TECHNICAL NOTE 2012/03

Department for Environment, Water and Natural Resources

SOUTH EAST TOWN WATER SUPPLY – KALANGADOO TWS 4 – KALANGADOO, SOUTH AUSTRALIA

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INTRODUCTION

In early 2011 the former Department for Water (DFW)), now the Department for Environment, Water and Natural Resources (DEWNR), was contracted by the South Australian Water Corporation (SA Water) to drill and construct a production well for the township of Kalangadoo in the South East region of South Australia, a region also known as the Limestone Coast. This well was part of a program of work undertaken during the first half of 2012 which also included the drilling and construction of production wells at Millicent, Mount Burr, Naracoorte and Lucindale. This report discusses the drilling and construction of production well Kalangadoo TWS 4 which was drilled as a replacement for the existing production well Kalangadoo TWS 1.

The original well was drilled by the Department for Mines and Energy in 1977 and used steel casing through both the Gambier Limestone and Dilwyn Formation. Casing integrity checks indicated corrosion of the steel casing which was considered a risk to the long-term viability of the well.

Diverse Resources Group Pty Ltd was contracted to drill and construct the new well. Drilling commenced on 14 May 2012 and was completed on 20 May 2012.

DFW Groundwater Technical Services conducted aquifer testing in May 2012.

KALANGADOO TOWN WATER SUPPLY

Kalangadoo is located approximately 28 kilometres north of the regional centre of Mount Gambier and is reliant on groundwater from the Dilwyn Formation confined aquifer for its town water supply.

The groundwater salinity of the existing water supply wells Kalangadoo TWS 1 and TWS 3, both completed in the Dilwyn Formation, was approximately 630 mg/L. These wells were pumped at approximately 20 to 25 L/s.

Details of the Kalangadoo production wells (historic and current) are given in Table 1. The location of the new and pre-existing wells is given in Fig. 1.

Kalangadoo TWS 2 was previously backfilled and abandoned.

Table 1. Kalangadoo production well details

Well name	Unit number	Drill date	Depth (m)	Obs date	DTW (m)	Obs date	TDS (mg/L)	Obs date	Yield (L/s)
Kalangadoo TWS 1	7022-690	1977	113	2012	23.4	2011	630	1982	11
Kalangadoo TWS 2	7022-3862	1977	116	1984	22.7	2005	585	1984	11
Kalangadoo TWS 3	7022-9985	2005	134	2005	22.5	2011	535	2006	14
Kalangadoo TWS 4	7022-10850	2012	144	2012	22.8	2012	555	2012	25

Figure 1. **Location of Kalangadoo production wells**

WELL DESIGN AND CONSTRUCTION

Diverse Resources Group Pty Ltd was engaged by DWR to drill and construct the production well. The drilling rig employed for the drilling operations was an Atlas Copco T3W. This rig is capable of rotary air and rotary mud drilling methods.

The site of of Kalangadoo TWS 4 (Fig. 1) was chosen by SA Water to target the sands of the Dilwyn Formation confined aquifer. This well targets the third sub-aquifer within the Dilwyn Formation and is characterised by slightly coarser sands than those encountered in Kalangadoo TWS 1. Land was purchased adjacent the SA Water compound to site the new well.

Kalangadoo TWS 4 was drilled as a production well under permit number 206967 (well unit number 7022-10850) and was completed on 20 May 2012.

The final design of Kalangadoo TWS 4 was based on the completion of Kalangadoo TWS 1, and the screen and casing were pre-ordered to facilitate the drilling and construction of the well. Strata samples were initially collected every two metres whch increased to every one metre through the aquifer zone. The final completion depth was based on the strata samples and the downhole geophysics. The well construction diagram (Fig. 2) shows the lithology encountered during drilling.

The well was drilled and constructed according to the following steps:

- A hole was drilled to a depth of 6 m using a 450 mm (17.7 inch) blade bit
- Steel surface control casing 355 mm (14 inch) ID was run into the drillhole to a depth of 6 m
- The pilot drillhole was mud drilled to total depth at 144 m using a 230 mm (9.1 inch) blade bit to collect strata samples for use in the well design
- The pilot drillhole was reamed to a depth of 122 m using a 355 mm (14 inch) blade bit
- A Class 12 PVC 253 mm (10 inch) ID casing string was run into the drillhole to a depth of 119.5 m
- The casing was pressure displacement cemented to surface
- Once the cement had set, the pilot drillhole was re-opened to 134 m using a 245 mm (9.6 inch) blade bit
- A stainless steel (316 grade) telescopic wire-wound screen 200 mm (8.7 inch) ID, 0.75 mm aperture, was set over the interval 120.5-128.5 m
- The screen was run with a Figure-K Packer and using a J-latch
- A riser pipe of 200 mm (8.7 inch) ID stainless steel (316 grade) zero-wound screen was set over the interval 118.5-120.5 m
- A sump of 200 mm (8.7 inch) ID stainless steel (316 grade) zero-wound screen was set over the interval 128.5-130.5 m
- The well was developed by airlifting until the groundwater being produced was clear and free of suspended solids. Development ceased as soon as the water was clean as it was not an intended to discharge water onto the neighbouring property. Further development occurred prior to the pumping tests during which water was directed to a property located further to the west.

Sterilisation of the well was achieved by adding chlorine to the drilling fluid and maintaining this throughout the drilling process.

A final depth to water of 22.8 m and airlift yield of 20 L/s were recorded at the conclusion of drilling.

Groundwater salinity was 520 mg/L (952 uScm) based on the result of laboratory water chemistry analysis.

The Drillers Well construction Report (Schedule 8) is given in Appendix A and a water well log (including lithological / stratigraphic description) is given in Appendix B. Sieve analysis curves are given in Appendix C.

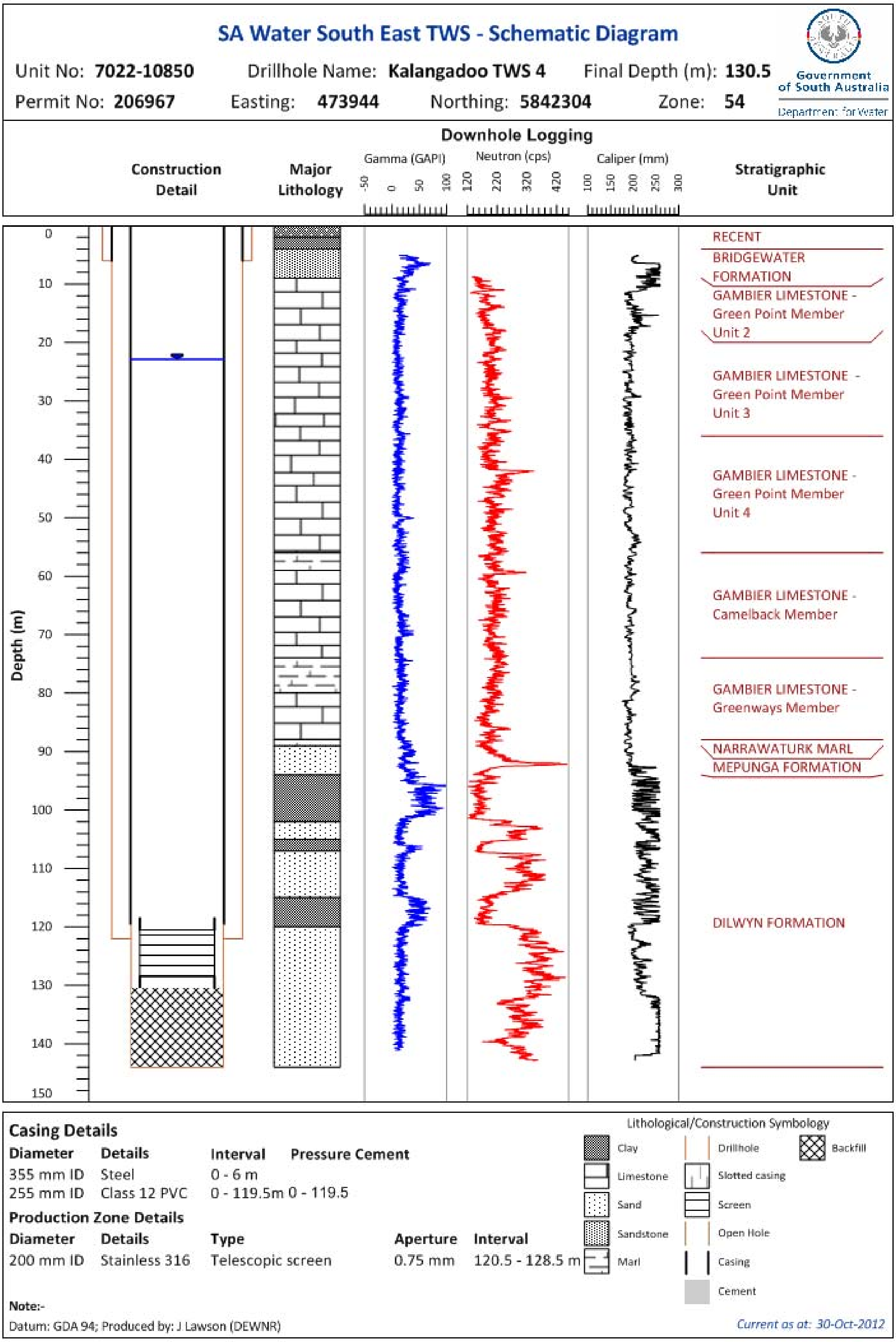


Figure 2. Well construction and lithological sequence Kalangadoo TWS 4

GEOLOGY - HYDROGEOLOGY

Kalangadoo is uniquely located from a geological perspective. The township is sited over the down thrown side of the Kalangadoo fault which is commonly mentioned in oil well exploration geology literature. As a result, the top of the Dilwyn Formation is intersected at a shallow depth of around 90 m below ground surface. Approximately three kilometres to the south of the SA Water town water supply compound the top of the Dilwyn Formation occurs within about 15 m of ground surface. A few kilometres north, the top of the Dilwyn Formation occurs at approximately 30 to 35 metres below ground surface. In summary the town water supply is located on the top of a Graben fault block. Previous groundwater modelling has indicated significant leakage occurs down this fault from the unconfined aquifer to the confined aquifer.There is also likely to be horizontal connection between the two aquifers.

The aquitard between the Gambier Limestone and the Dilwyn Formation is relatively thin at about 13 m of which 5 m are the poorly transmissive sands of the Mepunga Formation. The Dilwyn Formation clay aquitard is only 8 m thick. Assessment of the Dilwyn Formation clay between 96 and 98 m indicates that about 26% of the sand in the aquitard is greater than 0.3 mm diameter and this may indicate some potentlal for leakage at other sites. The results of the pumping test indicate that the Dilwyn Formation is well confined at the site of Kalangadoo TWS 4.

Table 2. Stratigraphic sequence for Kalangadoo TWS 4

Depth (m)	Lithological Description	Stratigraphic Description
0–4	Sand and Clay	Recent
4–9	Sandstone	Bridgewater Formation
9–18	Gambier Limestone	Green Point Member Unit 2
18–36		Green Point Member Unit 3
36–59		Green Point Member Unit 4
59–74		Camelback Member
74–88		Greenways Member
88–89	Limestone	Narrawaturk Marl
89–94	Sand	Mepunga Formation
94–102	Clay	Dilwyn Formation C1
102–105	Sand	Dilwyn Formation S1
105–107	Clay	Dilwyn Formation C2
107–115	Sand	Dilwyn Formation S2
115–120	Clay	Dilwyn Formation C3
120–144	Sand	Dilwyn Formation S3

PUMPING TESTS

PUMPING TEST DESIGN

A pumping test (aquifer test) is conducted by pumping a well and observing the aquifer 'response' or drawdown in the well and / or neighbouring observation wells. Pumping tests are carried out on wells to determine one or more of the following:

- The aquifer and aquitard hydraulic parameters used to determine the ability of the aquifer to store and transmit water and which can be used in analytical and numerical groundwater modelling
- The existence and potentially location of sub-surface hydraulic boundaries which may affect, beneficially or adversely, the long-term hydraulic behaviour and pumping performance of the well
- The long-term pumping rate of the well
- The design efficiency of the well
- The performance of the groundwater basin.

In this case, pumping tests were required to determine:

- The maximum sustainable pumping rate for a range of pumping times
- The pump setting
- Whether dewatering of the aquifer was occurring.

The pumping tests that were conducted consisted of a step drawdown test and a constant rate discharge test.

STEP DRAWDOWN TEST

The step drawdown test allows determination of the hydraulic behaviour of the well under pumping stress. The step drawdown test usually consists of three or more steps at increasing pumping rates, but with the rate ramaining constant throughout each step.

The objective of step drawdown testing is to determine the well equation (Equation 1) which reflects the efficiency of the well design and relates drawdown, pumping rate and time. This equation (ideally) allows prediction of the hydraulic performance of production wells for a design pumping rate and generation of yield drawdown curves for any given time.

