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Groundwater study of the Goomalling townsite

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GROUNDWATER STUDY OF THE GOOMALLING TOWNSITE

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Disclaimer

The contents of this report were based on the best available information at the time of publication. It is based in part on various assumptions and predictions. Conditions may change over time and conclusions should be interpreted in the light of the latest information available.

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Summary

A groundwater study was carried out in the townsite of Goomalling in February 2002. The study consisted of a drilling program to install a network of groundwater monitoring bores.

Drilling was undertaken at seven sites, however casing was only installed at five sites. At two sites competent crystalline bedrock was intersected at less than 2 metres depth which was considered too shallow to warrant installation of casing.

Watertable observation bores were installed at five sites, however piezometers were only installed at two sites where drilling progressed deeper than 10 metres. Depth to competent crystalline bedrock ranged from less than 1 metre to 14 metres at the sites drilled.

Groundwater was intersected at only three of the sites where casing was installed. Watertable depth ranged from about 3 metres below the ground surface along the main road (Railway Terrace) a few blocks west of the hotel to more than 5 metres below ground surface near the drainage line running through the caravan park.

Groundwater salinities ranged from about 280 milliSiemens per metre (~1400 milligrams per litre) at the site west of the hotel to about 840 mS/m (~4600 milligrams per litre) in the caravan park.

Goomalling townsite sits atop a dome-like hill where a skeletal regolith profile, typically less than 6 metres thick, overlies crystalline bedrock. The risk of salinity appears negligible. There is considerable topographic relief from the midst of the townsite on the crest of the hill to the drainage line north of the railway line (~20 m vertical relief over a distance of 700 metres). These gradients assist profile drainage. Most of the townsite occupies a low risk landscape position.

Prior to the installation of deep sewerage it is readily conceivable that septic disposal would have saturated the skeletal profile causing seeps and waterlogging. The installation of deep sewerage has reportedly eliminated these problems. However, with the limited storage capacity of such a thin regolith, temporary waterlogging may be a problem during particularly wet periods.

It is concluded that Goomalling has negligible salinity risk and recommended that no further action be adopted beyond continued groundwater monitoring.

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1. Introduction and background

This report describes a groundwater study of the Goomalling townsite undertaken by the Rural Towns Program. It was part of a larger investigation (called the Community Bores Project) that included nine towns in 2002. The investigations aimed to determine salinity risk and identify salinity management options.

The Goomalling study consisted of a drilling program to establish a groundwater monitoring network. This report documents background information for Goomalling and its catchment (Section 1); the hydrogeological investigations (Section 2); conclusions on the town's salinity risk (Section 3); and recommendations for improved water management (Section 4).

1.1 The town of Goomalling

Goomalling is located about 120 kilometres north-east of Perth in the Central Wheatbelt of Western Australia (Figure 1-1). The population of the townsite is about 600 (RAC 1999) with 1018 residents in the Shire of Goomalling (LGMA 2000).

Agriculture is the principal activity in the surrounding district with production dominated by wheat followed by sheep.

