifers of this area is not lower than in surrounding areas.

On the Para Fault Block salinity of pressure aquifers A and B ranges from 1 000 to 1 500 m.g./l in the southern and south western suburbs and salinity of water of Aquifer C in the north eastern suburbs is generally less than 1 000 m.g./l. In part of the Adelaide Plains, at North Adelaide, salinity of water within the Tertiary aquifers is high, up to 3 000 m.g./l. This is because it is a relatively high area where recharge can only occur locally and not from water of the River Torrens. Similar quality water occurs in the Northfield area, which is also a relatively high area where recharge of groundwater is from local rainfall.

Salinity of Shallow Aquifers

The pattern of waters in shallow aquifers is shown in Fig. II. Their composition is given in Table I.

The salinity of these aquifers reflects intake taking place along the stream courses. Salinities of less than 900 m.g./l occur in aquifers in the vicinity of Brown Hill Creek and other creeks traversing the Para Fault Block. West of the Para Fault salinity of the shallow aquifers is generally higher, with the better quality water ranging from 1 000 to 1 500 m.g./l, occurring near the Torrens River. Water with a salinity of 1 000-1 500 m.g./l also occurs over a limited area of coastal sand dunes north of Grange.

High salinity groundwater within Pleistocene - Recent sediments occurs near the Patawalonga Creek and near the Torrens River outlet. Relatively high salinity groundwater is also known to occur in the vicinity of Adelaide, and in the northern part of the Para Fault Block, for example at Northfield.

Salinity of shallow groundwater in the low lying coastal zone is also high, rising in places to more than 30 000 m.g./l and in the area west of a line from Kilburn to Henley Beach it usually exceeds 4 000 m.g./l.

In the Northern Adelaide Plains low salinity groundwater, generally less than 1 000 m.g./l occurs adjacent to the Gawler and Little Para Rivers. Some intake to a shallow aquifer occurs where Dry Creek traverses the Para Fault, where a salinity of less than 1 500 m.g./l is recorded.

Yields and Usage

Pressure Aquifers

Bores in the Tertiary aquifers of the Adelaide Plains may yield up to 38 litres per second but the average yield would be within the range 12.5-19 litres per second. In some areas the Pliocene sands of Aquifer A are unconsolidated, and present problems in development. In these cases if a suitable sand free supply cannot be obtained then it is necessary to deepen into the lower part of Aquifer A or into Aquifer B.

In the Northern Adelaide Plains, north of Gepps Cross, groundwater is used extensively for irrigation of market gardens and fodder crops. In the southern Adelaide Plains, large quantities probably are being pumped for use in industry and for the watering of golf courses and recreation grounds.

On occasions it has been necessary to augment the Metropolitan water supply from groundwater sources. The last occasion on which this occurred was in the 1967-68 summer, following an exceedingly dry year. During the period September 1967 to April 1968 up to 40 Government bores were pumped for a total of 9,470,150 cubic metres.

Shallow Aquifers

Few records are available for yields from shallow aquifers as most bores were drilled originally for stock supplies or for the watering of small gardens. Few bores are known to yield more than 6 litres per second and these are located in the most favourable area as regards recharge.

In the Northern Adelaide Plains shallow aquifers are pumped for market gardens, mainly near the Gawler and Little Para Rivers. In the Adelaide area little use is now made of the water of shallow aquifers. However, several bores in the eastern suburbs, yielding up to 2.5 litres per second are used for oval watering.

ADELAIDE HILLS

General

Within the Adelaide System of the Mt. Lofty Ranges, groundwater occurs in various rocky types including sandstone, quartzite, dolomite and slate. The rocks trend generally northerly, and in places a well developed joint system has developed. Apart from the Para, Eden and Burnside faults there are several sub-parallel faults further east.

Water is stored in joints and other openings and occasionally it is under pressure. The best aquifers are within the Aldgate Sandstone particularly where jointing and fracturing is well developed and yields of 25 litres per second or more have been obtained. Other rock types such as dolomite and slate generally yield smaller supplies, normally less than 5 litres per second.