The well equation allows determination of the maximum sustainable pumping rate of the well and consequently the selection of a suitable pumping rate for the constant rate discharge test.

$$s(t) = (a\,Q + c\,Q^2) + b\,\log(t)\,Q \qquad \textbf{Equation (1)}$$

Where:

s(t)	=	drawdown (m)
Q	=	pumping rate (m^3/min)
t	=	time (min)
a	=	constant related to well loss for laminar flow
c	=	constant related to well loss for turbulent flow
b	=	constant related to aquifer loss for laminar flow

and,

Well loss (m) = $a\,Q + c\,Q^2$

Aquifer loss (m) = $b \log(t)\, Q$

Well efficiency = (aquifer loss as a percentage of $S(t)$

The specific capacity is defined as:

$SC = Q/S$ = (L/s)/m of drawdown

CONSTANT RATE DISCHARGE TEST

The constant rate discharge test allows determination of the hydraulic behaviour of the aquifer system under pumping stress. The constant rate discharge test is conducted at a constant pumping rate for a duration commensurate with the intended use of the well, however this is often compromised by the cost of running long-term tests.

The water level data collected from the constant rate discharge test allows determination of:

- Aquifer and aquitard hydraulic parameters
- Presence of hydraulic boundaries which may have an effect on pumping sustainability under long-term operational pumping
- Dewatering of the aquifer system, which may have an effect on pumping sustainability under long-term operational pumping
- Interference of neighbouring production wells.

The constant rate discharge test should ideally be followed by a period of groundwater level monitoring during the recovery of he well, although this is frequently not undertaken to reduce cost. Recovery is ideally monitored until 95% of the drawdown has been recovered. The residual drawdown data can be used to determine whether interference effects are present from either recharge boundaries, or conversely from impermeable boundaries or dewatering of the aquifer:

- If no interference is present, the extrapolated residual drawdown should intersect the zero residual drawdown line at $t/t_1 = 1$
- If a recharge boundary has been encountered, the line will intersect the zero residual drawdown line at a value of $t/t_1 > 1$
- If dewatering has occurred or an impermeable boundary has been encountered, the line will intersect the zero residual drawdown line at a value of $t/t_1 < 1$.

Observations from monitoring during pumping provide important data for gaining a better understanding of the broader aquifer system. Data are more reliable than those measured in the production well where turbulence may exist due to the pump. The data indicate the extent of the hydraulic influence of the production well and allow accurate determination of aquifer and aquitard hydraulic parameters.

GROUNDWATER QUALITY TEST

Preliminary groundwater sampling for a town water supply production well with domestic application should be tested for the following suite of chemical parameters (pers. Comm. G Dworak and J West, SA Water 5 May 2011):

- basic chemistry: TDS, Na, Ca, Mg, K, CO3, HCO3, Cl, F, SO4, hardness and alkalinity
- pH, colour and turbidity
- nutrients: NH3, NO3, NO2, soluble P and DOC
- metals (total and soluble): Al, Cd, Sb, Ni, Cu, Zn, Pb, Cr, Mn, Fe, As, Ba, Mo, Se, Hg, B, Ag, Be, I, CN, Sn, Zn, Br and U
- radioactivity.

PUMPING TEST RESULTS

CONDUCT OF TEST

The pumping tests conducted on Kalangadoo TWS 4 consisted of a step drawdown test and a constant rate discharge test and recovery test over the period 24–26 May 2012. Test details are given in Table 3 the results are given in Appendix D.

DFW Groundwater Technical Services conducted the testing. Further development of the well was initially carried out during which pumping rates and groundwater levels were monitored. From this preliminary data, rates were selected for the step drawdown test.

Groundwater samples were analysed at the Australian Water Quality Centre (AWQC) (Appendix E).

Table 3. Pumping test details Kalangadoo TWS 4

Test type	Test date	Step	Duration (min)	Pumping Rate (L/s)
Step drawdown	24 May 2012	1	100	20
		2	100	25
		3	100	30
Constant rate discharge	25-26 May 2012	1	1440	25
Recovery	26 May 2012	–	450	0

STEP DRAWDOWN TEST

Analysis of the step drawdown results for Kalangadoo TWS 4 (Fig. 3) leads to the following well equation:

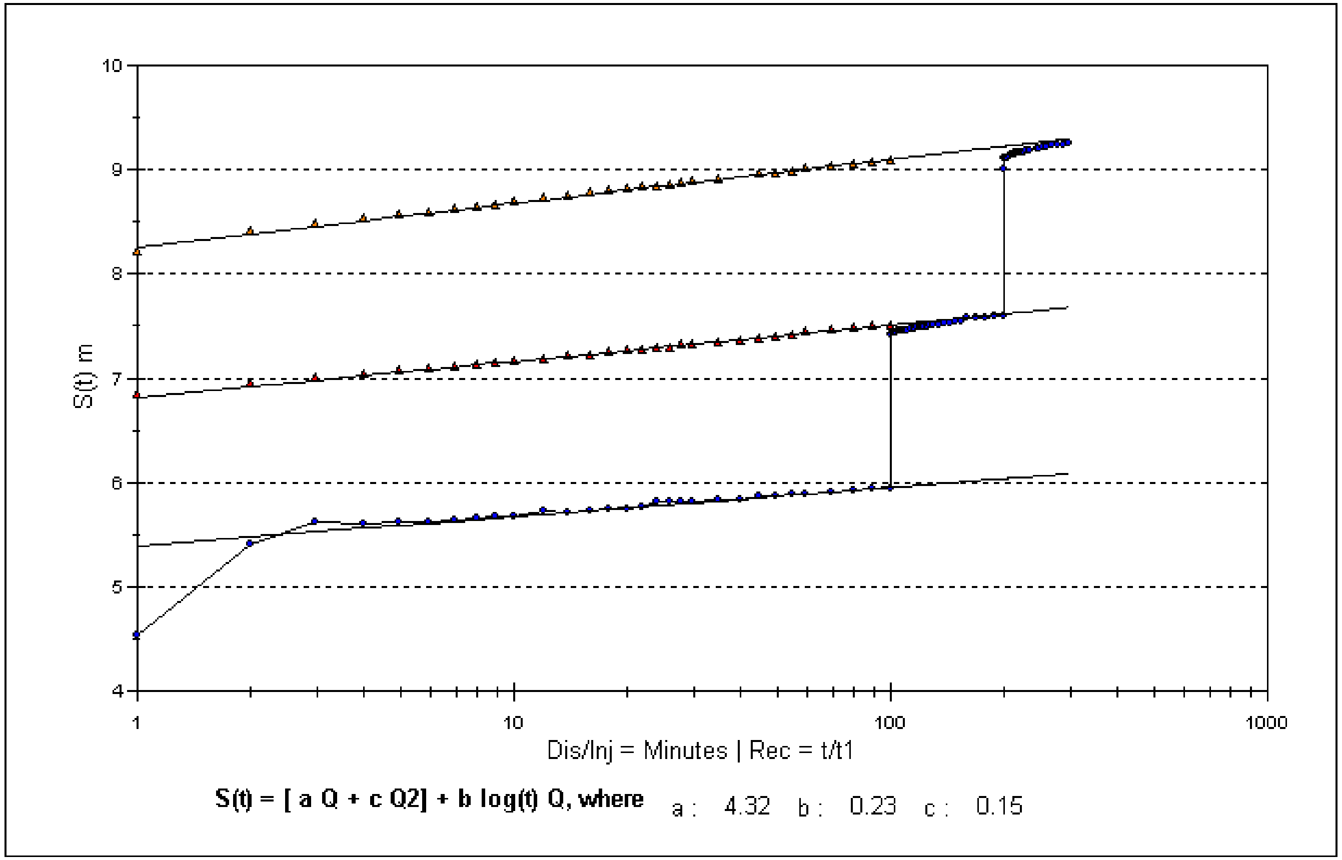
$s(t) = 4.32\,Q + 0.15\,Q^2 + 0.23 \log(t)\,Q$ Equation (2)

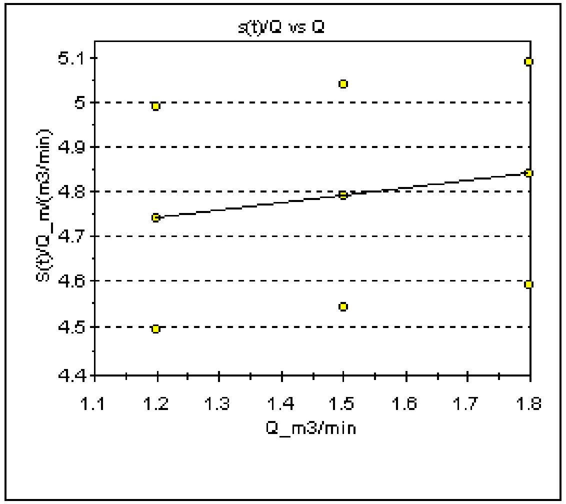
The well equation can be used as a predictive tool. Table 4 gives predicted drawdown for 1 000 000 minutes of continuous pumping at a range of pumping rates. While the theoretical available drawdown is 107 m, drawdowns are very small and this would obviously never be utilised.

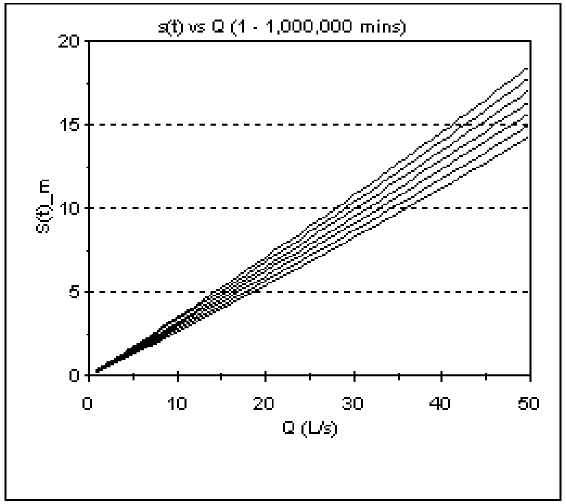
Table 4. Predicted drawdown Kalangadoo TWS 4

Pumping rate (L/s)	DTW (m)*	Casing length (m)	Theoretical Available DD (m)	Duration (min)	Predicted DD (m)
20	26.3	119.5	93.2	1000000	7.08
25	26.3	119.5	93.2	1000000	8.92
30	26.3	119.5	93.2	1000000	10.79
35	26.3	119.5	93.2	1000000	12.68

* Measurement taken at start of step drawdown test and rounded to a whole number







TheStep	Q_L/s	Q_m3/min	Duration_min	St1	St1/Q	St10	St10/Q	St100	St100/Q	dS	dS/Q	T_m2/day
1	20.00	1.20	100	5.40	4.50	5.68	4.73	5.96	4.97	0.28	0.23	1129
2	25.00	1.50	100	6.82	4.55	7.17	4.78	7.52	5.01	0.35	0.23	1129
3	30.00	1.80	100	8.26	4.59	8.68	4.82	9.10	5.06	0.42	0.23	1129
maintest	25.00	1.50	1440									

Figure 3. Step drawdown test analysis of drawdown using Hazel method Kalangadoo TWS 4

CONSTANT RATE DISCHARGE TEST

Production Well

Drawdown (residual drawdown) were recorded during the constant rate discharge test and recovery (Fig 4).

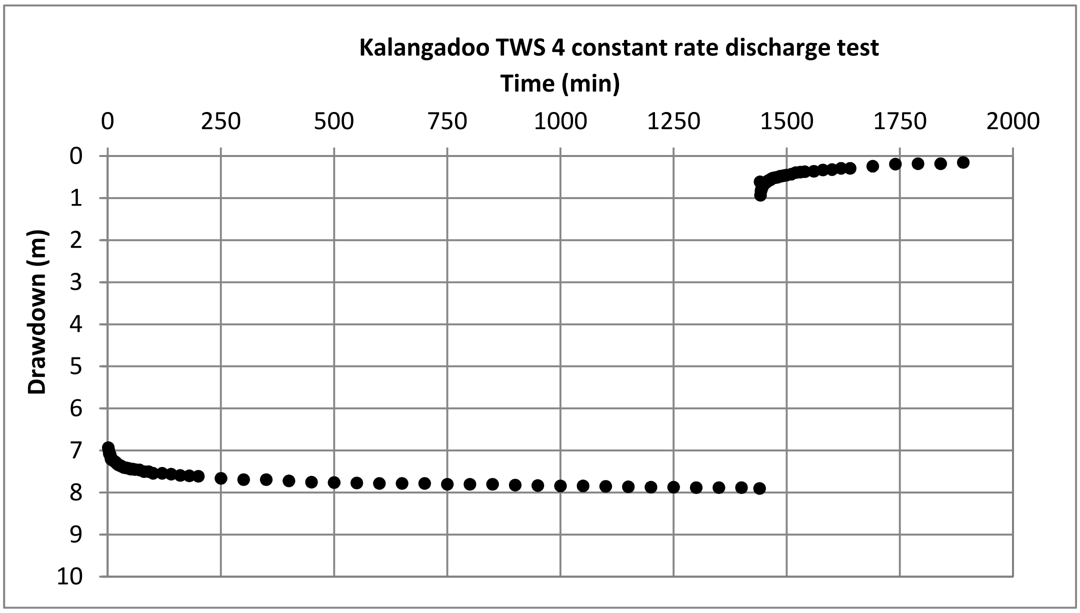


Figure 4. Linear–linear plot of drawdown Kalangadoo TWS 4 constant rate discharge test

Drawdown versus time and residual drawdown versus t/t_1 (where t is the time since pumping began and t_1 is the time since pumping stopped) are given in Fig 5.