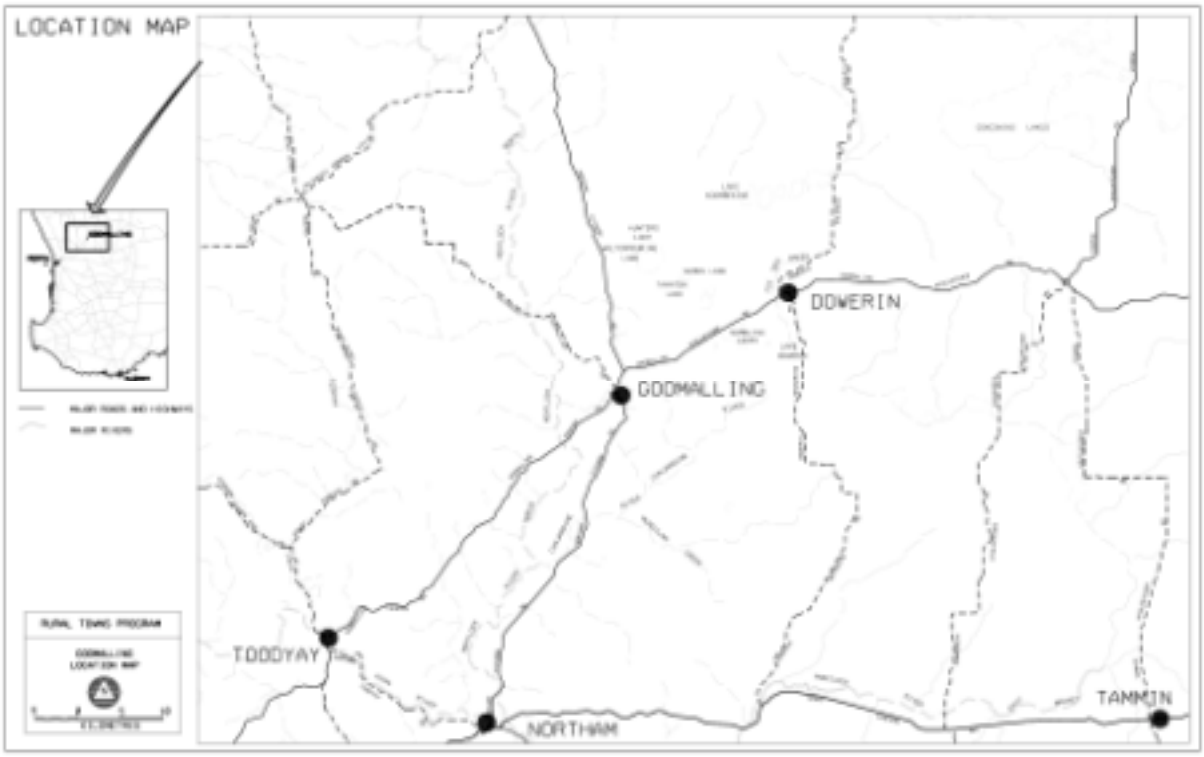

Figure 1-1. Location of Goomalling townsite

1.2 Description of the catchment

Goomalling is within the Mortlock River catchment. The townsite straddles a watershed. Figure 1-2 shows an image of the Digital Elevation Model (DEM) enhanced using computer-generated sun shading along with some cadastral information and surface elevation contours. Goomalling townsite occupies most of the hill in the central part of the image. Relict micro-relief on the north-facing slope of the DEM coincides with the main residential area.

Figure 1-3 shows the location of groundwater monitoring sites installed throughout the townsite from previous investigations (prefixed 00) and as part of this investigation (prefixed 02). Surface elevation contours show that most of the surface flow generated from within the townsite would shed to the north or west.

1.3 Geology

Goomalling lies in the midst of an approximately 4 kilometre wide northerly striking band of migmatite (Wilde and Low 1978). Migmatite is a rock displaying both igneous and metamorphic characteristics, typically showing large crystals and laminar flow structure (Press and Siever 1978). The term is used by Wilde and Low (1978) to describe gneissic rocks intimately admixed with granite.

Wilde and Low (1978) also mapped a large ultramafic dyke striking north through the townsite. This dyke may be showing up as a resistive ridge in the DEM (Figure 1-2) that is particularly prominent directly north of the townsite. Scattered dolerite rocks are common on vacant land within the townsite and two of the drill sites (02GT03 and 02GT05) intersected dolerite.