Within the Adelaide Hills groundwater is used for market gardening in areas where quality is good and yields are sufficient. For example at Piccadilly, yields are not generally large but 4-5 litres per second are obtained in a number of bores and occasionally yields up to 12.5 litres per second are obtained. In this area and, in much of the Adelaide Hills, where water is used for irrigation there is some evidence of declining water levels. No actual data are available but landholders in some of the more heavily pumped areas report declining water levels.

Occasionally, in fault zones large yields are obtained; for example, a bore in the Burnside Fault zone was reported to yield 25 litres per second of low salinity water. Such yields are unusual within the basement rocks of the hills and would only be obtained in areas where jointing or fracturing results in a relatively high permeability of the rock mass.

Salinity

The salinity of groundwater in Adelaide System Rocks ranges over wide limits and depends largely on the rocks in which it is stored, the degree of weathering and on recharge conditions.

For example salinity of water in the Aldgate Sandstone in areas of high rainfall may be as low as 100 m.g./l. On the other hand salinity ranges up to 3 000 m.g./l in areas of unjointed slate in a lower rainfall area, for example in the O'Halloran Hill-Morphett Vale area.

Apart from stock purposes little use is made of higher salinity groundwater, and no data are available on yields. Few have been tested and most stock bores are equipped with windmills pumping at 0.3-0.5 litres per second.

R.G. Shepherd

R.G. SHEPHERD
SENIOR GEOLOGIST
HYDROGEOLOGY SECTION

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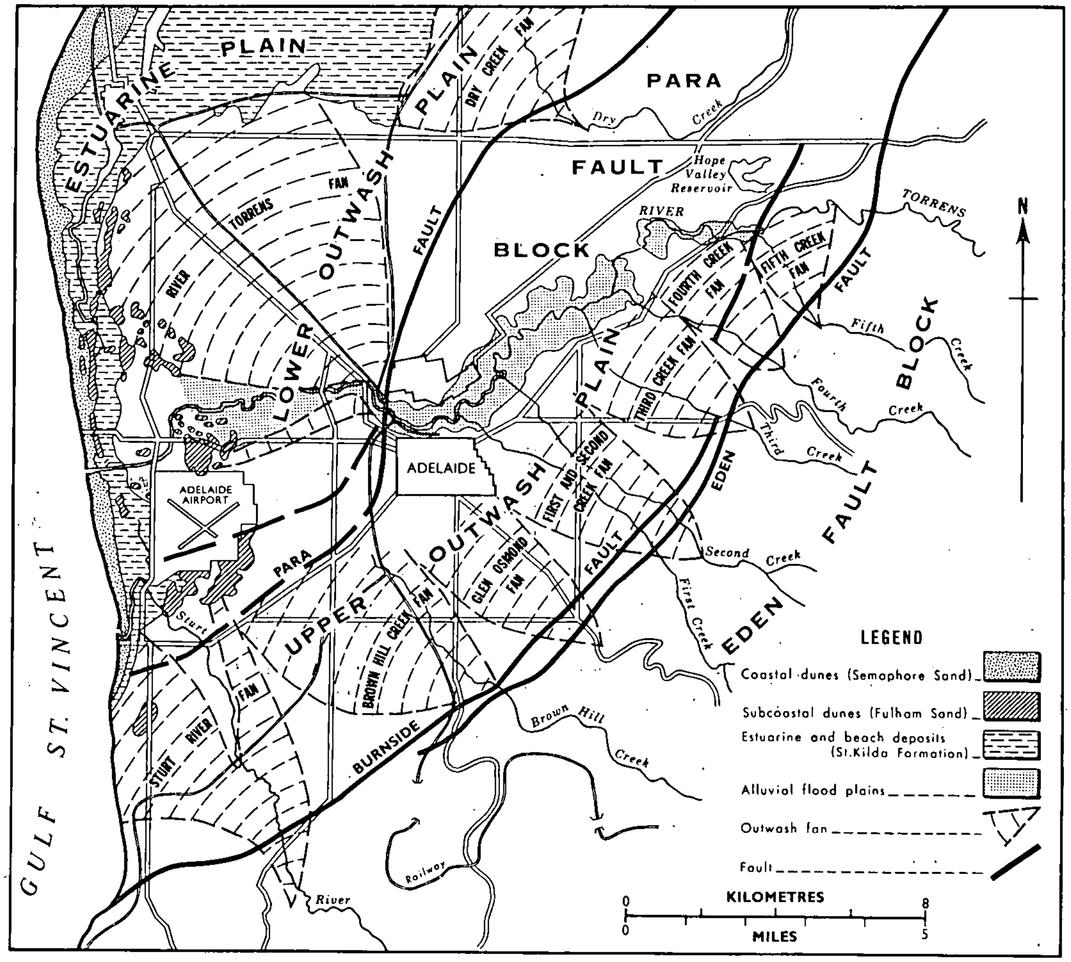