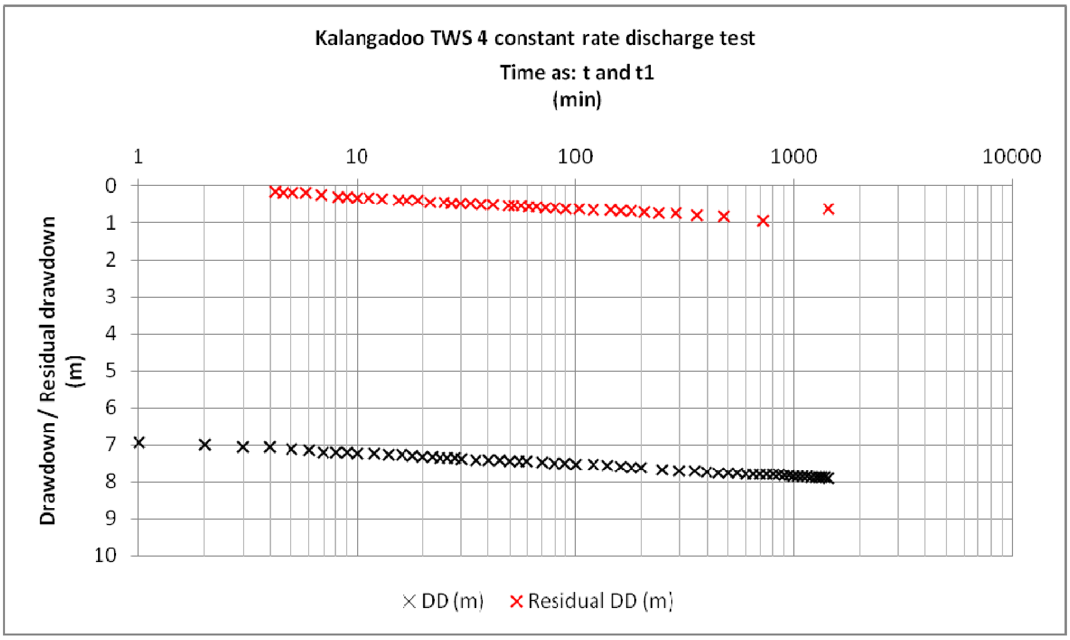


Figure 5. Log- linear plot of drawdown / residual drawdown Kalangadoo TWS 4 constant rate discharge test

The following general comments can be made:

- A drawdown of 7.90 m developed during the test.
- The well equation accurately predicts the observed drawdown at the end of the constant rate discharge test within -0.3% (Fig.6)
- The specific capacity at 100 minutes was 3.32 L/s per metre of drawdown
- Well loss was approximately 80% of drawdown at the end of the test
- Recovery was monitored until residual drawdown was within 2% of the total drawdown developed. Monitoring of recovery was terminated after 450 minutes and the data are insufficient to make any conclusive comments in relation to the aquifer. It should be noted that that Dilwyn Formation is a extensive regional confined aquifer and its capacity to meet demand does not present a problem.

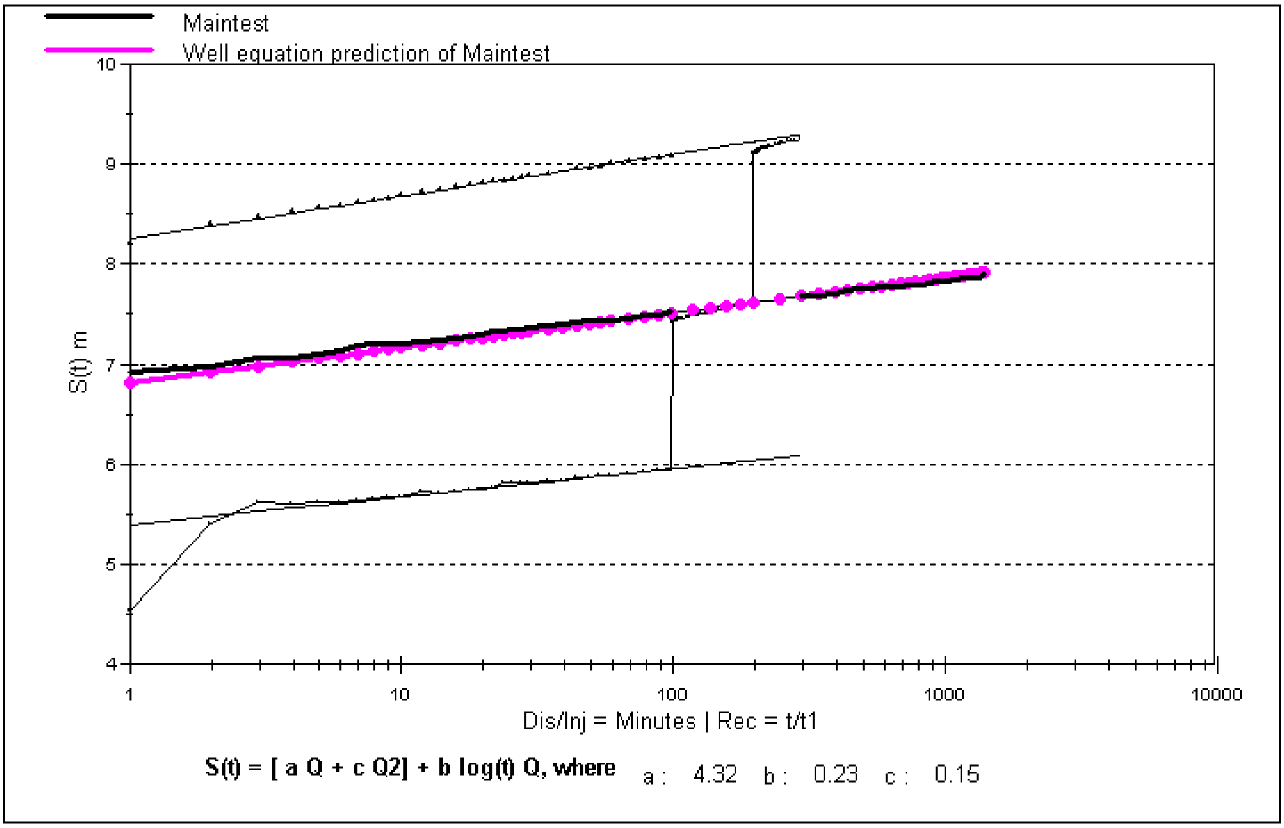


Figure 6. Well equation prediction of constant rate discharge test Kalangadoo TWS 4

Observation Well

The data from the observation well Kalangadoo TWS 3 at a radial distance of 30 m from the production were analysed using the Hantush method (Fig. 7). The following general comments can be made:

- A drawdown of 1.19 m developed during the test
- The Dilwyn Formation exhibited a drawdown signature at the observation well consistent with a well confined aquifer
- The hydraulic parameters of Dilwyn Formation and overlying aquitard are given Table 5
- During the period of the test no hydraulic boundaries were intersected.

Table 5. Analysis results observation well Kalangadoo TWS 3

Observation Well	Radial distance to production well (m)	Transmissivity (m^2/day)	Storage coefficient	Hydraulic resistance (day)	Method
Kalangadoo TWS 3	30	1,250	4.50 x 10-4	17,708	Hantush

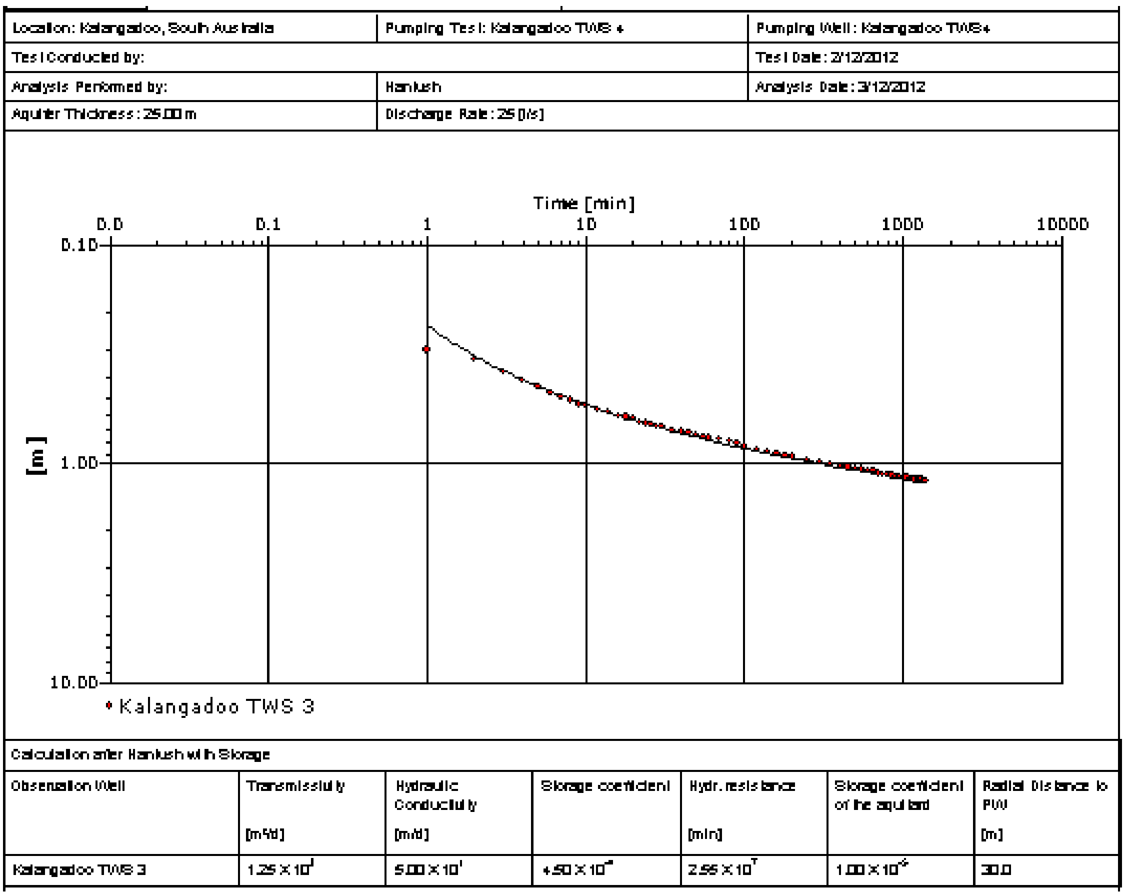


Figure 7. Hantush analysis of drawdown observation well Kalangadoo TWS 3

GROUNDWATER SALINITY

Groundwater salinity (Fig. 8) was continuously recorded in the field during the constant rate discharge test. Groundwater salinity was reasonably constant throughout the test ending at around 507 mg/L. A slight rise can be observed from about 800 minutes however it is small and probably irrelevant. Groundwater salinity was 520 mg/L (952 uScm) based on the result of laboratory water chemistry analysis.