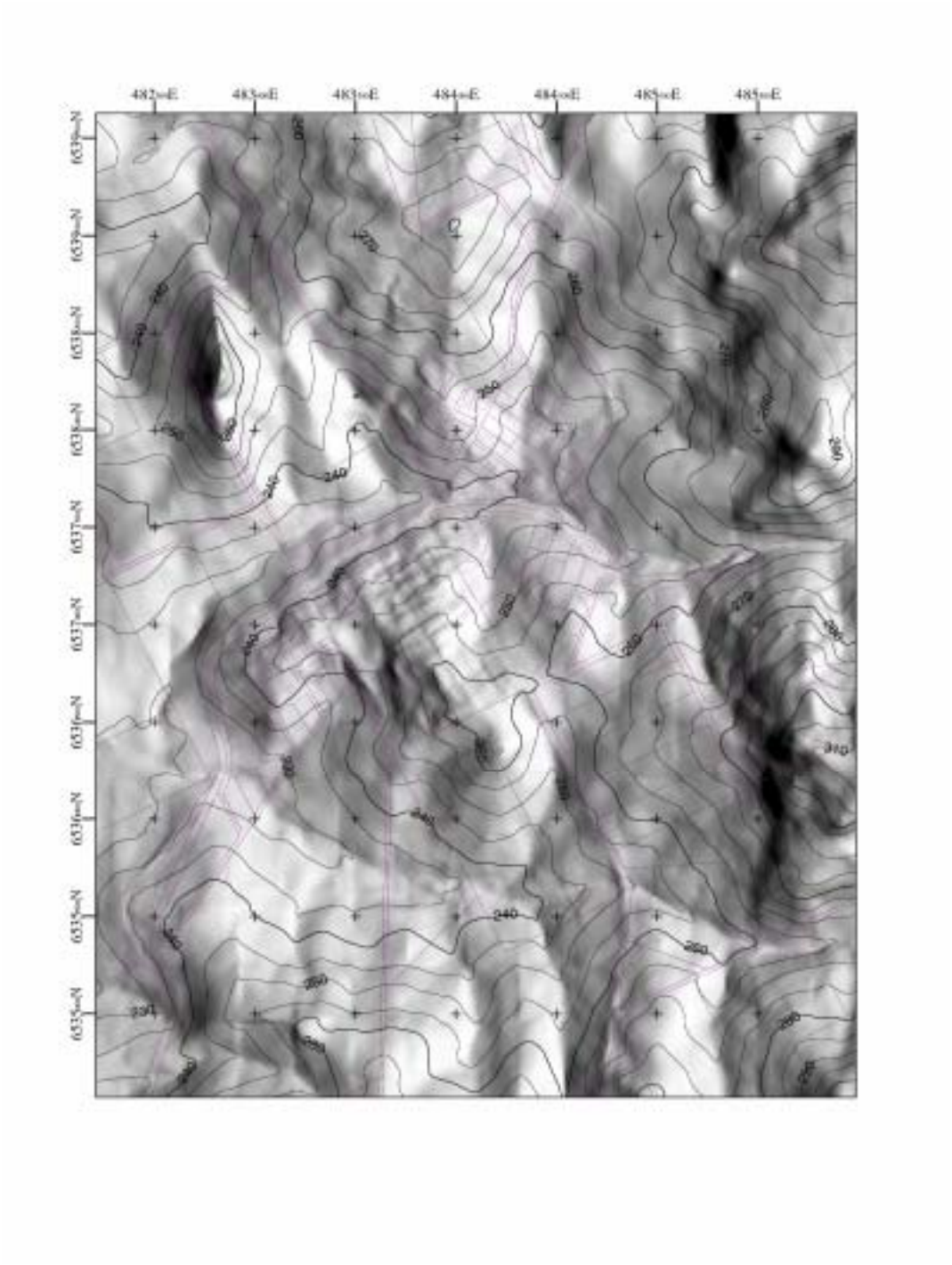

Figure 1-2. Shade-enhanced image of DEM (sun angle: azimuth = 82^0, elevation = 56^0) with surface elevation contours (Australian Height Datum) at 5-metre intervals and some cadastral information. Goomalling is located on the hill in the centre.

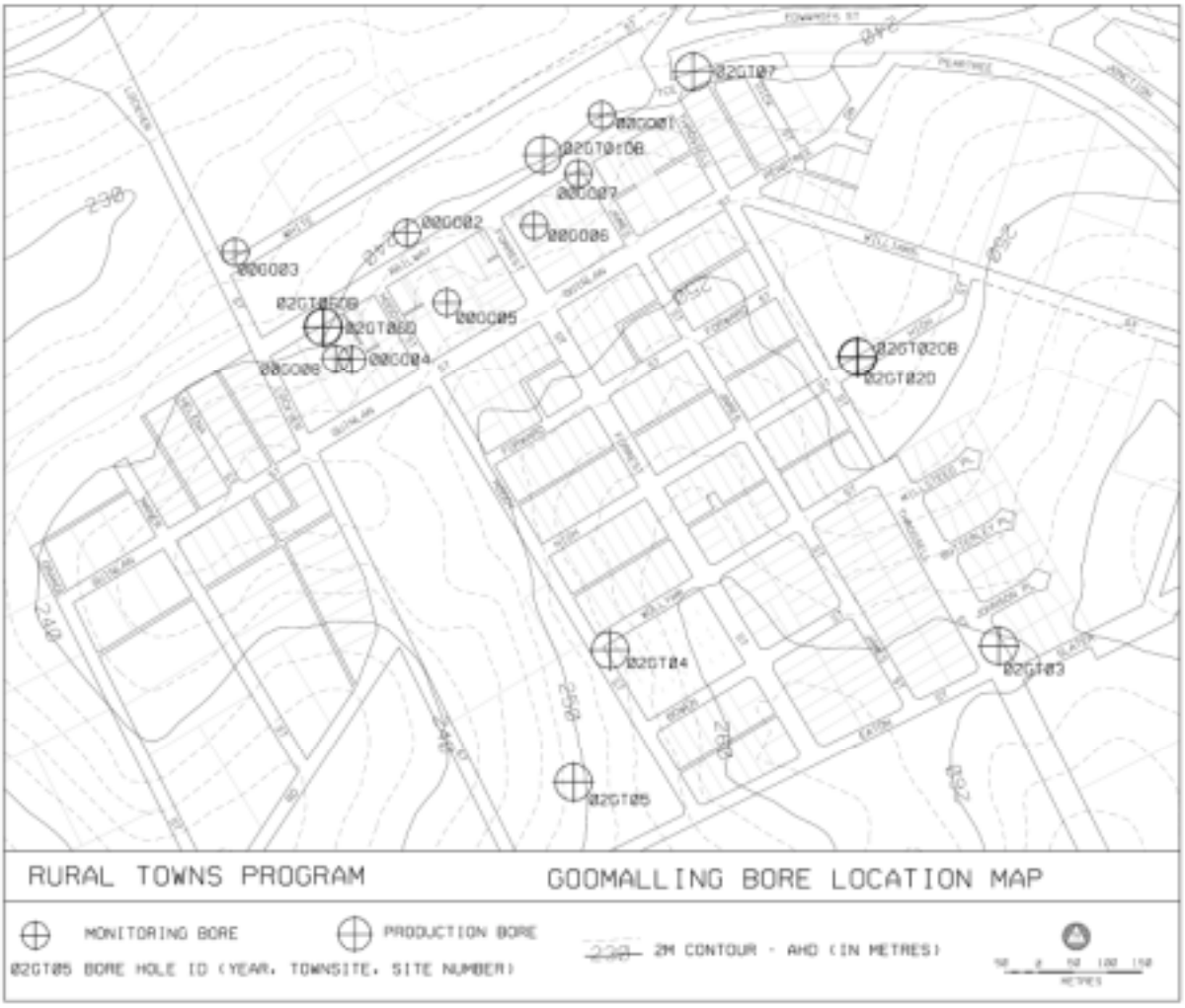

Figure 1-3. Location of bores within Goomalling townsite

1.4 Climate

The climate is typical of a warm temperate to semi-arid region with dominantly winter rainfall and hot dry summers. Goomalling receives an annual average of 368 mm, of which 77% (283 mm) falls from April to September. Summer rainfall events can be significant. The highest daily rainfall on record is 106 mm on 29 January 1990 (Bureau of Meteorology 2002).