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Drn. / Ckd.	
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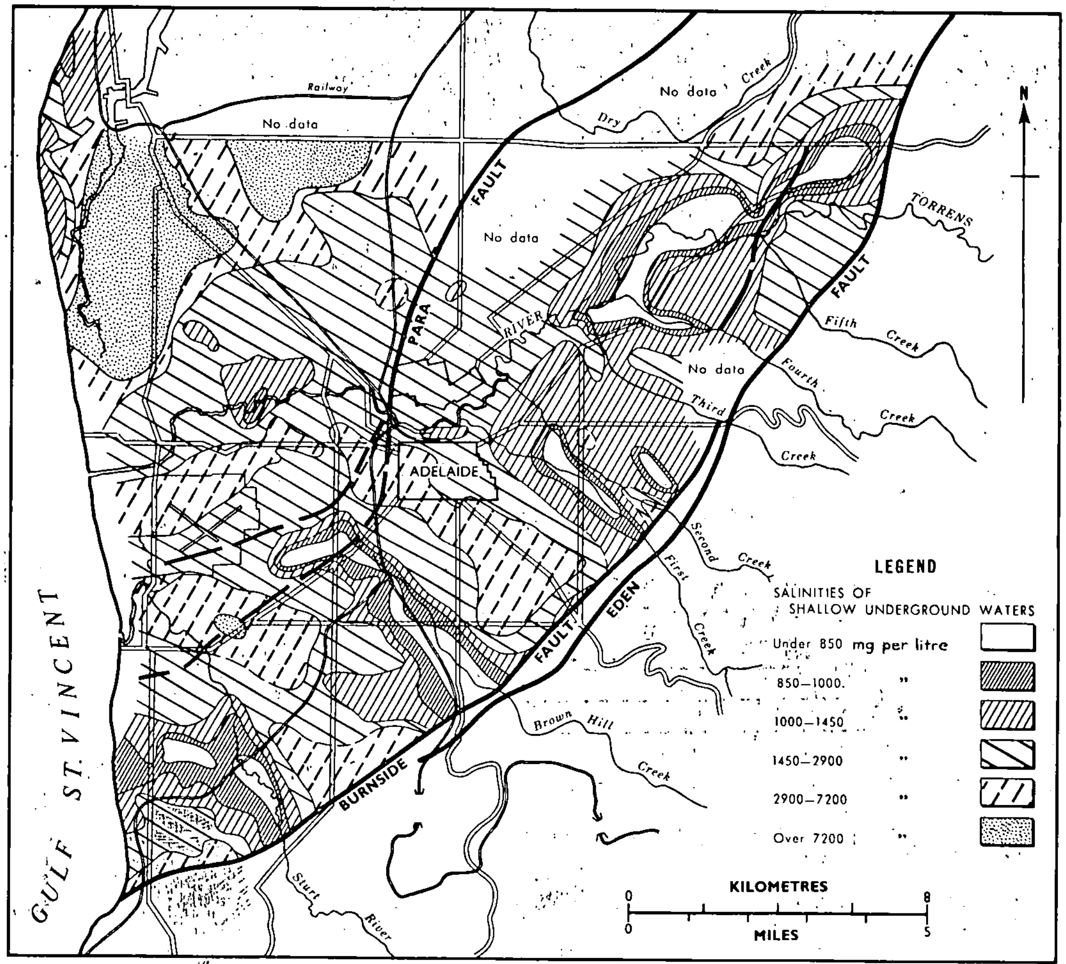

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