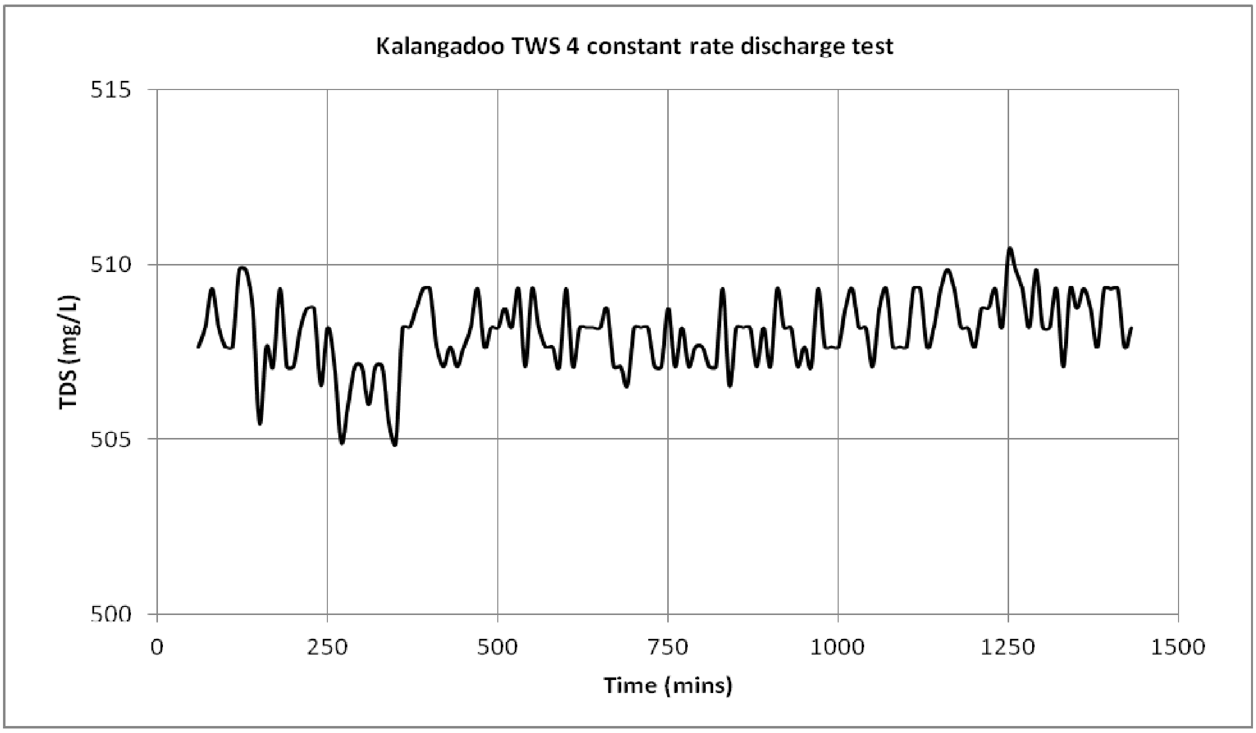


Figure 8. Groundwater salinity Kalangadoo TWS 4 constant rate discharge test

RECOMMENDATIONS

It is recommended Kalangadoo TWS 4 be pumped operationally and monitored for a full 12 months to confirm the long-term hydraulic behaviour of the well. The recommended pumping rate and pump depth are given in Table 5.

The current program of work included the design, implementation and testing of the production well. The report includes a brief analysis and interpretation of the constant rate discharge test. This analysis and interpretation can be futher explored in a future program of work dealing with regional aquifer and aquitard assesment.

Table 5. Well completion details and pumping test summary Kalangadoo TWS 4

	Parameter Description	Kalangadoo TWS 4
Well Design	Target aquifer	Dilwyn Formation
	Assumed depth to water (m)	27 [1]
	Nominal casing inner diameter (mm)	250
	Casing length (m)	119.5
	Available drawdown (m)	92.5
SA Water Specification	Required pumping rate (L/s)	11
	Required pumping duration	1 h twice per day
	Modelled pumping rate (L/s)	11
	Modelled pumping duration	2 h (120 min)
	Predicted drawdown (m)	3.2
DFW Recommendation	Pumping rate (L/s)	11
	Pumping duration	3 h (180 min)
	Predicted drawdown (m)	3.3
	Pump intake depth (m)	36 [2]
	Resultant available drawdown safety factor (m)	5.7

Note:

[1] Measurement taken at start of constant rate discharge test and consertaviley rounded to next whole number

[2] Pump intake depth based on 3 metre pump column

APPENDIXES

A. WELL CONSTRUCTION REPORT

DRILLERS WELL CONSTRUCTION REPORT
Natural Resource Management Act 2004
DETAILS OF ALL WORK UNDERTAKEN MUST BE REFLECTED IN THIS REPORT

1. PERMIT NO: 206767 Site 4

NAME OF DRILLER Paul Jutt Licence No. 8-123
Contact Phone/Mobile No. 0427 900 761
Name of plant operator if under supervision Darren Noll

PERMIT HOLDER or land occupier SA Water Corp
Postal Address PO Box 603 Mt Gambier
Post Code 5290

2. LOCATION OF WELL
Date of Survey 18/5/12 Surveyed by [illegible] Method [illegible]
GPS COORDINATES AND DATUM USED
☐ GDA 94/WGS84
☐ AGD 66/84
S 37° 33.953'
E 140° [illegible]
☐ ZONE 52 ☐ ZONE 53 ☐ ZONE 54

3. WELL NAME Kalangadoo 4
4. LAND IDENTIFICATION
Pastoral Lease or Hundred: Joyce
Title or Plan and Parcel SA 5689/979
Name of Property SA Water

5. SUMMARY *(Please tick appropriate boxes and complete all relevant details)*
Date work Commenced 14/5/12 Date work Completed 20/5/12
Work carried out New Well ☑ Deepen ☐ Enlarge ☐ Rehabilitate ☐ Backfill ☐
Is this a Replacement well? YES/NO if yes please quote replaced well number
Is this an Existing well? YES/NO **if yes please quote well number or GPS coordinates**
Was well Abandoned? YES/NO if so please state reason and method of backfill
Maximum Depth Drilled 144 (m) Final Depth 130.5 (m) Final Standing Water Level 22.8 (m) Final Yield 20 (L/sec)

6. DRILLING DETAILS If not a drilled well, please complete Sections 6.2, 9, 10, 11, 12 and 13 as necessary

6.1 Construction Details

From (m)	To (m)	Diam (mm)	Drilling Method Cable Tool, Rotary Auger, Down Hole Hammer, etc.	Fluid Used (Air, Water, Mud Type)
0	6	450	Rotary	Mud
6	122	350	Rotary	Mud
122	131	241	Rotary	Mud
131	144	229	Rotary	Mud

6.2 Water Cut Details (measurements from natural surface to nearest 0.1 m)

Date	Water Cut From (m)	Water Cut To (m)	Standing Water Level (m)	Estimated Yield (L/sec)	Hole Depth at Test (m)	Casing at Test (m)	Test Method	Salinity (mg/L) or Taste
19/5	120	140	22.8	20	130.5	130.5	Air	552ppm

7. CASING LEFT IN WELL

7.1 From (m)	To (m)	Internal Diam (mm)	7.2 Type Swell Joint, Welded Collar, Steel, PRP, PVC, etc	7.3 Casing Cemented Yes	No	From (m)	To (m)	Cement (bags)	Water (litres)	Other Additives	Cementing Method Used	Comments
0	6	350	Steel	☑	☐	0	6	10	270	–	Pumped	
0	119.5	250	PVC	☑	☐	0	122	30	[illegible]	5% Bent	Pumped	[illegible]

7.4 COLLAR CASING (must be cemented to surface)

8. CONSTRUCTION AT PRODUCTION LEVEL

8.1 Method
☐ Open Hole
☐ Slotted Casing
☑ Screen(s)
☐ Other, give details

8.2 Screen or Casing (*If variable aperture screen used give limits)

Type	From (m)	To (m)	Aperture* (mm)	Inner Diam (mm)	Outer Diam (mm)	Material	Trade Name	Completion of Base
Screen	120.5	130.5	0.75	200	220	[illegible]	Johnson	Plate

8.3 Liner Seal (Packer)

Material	Depth (m)	Internal Diam (mm)

8.4 Gravel Packing

Method of Placement	Gravel Passing Mesh Size	From (m)	To (m)

9. IF NOT A DRILLED WELL

Method	Depth (m)	Length (m)	Width (m)	Diam (m)	Lining Material	From (m)	To (m)

10. DEVELOPMENT (State methods and time taken)

Method	Hours	Minutes
Air	3	

11. PUMPING TEST (measurements from natural surface to nearest 0.1m)

Interval Tested From (m)	Interval Tested To (m)	Water Level (m)	Test Method	Pump Depth (m)	Discharge Rate (L/sec)	Method of Measuring Discharge	Hours Pumped	Draw Down (m)

12. SAMPLES
The Natural Resource Management Act 2004 and Regulations require that strata and water samples must be obtained. If any samples have not been obtained state reasons
No Strata Req
As the person responsible I advise that the work has been completed as described above.

Signature of Licensed Driller [signature] Date [illegible]

13. FORMATION LOG

From (m)	To (m)	Description of Material
0	1	Topsoil
1	18	Minor Sandstone
18	98	Limestone
98	106	Clay
106	117	Sand with Clay Lenses
117	140	Coarse Sand
140	144	Marl

DRILLER TO DELIVER THIS COPY TO
PERMIT HOLDER OR LAND OWNER

UNIT NUMBER

B. WATER WELL LOG

Project**: KALANGADOO TWS 4**

Permit Number:	**206967**	Backfilled (Y/N):	**N**
Date Completed:	**20/05/2012**	Total Depth (m):	**144**
Unit No: **7022-10850**		Drill Method:	**Rotary mud**
Drillhole Name:	**Kalangadoo TWS 4**	Drilling Company:	**Diverse Resource Group**
Logged By: **Jeff Lawson**		Driller: **Paul Juett**	

Coordinates

Easting:	**473944**	Ground Elevation (mAHD):	**69m DEM**
Northing:	**5842304**	Reference Elevation (mAHD):	**TBD**
Zone:	**54**	Reference Point Type:	**TOC**
Datum:	**GDA94**		

General Comments:

Lithological Description

Depth (m)		Major Lith Unit(s)	Lithology	Formation
From	**To**			
0	2	SANDY CLAY	Coarse sand, clear to iron stained. Mottled pale to dark brown clay.	RECENT
2	4	CLAY	Pale brown, weakly to moderately bounded. High sand content – medium to coarse grained.	
4	9	SANDSTONE	Pale brown to off white. Strongly cemented fine grained sandstone composed of sand and indistinguishable fossil material.	BRIDGEWATER FORMATION
9	10	LIMESTONE	White, coarse grained unconsolidated bryozoa.	GAMBIER LIMESTONE Green Point Member Unit 2 sub unit
10	12		White, unconsolidated fossil material some fragments to 1cm. Occasional strongly cemented fined grained fragments. 35% Flint – pale grey to black, angular.	
12	18		Reducing to a medium grained limestone, although some coarse fragments. Flint content reduced to 15 to 20%.	
18	22		White. Varies from fine to medium grained unconsolidated fossils to strongly cemented fine grained limestone. Shell fragments to 1cm. Overall medium grained.	GAMBIER LIMESTONE Green Point Member Unit 3 sub unit
22	24		Change in colour to pale grey from a 20% flint content. Limestone is white to off white. Unconsolidated, very coarse grained. Bryozoa to 1cm and shells to 1.5cm.	

Depth (m)		Major Lith Unit(s)	Lithology	Formation
From	To			
24	28		Slightly finer, but still coarse grained.	
28	36		Flint content increasing slightly. Limestone medium grained.	
36	38		White to off white. Minor iron staining. Weakly cemented to uncemented sediments – fine grained limestone.	GAMBIER LIMESTONE Green Point Member Unit 4
38	42	LIMESTONE	Off white, some glauconitic staining. Essentially strongly cemented fine grained chips and minor unconsolidated material. Very fine grained.	
42	44		Cream white. Weakly cemented to uncemented. Fine grained unconsolidated bryozoa. Overall fine grained. Very minor and weak marl content.	
44	50		Fine to medium grained limestone.	
50	52		White to off white. Weakly cemented to uncemented. Majority of the sample is unconsolidated fossil content. Fine to medium grained. Marl content a little higher.	
52	54		White, unconsolidated medium grained limestone.	
54	56		White, medium to coarse grained. Occasional iron stained fragments.	
56	58	MARL	Deep grey. Weakly bounded marl but probably influenced by up hole contamination. Approx 20 – 30% limestone.	
56	59	MARLY LIMESTONE	Grey weakly bounded marl. Medium grained fossil content. Unconsolidated.	
59	62	LIMESTONE	White, unconsolidated limestone with minor weakly cemented fragments. Fine to medium grained. Overall fine grained. Minor partially silicified flint (about 15%).	GAMBIER LIMESTONE Camelback Member sub unit
62	64		No flint.	
64	68		White, essentially unconsolidated with some weakly cemented fragments. Medium grained.	
68	70		Off white to grey. Coarse grained bryozoal limestone with partially silicified grey flint (25%)	
70	74		Coarse grained.	
74	76	MARLY LIMESTONE	Pale grey, weakly bounded marl. High limestone content, probably uphole contamination.	GAMBIER LIMESTONE Greenways Member sub unit.
76	80		Limestone content reducing.	
80	84	LIMESTONE	Off white uncemented. Minor marl. Medium to fine grained limestone	
84	88		White very weakly bound marl with medium to coarse grained limestone inclusions.	
88	89	MARLY LIMESTONE	Pale grey. Weakly bound marl and medium grained limestone. Strongly glauconitic.	NARRAWATURK MARL