The last three years have been significantly drier than the long-term average. Growing season rainfall (April to September) was more than 100 mm below average in 2000 and 2002 (Table 1-1).

Table 1-1. Comparison of long-term average seasonal and annual rainfall with 2000 to 2002

Period	Rainfall (mm)			
	Average	2000	2001	2002
April-September	283	179	195	181
Annual	368	273	301	260

1.5 Town water supply and disposal

Goomalling is supplied with scheme water from the Goldfields pipeline. Water restrictions imposed in September 2001 are still in force limiting sprinkler use to two days per week.

A deep sewerage scheme was initiated in 1978 and became functional in 1979-80. Sewage is pumped up to tanks north-east of the townsite. From there it is incorporated with a storm water system where it is mixed in open ponds and further treated with chlorine if required. Treated water is returned to the townsite where it used for irrigation, particularly on the oval (Shire of Goomalling, personal communication).

2. Hydrogeology investigation

2.1 Previous investigations

Observation bores were installed at eight sites in 2000. All sites are located in lower slope positions between Quinlan and White Streets with bore names prefixed with 00GO (Figure 1-3).

These bores were monitored monthly by Vanessa Malcolm, Community Landcare Coordinator, throughout the 2001 growing season. Since February 2002, monitoring has been carried out by the Rural Towns Program on a quarterly basis with results stored in the Agbores database.

The data set is limited by the short period of monitoring, however all sites indicate declining groundwater levels from 2001 to 2002, consistent with expected response to climate (see Table 1-1). In August 2002 the depth to watertable observed in these bores ranged from 2.2 to 4.3 metres below the ground surface at the monitoring sites and groundwater quality ranged from 240 to 1610 milliSiemens per metre (~1300 to 8800 milligrams per litre).

2.2 Method

Drilling was carried out on 4 and 5 February 2002. Two piezometers (02GT02D and 02GT06D) and five observation bores (02GT01OB, 02GT02OB, 02GT03OB, 02GT04OB and 02GT06OB) were installed at five sites (Figure 2-1). At two sites, (02GT05 and 02GT07), drilling terminated on competent crystalline bedrock at less than 2 metres and no casing was installed.

2.2.1 Drill site selection

Drill site selection was based on access for the rig; long-term protection of bore headworks; and suitable spacing of monitoring sites to accomplish the aims of the investigation.

2.2.2 Drilling methods

Austral Drilling Services were contracted to drill the sites and install casing to construct piezometers and observation bores. The drilling method was reverse circulation air core with a 123 mm drill bit diameter.

2.2.3 Bore construction

Bores were constructed with 50 mm-diameter class 12 PVC casing with class 18 PVC end caps. The bottom end caps are 40 mm and were inserted inside the casing. The bottom end caps of every observation bore had four or five 6.5 mm diameter holes drilled through to ensure the casing and end cap completely drains

if the watertable recedes below the cased depth. The casing intake section was machine slotted over a 2-metre interval at one end of a 6 metre length. Hence the slotted intake section is a standard 2 metres for all observation bores and piezometers.

The PVC casing was inserted down the inner tube of the drill rods at the end of drilling. The drill rods were then pulled and the PVC casing was cut with 0.6 metres protruding above ground level.

The annulus around the slotted intake section was packed with 8-16 gravel (about 1.6 to 3.2 mm diameter). Bentonite pellets were used to seal the annulus above the slotted intake section. The annulus was then back-filled to ground surface with 8-16 gravel.

Bore headworks were completed by sleeving a lockable steel collar over the protruding PVC casing. The steel collar is secured in cement and padlocked using key number 581. Table 2-1 provides location and construction details for all sites drilled as part of this investigation.

2.2.4 Drill sample analyses

Drill samples were collected and described over 1 metre intervals during drilling. Compiled drill logs are presented in Appendix 1.

2.2.5 Groundwater monitoring and sample analyses

The Department of Agriculture commenced routine monitoring on 19 March 2002. Monitoring was initially undertaken at six-weekly intervals. After three months monitoring frequency was reduced to quarterly.

Depth to groundwater and electrical conductivity measurements are taken for all bores including those drilled in 2000. Groundwater pH is measured once a year. Results are stored on the AgBores database.

2.2.6 Surveying

Locations (eastings and northings) and elevations of groundwater monitoring sites were surveyed using a differential global positioning system. Positions are reported in the Australian Geodetic Datum of 1994 (GDA94).

Each site was surveyed twice, on completely separate occasions, and the largest difference in values obtained was within 5 centimetres. Survey data is included in Table 2-1.