Depth (m)		Major Lith Unit(s)	Lithology	Formation
From	To			
89	94	SAND	Light brown, well rounded sand. Limonitic and iron stained medium grained sand. Occasional glauconitic grains.	MEPUNGA FORMATION
94	96	CLAY	Brown, soft, pliable well bounded clay. High % of embedded sand. Aquitard boundary (C1).	DILWYN FORMATION (C1)
96	102		Low % of fine embedded sand	
102	105	SAND	Clear to frosted, unconsolidated fine sand. Minor clay pieces. First sand layer (S1). 50% sand average 0.42mm.	DILWYN FORMATION (S1)
105	107	CLAY	Brown clay. Second aquitard layer (C2).	DILWYN FORMATION (C2)
107	110	SAND	50% sand retention average – 0.51mm. Second sand sub aquifer (S2).	DILWYN FORMATION (S2)
110	112		50% sand retention average – 0.4mm	
112	114		50% sand retention average – 0.61mm	
114	115		50% sand retention average – 0.75mm	
115	120	CLAY	Brown clay. Third aquitard layer (C3).	DILWYN FORMATION (C3)
120	121	SAND	50% sand retention average – 0.61mm. Third sub aquifer (S3).	DILWYN FORMATION (S3)
121	123		No results	
123	124		50% sand retention average – 0.48mm	
124	125		50% sand retention average – 0.79mm	
125	126		50% sand retention average – 0..52mm	
126	127		50% sand retention average – 0.1mm	
127	128		50% sand retention average – 0.42mm	
128	129		50% sand retention average – 0.49mm	
129	130		50% sand retention average – 0.43mm	
130	131		50% sand retention average – 0.42mm	
131	132		50% sand retention average – 0.48mm	
132	133		50% sand retention average – 1.3mm	
133	134		50% sand retention average – 0.4mm	
134	135		50% sand retention average – 0.54mm	
135	136		50% sand retention average – 0.7mm	
136	137		50% sand retention average – 0.69mm	
137	138		50% sand retention average – 0.8mm	
138	139		50% sand retention average – 0.67mm	
139	140		50% sand retention average – 0.51mm	
140	141		50% sand retention average – 0.48mm	
141	142		50% sand retention average – 0.68mm	
142	143		50% sand retention average – 0.61mm	

Depth (m)		Major Lith Unit(s)	Lithology	Formation
From	To			
143	144		50% sand retention average – 0.7mm	

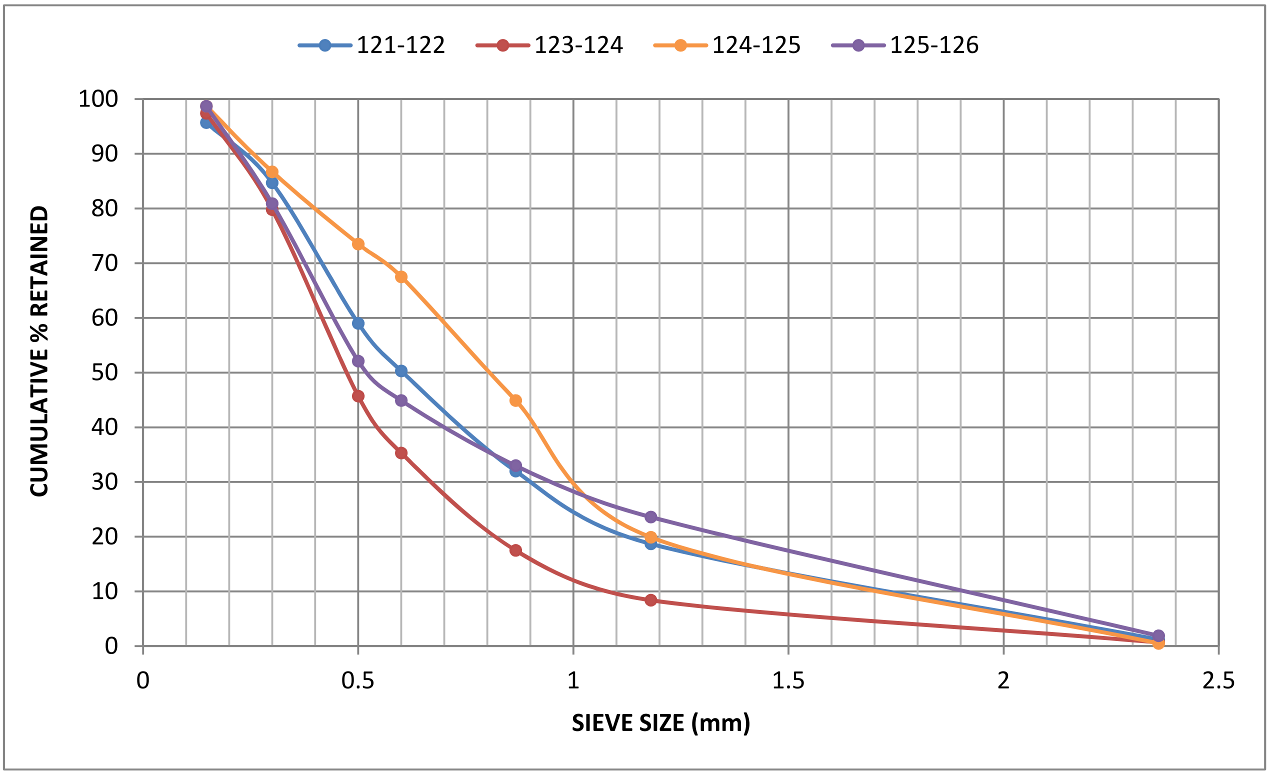
Water Cut Information

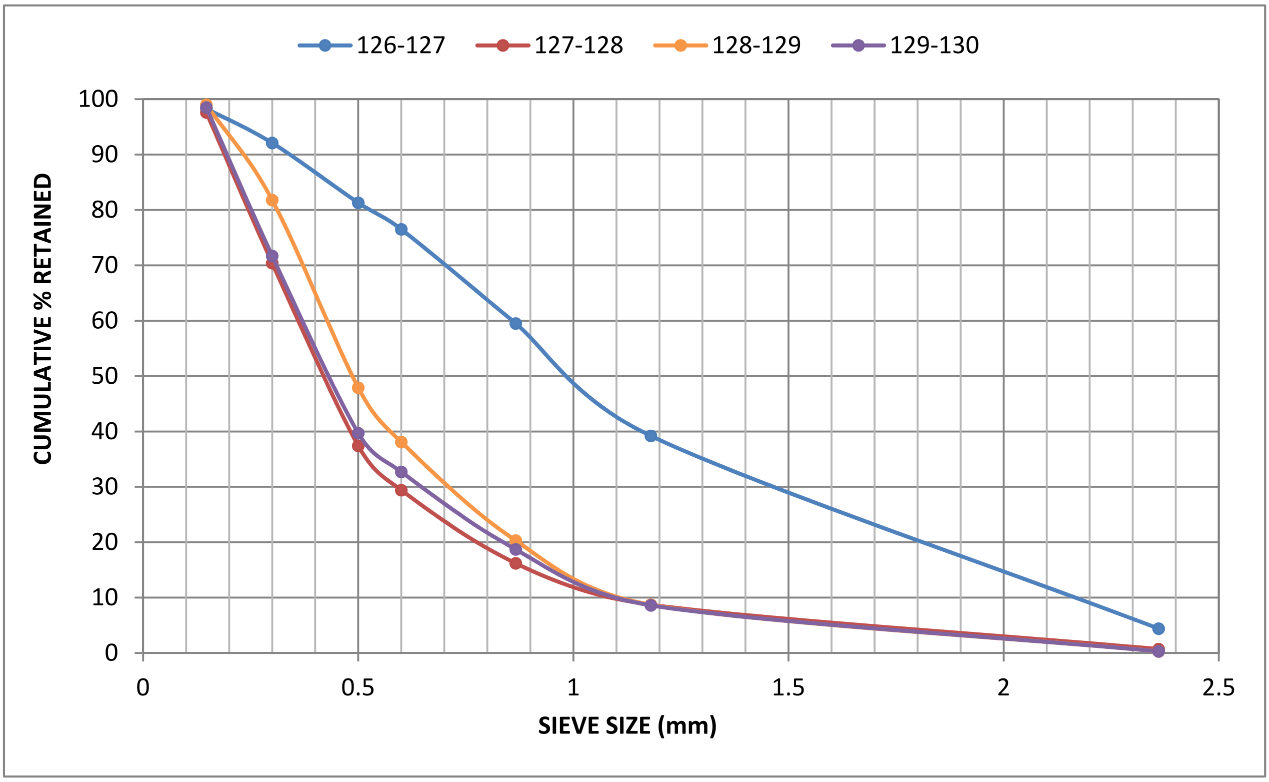
Depth (m)		Depth to Water (m)	Supply			Water Analysis		
From	To		Yield (L/s)	Test Length (min)	Method	Sample No.	Salinity	Salinity Unit (mg/L / EC)
0	128.5	26.31	25	1440	Pump	N/A	N/A	520/(952

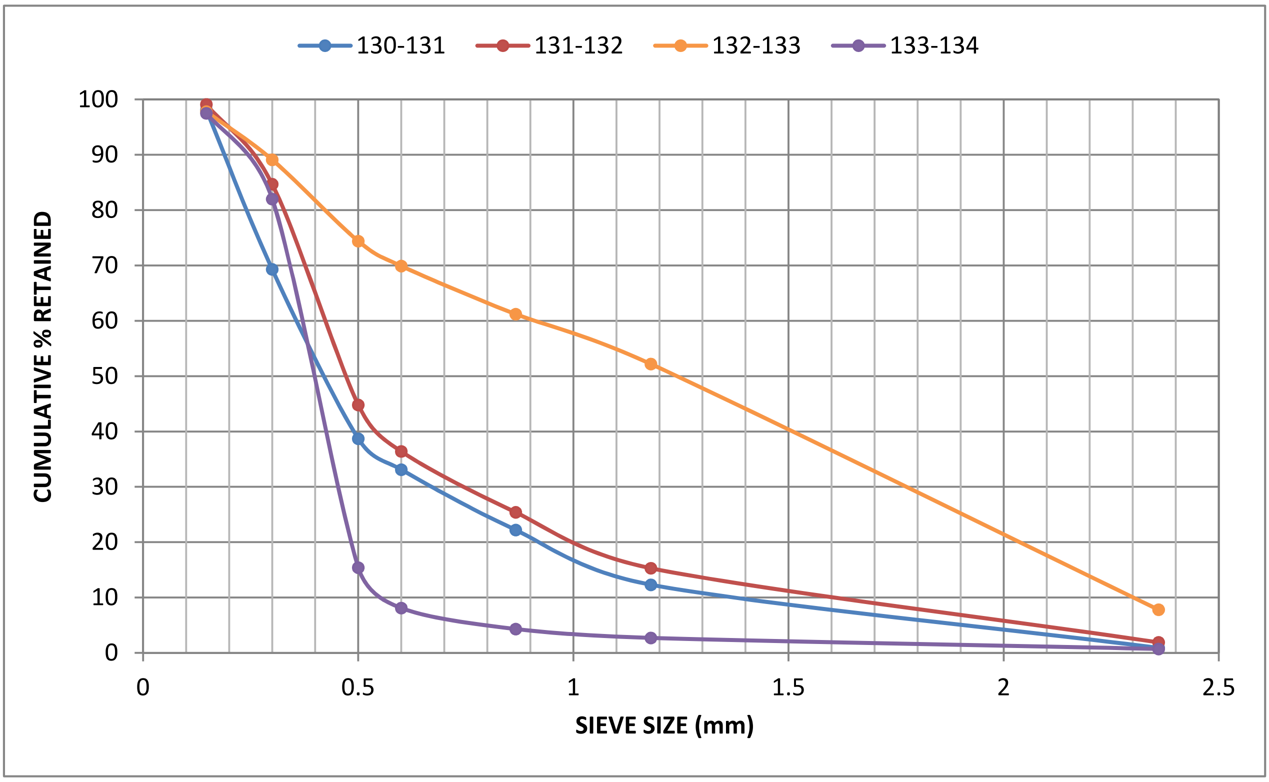
Casing and Production Zone Information

Case or Production Zone	Depth (m)		Inner Diam (mm)	Material	Aperture (mm)	Cementing		
	From	To				Y/N	From (m)	To (m)
Surface control casing	0	6	355	Schedule 20 steel		y	0	6
Well Casing	0	119.5	253	Class 12 PVC		Y	0	119.5
Riser Pipe	118.5	120.5	200	Zero aperture stainless steel				
Prod zone	120.5	128.5	200	316 Stainless wire-wound screen	0.75			
Sump	128.5	130.5		Zero aperture stainless steel				