Table 2-1. Drill site location and bore construction details (groundwater depth and electrical conductivity measurements recorded on 19 March 2002; yield estimates performed at the completion of drilling and casing installation)

Drill hole	Ground elevation above AHD (m)	Depth drilled (m)	Screen interval (m)	Groundwater depth below surface (m)	Electrical conductivity (mS/m)	Airlift estimated yield (L/sec)
02GT01OB	239.53	5	2.67–4.67	Dry	na	na
02GT02D	246.77	14	10.94–12.94	5.32	835	0.04
02GT02OB		5	3.31–5.31	Dry	na	na
02GT03OB	260.24	5	2.78–4.78	Dry	na	na
02GT04OB	253.40	7	4.03–6.03	4.34	614	nil
02GT05	248.98	2	abandoned	na	na	na
02GT06D	239.03	10	7.12–9.12	3.24	288	0.01
02GT06OB		5	3.41–5.41	3.27	284	nil
02GT07	238.08	<1	abandoned	na	na	na

2.3 Results

2.3.1 Profile descriptions

At most drill sites the profile is skeletal with typically only a metre of soil profile overlying saprolite grits. The saprolite grits consist of fresh granitic rock fragments and represent a transitional zone of partial weathering. This zone grades into competent crystalline (granitic) bedrock in which groundwater is absent.

Drilling proceeded to 10 metres at site 02GT06 (west of the hotel on Railway Terrace) and the deepest profile intersected was 14 metres at site 02GT02 (in the caravan park). At both of these sites the profile consists of 1 metre of soil overlying a zone of deeply weathered gritty clay saprolite. The gritty clay grades with increasing depth into a zone of saprolite grits above competent crystalline bedrock.

Detailed drill logs are presented in Appendix 1 and depth drilled at each site is listed in Table 2-1. Figure 2-1 shows a cross-section constructed from drilling results and a conceptual model of the profile. The section indicates the profile across the southern part of town from site 02GT03 to 02GT04, then along the western edge of town to site 02GT06 and beyond to the drainage line north of the railway track.

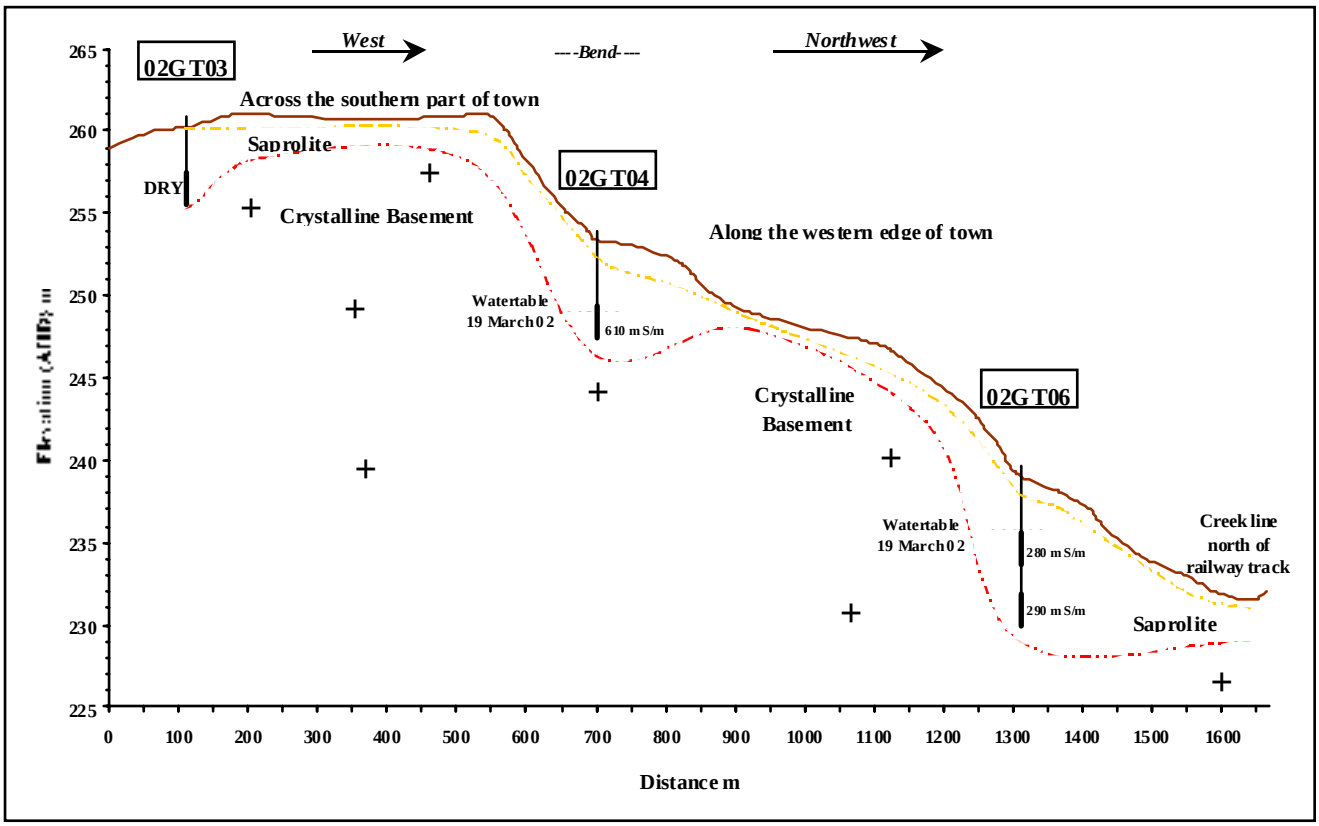

Figure 2-1: Cross-section constructed from drilling results and conceptual model of profile

2.3.2 Groundwater data

2.3.2.1 Groundwater levels

The depth to groundwater measured on 19 March 2002 is listed in Table 2-1. Groundwater was intersected at three of the five sites where PVC casing was installed.