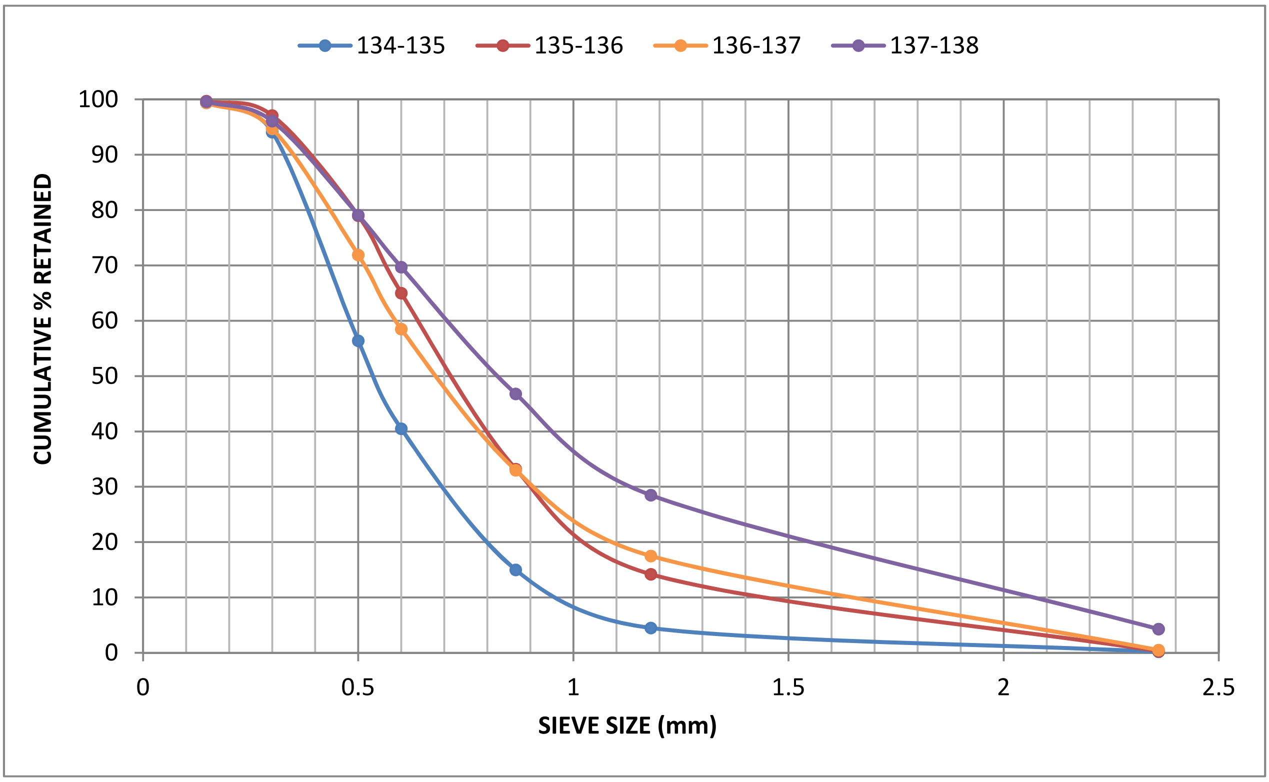
C. DILWYN FORMATION SIEVE ANALYSIS



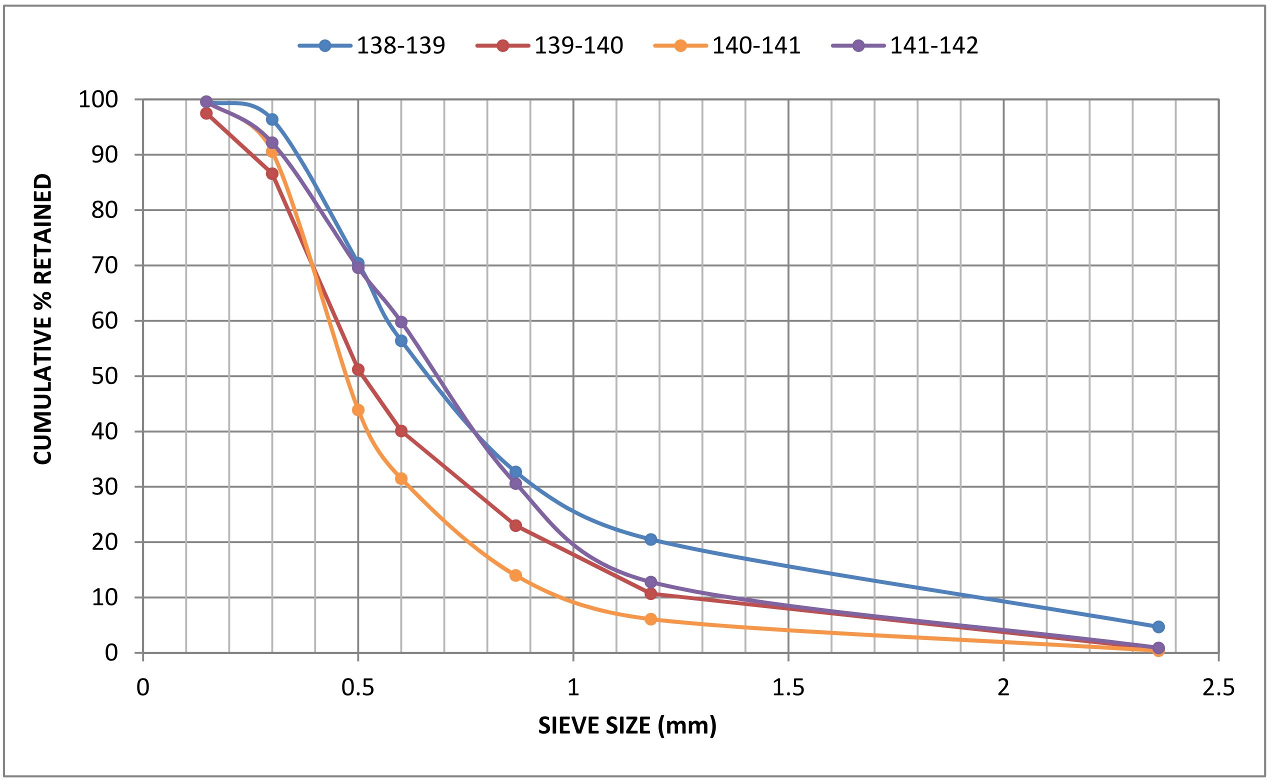


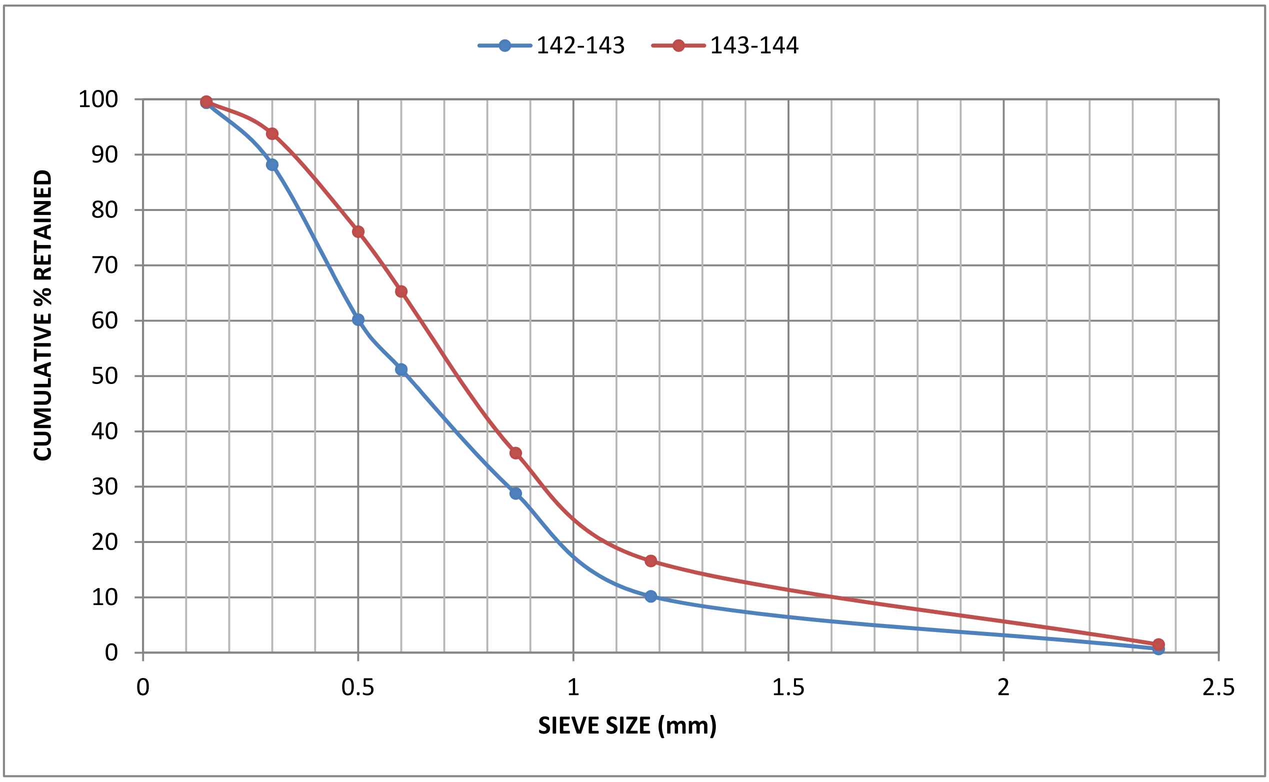


130-131
131-132
132-133
133-134
CUMULATIVE % RETAINED
100
90
80
70
60
50
40
30
20
10
0
0
0.5
1
1.5
2
2.5
SIEVE SIZE (mm)



134-135
135-136
136-137
137-138
CUMULATIVE % RETAINED
100
90
80
70
60
50
40
30
20
10
0
0
0.5
1
1.5
2
2.5
SIEVE SIZE (mm)


138-139
139-140
140-141
141-142
CUMULATIVE % RETAINED
SIEVE SIZE (mm)


142-143
143-144
CUMULATIVE % RETAINED
SIEVE SIZE (mm)

D. PUMPING TEST DATA

D.1 KALANGADOO TWS 4 STEP DRAWDOWN TEST

KALANGADOO TWS 4

Start date	Start time	Step	Duration (min)	Q (L/s)	Well Name	Well Type	r (m)	Aquifer	Ref Elev. (mAHD)
24/05/2012	08:30	1	100	20	Kalangadoo TWS 4 7022-10850	Prod.	0	Dilwyn Formation	68.9 m (DEM)
"		2	100	25	"	"	"	"	"
"		3	100	30	"	"	"	"	"

KALANGADOO TWS4 MANUAL DATA

Step No.	Q (L/s)	Time (min)	DTW (m)	DD (m)
		0	26.31	
1	20	1	30.86	4.55
1	20	2	31.73	5.42
1	20	3	31.94	5.63
1	20	4	31.92	5.61
1	20	5	31.94	5.63
1	20	6	31.94	5.63
1	20	7	31.96	5.65
1	20	8	31.98	5.67
1	20	9	31.99	5.68
1	20	10	32.00	5.69
1	20	12	32.04	5.73
1	20	14	32.03	5.72
1	20	16	32.05	5.74
1	20	18	32.06	5.75
1	20	20	32.07	5.76
1	20	22	32.09	5.78
1	20	24	32.13	5.82
1	20	26	32.13	5.82
1	20	28	32.13	5.82
1	20	30	32.14	5.83
1	20	35	32.15	5.84
1	20	40	32.16	5.85
1	20	45	32.18	5.87
1	20	50	32.19	5.88
1	20	55	32.20	5.89
1	20	60	32.20	5.89
1	20	70	32.23	5.92

Step No.	Q (L/s)	Time (min)	DTW (m)	DD (m)
1	20	80	32.25	5.94
1	20	90	32.26	5.95
1	20	100	32.26	5.95
2	25	101	33.73	7.42
2	25	102	33.75	7.44
2	25	103	33.75	7.44
2	25	104	33.76	7.45
2	25	105	33.77	7.46
2	25	106	33.77	7.46
2	25	107	33.77	7.46
2	25	108	33.77	7.46
2	25	109	33.78	7.47
2	25	110	33.78	7.47
2	25	112	33.78	7.47
1	20	100	32.26	5.95
2	25	101	33.73	7.42
2	25	102	33.75	7.44
2	25	103	33.75	7.44
2	25	104	33.76	7.45
2	25	105	33.77	7.46
2	25	106	33.77	7.46
2	25	107	33.77	7.46
2	25	108	33.77	7.46
2	25	109	33.78	7.47
2	25	110	33.78	7.47
2	25	112	33.78	7.47
2	25	114	33.79	7.48
2	25	116	33.79	7.48
2	25	118	33.8	7.49
2	25	120	33.81	7.5
2	25	122	33.81	7.5
2	25	124	33.81	7.5
2	25	126	33.81	7.5
2	25	128	33.83	7.52
2	25	130	33.83	7.52
2	25	135	33.83	7.52
2	25	140	33.84	7.53
2	25	145	33.85	7.54
2	25	150	33.86	7.55
2	25	155	33.87	7.56
2	25	160	33.89	7.58