The depth to groundwater exceeded 3 metres at all sites where a groundwater system was intersected. The shallowest groundwater level was 3.24 metres below the surface at site 02GT06 on Railway Terrace west of the hotel (Table 2-1).

Table 2-2 lists the depth to groundwater recorded on 19 August 2002 for the entire suite of monitoring bores installed in 2000 and 2002.

2.3.2.2 Groundwater electrical conductivity

Electrical conductivity values recorded on 19 March 2002 are listed in Table 2-1. Groundwater was brackish measuring around 280 to 840 milliSiemens per metre (1500 to 4600 milligrams per litre).

Table 2-2 lists the electrical conductivity recorded on 19 August 2002 for the entire suite of monitoring bores installed in 2000 and 2002.

2.3.2.3 Groundwater pH

Groundwater pH was measured on 19 August 2002. Measurements ranged from slightly acid to slightly alkaline and values for all monitoring bores installed in 2000 and 2002 are listed in Table 2-2.

Table 2-2. Groundwater depth, electrical conductivity and pH values recorded on 19 August 2002 for all monitoring bores installed in 2000 and 2002

Bore	Groundwater depth below surface (m)	Electrical conductivity (mS/m)	pH
00GO01	4.06	242	7.1
00GO02	2.34	785	6.7
00GO03	3.17	563	7.3
00GO04	2.20	244	6.9
00GO05	4.28	1234	6.8
00GO06	2.61	1606	6.9
00GO07	7.07	982	7.2
00GO08	3.95	551	7.0
02GO01OB	Dry	N/a	N/a
02GO02D	5.46	814	6.8
02GO02OB	Dry	N/a	N/a
02GO03OB	Dry	N/a	N/a
02GO04OB	4.65	609	7.1
02GO06D	3.62	265	6.5
02GO06OB	3.66	522	6.5

2.4 Interpretation and discussion of results

This section presents interpretation of the recharge, groundwater flow and discharge processes affecting Goomalling, based on the limited available information.

2.4.1 Recharge

Goomalling's upper landscape position dictates that sources of groundwater recharge only occur within the town itself. Within the townsite, water can enter the profile by direct infiltration of rainfall, infiltration of surface water run-off redistributed locally within the townsite and from water imported for residential use. Water used for gardens, parks, reserves and ovals is a potential source of recharge.

Prior to the installation of deep sewerage it is likely that significant point source recharge occurred via disposal of waste water into septic tanks and leach drains.

2.4.2 Groundwater flow systems

Beneath Goomalling, groundwater occurs in isolated and discrete pockets where the depth of weathering is sufficient to support the accumulation and persistence of groundwater.

Conceptually, Goomalling townsite can be considered to straddle a dome-like hill of granitic bedrock with a skeletal veneer of regolith and soil profile. Groundwater is confined to individual and isolated 'gnamma' holes within the rounded granitic hill. Individual holes may fill up generating surface seeps but do not have groundwater connection.

2.4.3 Assessment of salinity risk

The risk of salinity appears to be negligible. Most of Goomalling townsite occupies a low risk landscape position.

There is considerable topographic relief from the midst of the townsite area on the hill crest to the drainage line north of the railway line (~20 metres vertical relief over 700 metres). These gradients assist profile drainage.

Where pockets of groundwater are present, the depth to groundwater is typically greater than 3 metres. However, at three monitoring sites installed in 2000, the depth to groundwater was between 2 and 3 metres in August 2002 (00GO02, 00GO04 and 00GO06, Figure 1-3).

Prior to the installation of deep sewerage it is conceivable that septic disposal would have saturated the skeletal profile causing seeps and waterlogging. The installation of deep sewerage has reportedly eliminated these problems (C. Kerp, personal communication 2002).

However, the limited storage capacity of a thin regolith throughout the townsite is a waterlogging hazard. Temporary waterlogging may be an issue during particularly wet periods. This is not readily managed beyond alleviating other sources of excess water such as septic and leach drains, which Goomalling Shire has already implemented. Considering Goomalling's landscape position and gradients that would assist profile drainage, waterlogging would not be expected to persist unreasonably beyond the wet period that might cause it.

3. Conclusions

Goomalling appears to have negligible risk of salinity. The townsite straddles a dome-like hill of granitic bedrock with only a skeletal veneer of regolith and soil.

Groundwater occurs in small, discrete and isolated pockets. Where groundwater is present, it is typically more than 3 metres below the surface with groundwater salinity typically ranging from about 240 to 1600 milliSiemens per metre.

The thin regolith profile throughout Goomalling is prone to saturation from particularly wet conditions. However, profile drainage would be assisted by the towns landscape position and considerable gradients and waterlogging would not be expected to persist unreasonably beyond the wet period that may cause it.

4. Recommendations

Although Goomalling does not have a salinity problem, some improved water management would have other benefits (e.g. reduced water supply costs, less waste of rainfall, less infrastructure damage from surface water) and so should be considered.

Ways to improve water management within the townsite include:

- checking for and mending leaks from water pipes, pools, dams, drains and culverts;
- monitoring the amount of water required by gardens, parks and sports grounds and avoiding over-watering;
- preventing surface water from ponding in areas where it may become recharge;
- growing perennials on any bare land (including disused sand and gravel pits) and grassed areas.

Continued groundwater monitoring is recommended to confirm that salinity poses negligible risk in Goomalling townsite.

5. Acknowledgments

Louise Hopgood coordinated and initiated this groundwater study of Goomalling townsite. Jim Prince collected survey data. David Robinson prepared Figures 1-1 and 1-3. Ed Solin continues to collect groundwater data.

6. References

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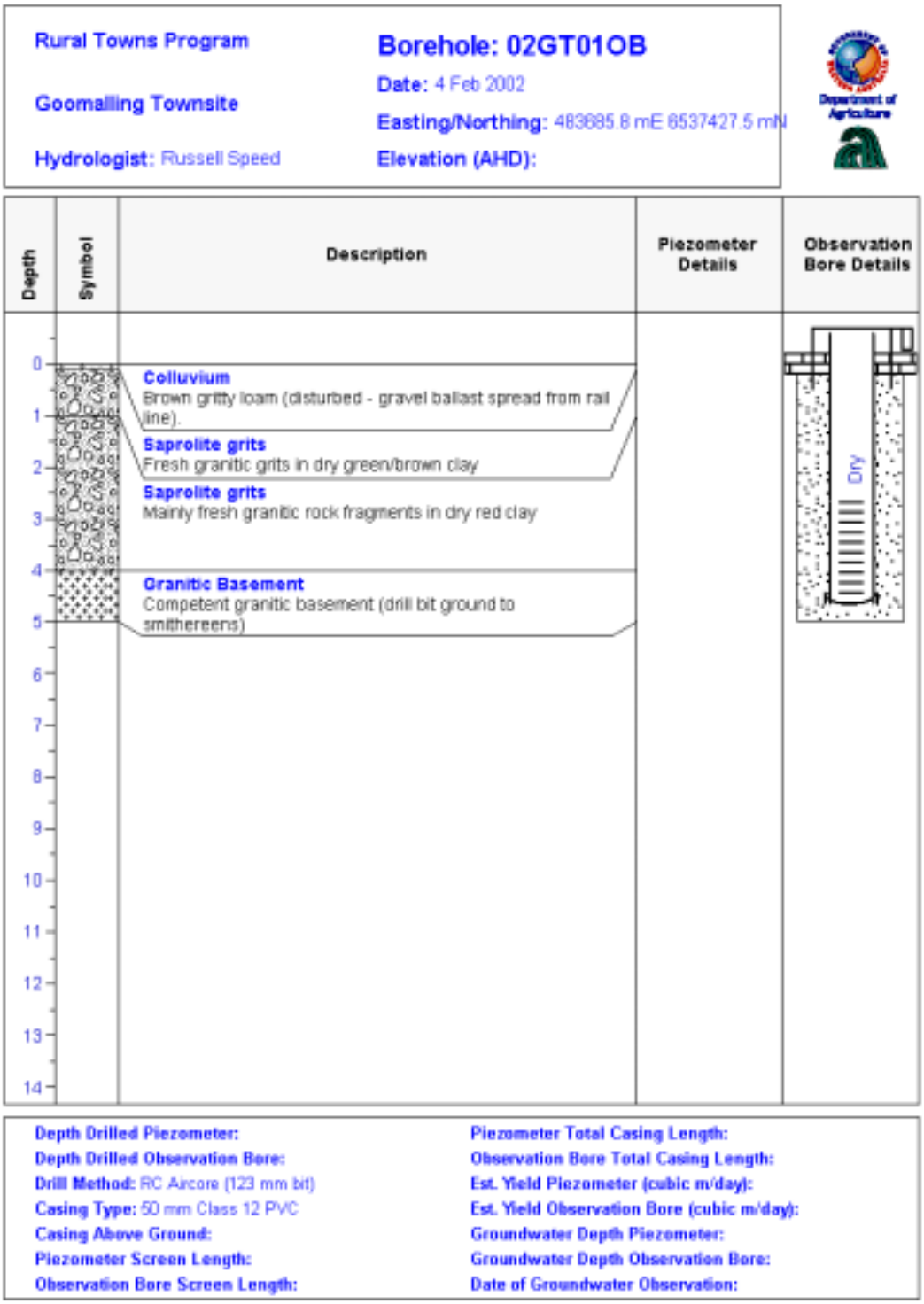
Appendix: Drill logs and bore construction details

The following pages contain drill logs for the five sites where casing was installed in 2002. They include details about the depth of drilling, the nature of the profile intersected, bore construction details, and groundwater yields, depth and quality.