Step No.	Q (L/s)	Time (min)	DTW (m)	DD (m)
2	25	170	33.89	7.58
2	25	180	33.9	7.59
2	25	190	33.91	7.6
2	25	200	33.91	7.6
3	30	201	35.33	9.02
3	30	202	35.42	9.11
3	30	203	35.43	9.12
3	30	204	35.43	9.12
3	30	205	35.43	9.12
3	30	206	35.43	9.12
3	30	207	35.44	9.13
3	30	208	35.45	9.14
3	30	209	35.45	9.14
3	30	210	35.46	9.15
3	30	212	35.47	9.16
3	30	214	35.47	9.16
3	30	216	35.48	9.17
3	30	218	35.49	9.18
3	30	220	35.49	9.18
3	30	222	35.49	9.18
3	30	224	35.49	9.18
3	30	226	35.49	9.18
3	30	228	35.49	9.18
3	30	230	35.50	9.19
3	30	235	35.50	9.19
3	30	240	33.51	9.2
3	30	245	35.52	9.21
3	30	250	35.52	9.21
3	30	255	35.53	9.22
3	30	260	35.54	9.23
3	30	270	35.55	9.24
3	30	280	35.56	9.25
3	30	290	35.56	9.25
3	30	300	35.57	9.26

D2 KALANGADOO TWS 4 CONSTANT RATE DISCHARGE TEST

KALANGADOO TWS 4

Start date	Start time	Step	Duration (min)	Q (L/s)	Well Name	Well Type	r (m)	Aquifer	Ref Elev. (mAHD)
25/05/2012	08:30	1	Pumping 1440 Recovery 450	25	Kalangadoo TWS 4 7022-10850	Prod.	0	Dilwyn Formation	68.9 m (DEM)
					Kalangadoo TWS 3	Obs	30	Dilwyn Formation	69.0 m (DEM)

KALANGADOO TWS 4 MANUAL DATA

Q (L/s)	Time (min)	DTW (m)	DD (m)
	0	26.31	
25	1	33.24	6.93
25	2	33.30	6.99
25	3	33.38	7.07
25	4	33.38	7.07
25	5	33.41	7.10
25	6	33.45	7.14
25	7	33.51	7.2
25	8	33.52	7.21
25	9	33.52	7.21
25	10	33.53	7.22
25	12	33.55	7.24
25	14	33.56	7.25
25	16	33.58	7.27
25	18	33.59	7.28
25	20	33.62	7.31
25	22	33.64	7.33
25	24	33.65	7.34
25	26	33.66	7.35
25	28	33.67	7.36
25	30	33.68	7.37
25	35	33.71	7.40
25	40	33.72	7.41
25	45	33.73	7.42
25	50	33.75	7.44
25	55	33.75	7.44
25	60	33.76	7.45
25	70	33.77	7.46
25	80	33.81	7.50
25	90	33.81	7.50
25	100	33.85	7.54

Q (L/s)	Time (min)	DTW (m)	DD (m)
25	120	33.85	7.54
25	140	33.87	7.56
25	160	33.90	7.59
25	180	33.91	7.60
25	200	33.92	7.61
25	250	33.97	7.66
25	300	34.00	7.69
25	350	34.00	7.69
25	400	34.03	7.72
25	450	34.06	7.75
25	500	34.07	7.76
25	550	34.08	7.77
25	600	34.09	7.78
25	650	34.09	7.78
25	700	34.09	7.78
25	750	34.11	7.80
25	800	34.11	7.80
25	850	34.11	7.80
25	900	34.13	7.82
25	950	34.14	7.83
25	1000	34.15	7.84
25	1050	34.15	7.84
25	1100	34.16	7.85
25	1150	34.17	7.86
25	1200	34.18	7.87
25	1250	34.18	7.87
25	1300	34.19	7.88
25	1350	34.19	7.88
25	1400	34.19	7.88
25	1440	34.21	7.90
0	1441	26.92	0.61
0	1442	27.24	0.93
0	1443	27.14	0.83
0	1444	27.10	0.79
0	1445	27.06	0.75
0	1446	27.05	0.74
0	1447	27.01	0.70
0	1448	27.00	0.69
0	1449	26.98	0.67
0	1450	26.97	0.66
0	1452	26.96	0.65

Q (L/s)	Time (min)	DTW (m)	DD (m)
0	1454	26.93	0.62
0	1456	26.92	0.61
0	1458	26.90	0.59
0	1460	26.89	0.58
0	1462	26.88	0.57
0	1464	26.87	0.56
0	1466	26.85	0.54
0	1468	26.84	0.53
0	1470	26.83	0.52
0	1475	26.82	0.51
0	1480	26.81	0.5
0	1485	26.79	0.48
0	1490	26.78	0.47
0	1495	26.77	0.46
0	1500	26.76	0.45
0	1510	26.74	0.43
0	1520	26.70	0.39
0	1530	26.69	0.38
0	1540	26.68	0.37
0	1560	26.67	0.36
0	1580	26.64	0.33
0	1600	26.63	0.32
0	1620	26.60	0.29
0	1640	26.60	0.29
0	1690	26.55	0.24
0	1740	26.50	0.19
0	1790	26.49	0.18
0	1840	26.49	0.18
0	1890	26.46	0.15

KALANGADOO TWS 3 MANUAL DATA

Q (L/s)	Time (min)	DTW (m)	DD (m)
	0	25.86	
	1	26.16	0.30
	2	26.19	0.33
	3	26.24	0.38
	4	26.27	0.41
	5	26.30	0.44
	6	26.33	0.47
	7	26.35	0.49
	8	26.37	0.51
	9	26.39	0.53
	10	26.40	0.54
	12	26.42	0.56
	14	26.44	0.58
	16	26.46	0.60
	18	26.47	0.61
	20	26.48	0.62
	22	26.50	0.64
	24	26.51	0.65
	26	26.52	0.66
	28	26.53	0.67
	30	26.53	0.67
	35	26.56	0.70
	40	26.57	0.71
	45	26.58	0.72
	50	26.59	0.73
	55	26.61	0.75
	60	26.62	0.76
	70	26.63	0.77
	80	26.64	0.78
	90	26.66	0.80
	100	26.69	0.83
	120	26.71	0.85
	140	26.74	0.88
	160	26.76	0.90
	180	26.78	0.92
	200	26.79	0.93
	250	26.82	0.96
	300	26.84	0.98
	350	26.86	1.00
	400	26.88	1.02

Q (L/s)	Time (min)	DTW (m)	DD (m)
	450	26.90	1.04
	500	26.91	1.05
	550	26.92	1.06
	600	26.93	1.07
	650	26.93	1.07
	700	26.96	1.10
	750	26.97	1.11
	800	26.98	1.12
	850	26.99	1.13
	900	27.00	1.14
	950	27.00	1.14
	1000	27.01	1.15
	1050	27.02	1.16
	1100	27.03	1.17
	1150	27.03	1.17
	1200	27.04	1.18
	1250	27.04	1.18
	1300	27.04	1.18
	1350	27.05	1.19
	1440	27.05	1.19
	1441	25.93	0.07
	1445	26.63	0.77
	1449	26.54	0.68
	1450	26.53	0.67
	1456	26.46	0.60
	1460	26.43	0.57
	1470	26.39	0.53
	1475	26.36	0.50
	1480	26.35	0.49
	1485	26.32	0.46
	1495	26.3	0.43
	1500	26.29	0.40
	1520	26.26	0.38
	1530	26.25	0.35
	1540	26.24	0.32
	1560	26.21	0.31
	1580	26.18	0.29
	1600	26.17	0.28
	1620	26.15	0.25
	1640	26.14	0.20
	1690	26.11	0.25

Q (L/s)	Time (min)	DTW (m)	DD (m)
	1840	26.06	0.20

E. WATER CHEMISTRY

PO Box 1751
Adelaide SA 5001

250 Victoria Square/
Tarndanyangga
Adelaide SA 5000

Tel : 1300 653 366
Fax : 1300 883 171

Internet : www.awqc.com.au
Email : awqc@sawater.com.au

Australian Water Quality Centre

SAW Infrastructure
ATTN: Tim Driver
250 Victoria Square
Adelaide
SA 5100 AUSTRALIA

01/02/2013

Dear Tim

Please find attached the Final Analytical Report for

Customer Service Request:	105296-2012-CSR-58
Account:	105296
Project:	AWQC-66906 SAW Infrastructure - Kalangadoo Bore 4 Commissioning

This report has also been sent to: Maree Shephard Wes Barrat

AWQC Sample Receipt hours are Monday and Tuesday 8:30am to 8pm and Wednesday, Thursday and Friday 8:30am to 4:30pm.

Yours sincerely,

Pat Poldervaart
Account Manager
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Australian Water Quality Centre

FINAL REPORT: 114766

Report Information

Project Name	AWQC-66906
Customer	SAW Infrastructure
CSR_ID	105296-2012-CSR-58

Analytical Results

Sampling Point	23472-Kalangadoo Bore No 4
Sampled Date	11/12/2012 12:00:00AM
Sample Received Date	11/12/2012 8:27:34PM
Sample ID	2012-008-8741
Status	Endorsed
Collection Type	Customer Collected

Bacteriology	LOR	Result
Coliforms T0080-07 WMZ-500		
Coliforms		0 /100mL
Coliforms - Presumptive		0 /100mL
E.coli T0081-07 WMZ-500		
E.coli		0 /100mL
E.coli - Presumptive		0 /100mL

Inorganic Chemistry - Metals	LOR	Result
Aluminium - Acid Soluble TIC-003 W09-023		
Aluminium - Acid Soluble	0.001	0.002 mg/L
Aluminium - Soluble TIC-003 W09-023		
Aluminium - Soluble	0.001	0.001 mg/L
Aluminium - Total TIC-003 W09-023		
Aluminium - Total	0.001	0.010 mg/L
Antimony - Soluble TIC-003 W09-023		
Antimony - Soluble	0.0005	<0.0005 mg/L
Antimony - Total TIC-003 W09-023		
Antimony - Total	0.0005	<0.0005 mg/L
Arsenic - Soluble TIC-003 W09-023		
Arsenic - Soluble	0.0003	0.0007 mg/L
Arsenic - Total TIC-003 W09-023		
Arsenic - Total	0.0003	0.0008 mg/L
Barium - Soluble TIC-003 W09-023		
Barium - Soluble	0.0005	0.0176 mg/L
Barium - Total TIC-003 W09-023		
Barium - Total	0.0005	0.0185 mg/L
Beryllium - Soluble TIC-003 W09-023		
Beryllium - Soluble	0.0003	<0.0003 mg/L
Beryllium - Total TIC-003 W09-023		
Beryllium - Total	0.0003	<0.0003 mg/L
Boron - Soluble TIC-003 W09-023		
Boron - Soluble	0.020	0.035 mg/L

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Cadmium - Soluble TIC-003 W09-023		
Cadmium - Soluble	0.0001	<0.0001 mg/L
Cadmium - Total TIC-003 W09-023		
Cadmium - Total	0.0001	0.0001 mg/L
Calcium Hardness as CaCO3 W09-023		
Calcium Hardness as CaCO3	2.0	290 mg/L
Calcium TIC-003 W09-023		
Calcium	0.04	116 mg/L
Carbonate Hardness as CaCO3 T0203-01 W09-023		
Carbonate hardness as CaCO3	2	336 mg/L
Chlorides - Total as NaCl W09-023		
Chlorides - Total as NaCl	7	181 mg/L
Chromium - Soluble TIC-003 W09-023		
Chromium - Soluble	0.0001	<0.0001 mg/L
Chromium - Total TIC-003 W09-023		
Chromium - Total	0.0001	0.0001 mg/L
Copper - Soluble TIC-003 W09-023		
Copper - Soluble	0.0001	0.0039 mg/L
Copper - Total TIC-003 W09-023		
Copper - Total	0.0001	0.0091 mg/L
Dissolved Solids by Calculation W09-023		
Dissolved solids by calculation	0	510 mg/L
Ion Balance W09-023		
Ion balance		-4.2 %
Iron - Soluble TIC-003 W09-023		
Iron - Soluble	0.0005	0.0149 mg/L
Iron - Total TIC-003 W09-023		
Iron - Total	0.0005	0.4025 mg/L
Langelier Index W09-023		
Langelier Index		0.65
Lead - Soluble TIC-003 W09-023		
Lead - Soluble	0.0001	0.0002 mg/L
Lead - Total TIC-003 W09-023		
Lead - Total	0.0001	0.0110 mg/L
Magnesium Hardness as CaCO3 W09-023		
Magnesium Hardness as CaCO3	2	47 mg/L
Magnesium TIC-003 W09-023		
Magnesium	0.04	11.3 mg/L