Borehole: 02GT02D

Project: Rural Towns
Location: Goomalling Townsite
Hydrologist: Russell Speed
Date: 5 Feb 2002
Easting/Northing: 484143.1 mE 6537134.0 mN
AHD: 246.8 m

Depth	Symbol	Description	Hydrogeology	Well Completion Details
0–1		**Soil** Brown clay loam		835 mS/m
1–2		**Colluvium** Yellow-brown loamy clay		
2–5		**Colluvium** Yellow-brown clay		
5–8		**Saprolite** White indurated saprolite with fine gritty yellow clay (grits <1mm).		
8–10		**Saprolite** Pale yellow fine gritty clay - some induration (= core recovery).		
10–11		**Saprolite grits**		
11–13		**Saprock**		
13–14		**Crystalline Basement**		

Depth Drilled (m): 14 m
Drill Method: RC Aircore (123 mm bit)
Depth to Water (m): 5.32 (02GT02OB = Dry)
Estimated Yield (L/s): 0.04 L/s
Casing Type: 50 mm Class 12 PVC
Casing Above Ground (m): 0.60 m
Casing Total Length (m): 13.54 m (02GT02OB = 5.91)
Screen (m): 2.0 m

Borehole: 02GT03OB

Project: Rural Towns
Location: Goomalling Townsite
Hydrologist: Russell Speed
Date: 5 Feb 2002
Easting/Northing: 484347.9 mE 6536714.3 mN
AHD: 260.24

Depth	Symbol	Description	Hydrogeology	Well Completion Details
0–1		**Soil** Red brown earth		Dry
1–2		**Saprolite** Red brown earth with abundant fresh (mainly dolerite) rock fragments		
2–5		**Saprolite** Light brown grey dolerite saprolite - partially competent - becoming harder and fresher with depth		
5–6		**Crystalline Basement** Dolerite		

Depth Drilled (m): 5 m
Drill Method: RC Aircore (123 mm bit)
Depth to Water (m): Dry
Estimated Yield (L/s): nil
Casing Type: 50 mm Class 12 PVC
Casing Above Ground (m): 0.60 m
Casing Total Length (m): 5.38 m
Screen (m): 2.0 m

Borehole: 02GT04OB

Project: Rural Towns
Location: Goomalling Townsite
Hydrologist: Russell Speed
Date: 5 Feb 2002
Easting/Northing: 483783.4 mE 6536708.5 mN
AHD: 253.40 m

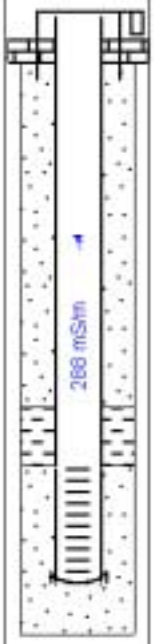
Depth	Symbol	Description	Hydrogeology	Well Completion Details
0–1		**Soil** Grey brown sandy loam		
1–2		**Colluvium** Light brown gravelly loam (gravel composed of granitic fragments)		
2–7		**Saprolite** Granitic saprolite grits/saprock (grit size coarse sand). Moist from 3 m. From 4 - 5 and 6 - 7, more rock fragments.		614 mS/m
7–8		**Crystalline Basement**		

Depth Drilled (m): 7 m
Drill Method: RC Aircore (123 mm bit)
Depth to Water (m): 4.34
Estimated Yield (L/s): n/a
Casing Type: 50 mm Class 12 PVC
Casing Above Ground (m): 0.60 m
Casing Total Length (m): 6.63 m
Screen (m): 2.0 m

Borehole: 02GT06D

Project: Rural Towns
Location: Goomalling Townsite
Hydrologist: Russell Speed
Date: 5 Feb 2002
Easting/Northing: 483367.6 mE 6537177.7 mN
AHD: 239.03

Depth	Symbol	Description	Hydrogeology	Well Completion Details
0–1		**Surface** Light brown sandy loam (fill ?).		
1–2		**Colluvium** Gravelly brown loam (gravel = granitic fragments).		
2–3		**Saprolite** Indurated granitic saprolite.		
3–4		**Saprolite** Grading to reddy brown gritty clay.		
4–5		**Saprolite** Grading to moist grey gritty clay (grits 2 - 4 mm.)		
5–6		**Saprolite** Greeny yellow brown clay with abundant fresh (quartz) fragments.		
6–10		**Saprolite** Dark greeny grey clay. Core fragments showing mica rich crystalline texture.		
10–11		**Crystalline Basement**		



Depth Drilled (m): 10
Drill Method: RC Aircore (123 mm bit)
Depth to Water (m): 3.24 m (02GT06OB = 3.27)
Estimated Yield (L/s): 0.009 L/s
Casing Type: 50 mm Class 12 PVC
Casing Above Ground (m): 0.60 m
Casing Total Length (m): 9.72 m (02GT06OB = 6.01 m)
Screen (m): 2.0 m