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Manganese - Soluble TIC-003 W09-023		
Manganese - Soluble	0.0001	0.0171 mg/L
Manganese - Total TIC-003 W09-023		
Manganese - Total	0.0001	0.0171 mg/L
Mercury - Soluble TIC-003 W09-023		
Mercury - Soluble	0.00003	<0.00003 mg/L
Mercury - Total TIC-003 W09-023		
Mercury - Total	0.00003	<0.00003 mg/L
Molybdenum - Soluble TIC-003 W09-023		
Molybdenum - Soluble	0.0001	0.0003 mg/L
Molybdenum - Total TIC-003 W09-023		
Molybdenum - Total	0.0001	0.0003 mg/L
Nickel - Soluble TIC-003 W09-023		
Nickel - Soluble	0.0001	0.0002 mg/L
Nickel - Total TIC-003 W09-023		
Nickel - Total	0.0001	0.0003 mg/L
Noncarbonate Hardness as CaCO3 T0204-01 W09-023		
Noncarbonate hardness as CaCO3	2	<2 mg/L
Potassium TIC-003 W09-023		
Potassium	0.040	1.81 mg/L
Selenium - Soluble TIC-003 W09-023		
Selenium - Soluble	0.0001	<0.0001 mg/L
Selenium - Total TIC-003 W09-023		
Selenium - Total	0.0001	<0.0001 mg/L
Silver - Soluble TIC-003 W09-023		
Silver - Soluble	0.00003	<0.00003 mg/L
Silver - Total TIC-003 W09-023		
Silver - Total	0.00003	<0.00003 mg/L
Sodium Adsorption Ratio W09-023		
Sodium Adsorption Ratio - Calculation		1.39
Sodium TIC-003 W09-023		
Sodium	0.04	58.4 mg/L
Sodium/Total Cations Ratio W09-023		
Sodium/Total cations ratio	1	27.3 %
Sulphur TIC-004 W09-023		
Sulphate	1.5	6.9 mg/L
Tin - Soluble TIC-003 W09-023		
Tin - Soluble	0.0005	<0.0005 mg/L

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Tin - Total TIC-003 W09-023		
Tin - Total	0.0005	<0.0005 mg/L
Total Hardness as CaCO3 W09-023		
Total Hardness as CaCO3	2.0	336 mg/L
Uranium - Soluble TIC-003 W09-023		
Uranium - Soluble	0.0001	<0.0001 mg/L
Uranium - Total TIC-003 W09-023		
Uranium - Total	0.0001	<0.0001 mg/L
Zinc - soluble TIC-003 W09-023		
Zinc - Soluble	0.0003	0.0212 mg/L
Zinc - Total TIC-003 W09-023		
Zinc - Total	0.0003	0.0230 mg/L

Inorganic Chemistry - Nutrients	LOR	Result
Ammonia as N T0100-01 W09-023		
Ammonia as N	0.005	0.037 mg/L
Bromide T0114-01 W09-023		
# Bromide	0.025	0.28 mg/L
Chloride T0104-02 W09-023		
Chloride	4.0	110 mg/L
Fluoride W09-023		
Fluoride	0.10	0.14 mg/L
Iodide T0117-01 W09-023		
# Iodide	0.01	0.02 mg/L
Nitrate + Nitrite as N T0161-01 W09-023		
Nitrate + Nitrite as N	0.003	<0.003 mg/L
Nitrate + Nitrite as NO3 T0161-01 W09-023		
Nitrate + Nitrite as NO3	0.02	<0.02 mg/L
Nitrate as N W09-023		
Nitrate as Nitrogen	0.005	<0.005 mg/L
Nitrite as N T0107-01 W09-023		
Nitrite as Nitrogen	0.003	<0.003 mg/L
Phosphorus - Filterable Reactive as P T0108-01 W09-023		
Phosphorus - Filterable Reactive as P	0.003	0.007 mg/L
Phosphorus - Total T0109-01 W09-023		
Phosphorus - Total	0.005	0.216 mg/L
Silica - Reactive T0111-01 W09-023		
Silica - Reactive	1	13 mg/L

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TKN as N T0112-01 W09-023		
TKN as Nitrogen	0.05	1.31 mg/L

Organic Chemistry	LOR	Result
Acidic Herbicides T0803-03 W09-023		
# 2 4 5-T	0.05	<0.05 µg/L
# 2 4-D	0.05	<0.05 µg/L
# Chlorsulfuron	0.05	<0.05 µg/L
# Clopyralid	0.5	<0.5 µg/L
# Dicamba	0.2	<0.2 µg/L
# MCPA	0.05	<0.05 µg/L
# Metsulfuron Methyl	0.05	<0.05 µg/L
# Picloram	0.2	<0.2 µg/L
# Silvex	0.05	<0.05 µg/L
# Sulfometuron	0.05	<0.05 µg/L
# Triclopyr	0.1	<0.1 µg/L
BTEX T1120-01 W09-023		
Benzene	1	<1 µg/L
Ethylbenzene	1	<1 µg/L
m-p-xylene	1	<1 µg/L
o-xylene	1	<1 µg/L
Toluene	1	<1 µg/L
Dissolved Organic Carbon W09-023		
Dissolved Organic Carbon	0.3	1.3 mg/L
GCMS Scan - Dichloromethane T1072-01 W09-023		
# GCMS Scan		No semi-volatile organic compounds were detected. Some compounds may not have been extracted using dichloromethane and/or detected by GC/MS.
OrganoChlorine Pesticides T0700-01 W09-023		
Aldrin	0.01	<0.01 µg/L
Chlordane-a	0.01	<0.01 µg/L
Chlordane-g	0.01	<0.01 µg/L
Chlorothalonil	0.05	<0.05 µg/L
Chlorpyrifos	0.05	<0.05 µg/L
Chlorthal-Dimethyl	0.05	<0.05 µg/L
DDD	0.05	<0.05 µg/L
DDE	0.05	<0.05 µg/L
DDT	0.05	<0.05 µg/L

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OrganoChlorine Pesticides T0700-01 W09-023

Dieldrin	0.01	<0.01 µg/L
Endosulfan 1	0.05	<0.05 µg/L
Endosulfan 2	0.05	<0.05 µg/L
Endosulfan Sulphate	0.05	<0.05 µg/L
Endrin	0.05	<0.05 µg/L
Heptachlor	0.05	<0.05 µg/L
Heptachlor Epoxide	0.05	<0.05 µg/L
Hexachlorobenzene	0.05	<0.05 µg/L
Lindane	0.05	<0.05 µg/L
Methoxychlor	0.05	<0.05 µg/L
Total Aldrin and Dieldrin	0.02	<0.02 µg/L
Trifluralin	0.05	<0.05 µg/L
Vinclozolin	0.05	<0.05 µg/L

Organophosphorous and Triazine Pesticides T0800-01 W09-023

Atrazine	0.5	<0.5 µg/L
Azinphos-methyl	0.5	<0.5 µg/L
Diazinon	0.5	<0.5 µg/L
Fenitrothion	0.5	<0.5 µg/L
Hexazinone	0.5	<0.5 µg/L
Malathion	0.5	<0.5 µg/L
Parathion	0.5	<0.5 µg/L
Parathion methyl	0.3	<0.3 µg/L
Prometryne	0.5	<0.5 µg/L
Simazine	0.5	<0.5 µg/L

Inorganic Chemistry - Physical	LOR	Result
Alkalinity Carbonate Bicarbonate and Hydroxide T0101-01 W09-023		
Alkalinity as Calcium Carbonate		343 mg/L
Bicarbonate		419 mg/L
Carbonate		0 mg/L
Hydroxide		0 mg/L
Carbon Dioxide - Free W09-023		
Carbon Dioxide - Free	0	17 mg/L
Colour - True (456nm) Filtered T0029-01 W09-023		
Colour - True (456nm)	1	1 HU
Conductivity & Total Dissolved Solids T0016-01 W09-023		
Conductivity	1	952 µScm
Total Dissolved Solids (by EC)	1.0	520 mg/L
pH T0010-01 W09-023		

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	LOR	Result
pH T0010-01 W09-023		
pH		7.6 pH units
Turbidity T0018-01 W09-023		
Turbidity	0.1	2.7 NTU

Protozoology	LOR	Result
Amoeba Count - Quantitative TPZ-001 WPZ-019		
Amoebae - Total		<2 /L
Naegleria - Total		not detected /L

Inorganic Chemistry - Waste Water	LOR	Result
Cyanide - Total T0167-03 W09-023		
Cyanide as CN - Total	0.05	<0.05 mg/L

Western Radiation Services	LOR	Result
Gross Alpha Activity W09-023		
!External Lab Report No.		WRSJ7242
Gross Alpha Activity	0.005	0.020 Bq/L
Gross Beta Activity (K-40 corrected) W09-023		
!External Lab Report No.		WRSJ7242
Gross Beta Activity (K-40 corrected)	0.010	0.046 Bq/L

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Ivana Cech - Inorganic Chemistry Laboratory Attendent

Vickie Dalgleish - Microbiology Senior Technical Officer

Suzanne Hayes - Protozoology Team Leader

Roger Kennedy - Inorganic Chemistry Process Coordinator

Stephanie Semczuk - Inorganic Chemistry Team Leader

Kamilla Springer - Organic Chemistry Technical Officer

Boutsaba Vorakoumane - Organic Chemistry Scientific Officer

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Analytical Method

Analytical Method Code	Description	Reference Method
T0010-01	Determination of pH	APHA 4500-H B
T0016-01	Determination of Conductivity	APHA 2510 B
T0018-01	Turbidity - Nephelometric Measurement	APHA-AWWA-WEF
T0029-01	Colour, True - Spectrophotometric Measurement	APHA 2120C
T0080-07	Coliforms - MPN Defined Substrate Technique	AS 4276.21-2005
T0081-07	E Coli - MPN Define Substrate Technique Refer T0080-07	AS 4276.21-2005
T0100-01	Ammonia/Ammonium - Automated Flow Colorimetry	APHA 4500-NH3 G
T0101-01	Alkalinity - Automated Acidimetric Titration	APHA 2320 B
T0104-02	Chloride - Automated Flow Colorimetry	APHA 4500-Cl- E
T0107-01	Nitrite - Automated Flow Colorimetry	APHA 4500-NO3-I
T0108-01	Filterable Reactive Phosphorus - Automated Flow Colorimetry	APHA 4500-P G
T0109-01	Total Phosphorus - Automated Flow Colorimetry	APHA 4500-P F
T0111-01	Reactive Silica - Automated Flow Coloimetry	EMPTY
T0112-01	TKN - Automated Flow Colorimetry	APHA-N org A
T0114-01	Bromide	USEPA Method 300.0 (1993).
T0117-01	Iodide	USEPA Method 300.0 (1993).
T0161-01	Nitrate + Nitrate (NOx) - Automated Flow Colorimetry	APHA 4500-NO3-I
T0167-03	Cyanide - Total	APHA 4500-Cl- E
T0203-01	Carbonate Hardness as CaCo3	
T0204-01	Noncarbonate Hardness as CaCo3	
T0700-01	Chlorinated Pesticides	USEPA Method 508
T0800-01	Nitrogen and Phosphorous Containing Pesticides	USEPA Method 507
T0803-03	Acidic Herbicides by LCMS	In House
T1072-01	Fullscan by GCMS	In House
T1120-01	Aromatic Hydrocarbons	USEPA Method 524.2
TIC-003	Elemental Analysis - ICP Mass Spectrometry	EPA method 200.8
TIC-004	Determination of Metals - ICP Spectrometry by ICP2	APHA 3120
TPZ-001	Detection and/or Enumeration of Free Living Amoebae in Water	In House
W-052	Preparation of Samples for Metal Analysis	

Sampling Method

Sampling Method Code	Description
W09-023	Sampling Method for Chemical Analyses
WMZ-500	Sampling Method for Microbiological Analyses
WPZ-019	Sampling Method for Protozoological Analyses

Corporate Accreditation No.1115
Chemical and Biological Testing
This document is issued in accordance with NATA's accreditation requirements.

WORLD RECOGNISED ACCREDITATION

Notes
1. The last figure of the result value is a significant figure.
2. Samples are analysed as received.
3. # determination of the component is not covered by NATA Accreditation.
4. ^ indicates result is out of specification according to the reference Guideline. Refer to Report footer.
5. * indicates incident have been recorded against the sample. Refer to Report footer.
6. & Indicates the results have changed since the last issued report.
7. The Limit of Reporting (LOR) is the lowest concentration of analyte which is reported at the AWQC and is based on the LOQ rounded up to a more readily used value. The Limit of Quantitation (LOQ) is the lowest concentration of analyte for which quantitative results may be obtained within a specified degree of confidence.

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Australian Water Quality Centre

FINAL REPORT: 114766

Laboratory Information

Laboratory	NATA accreditation ID
Bacteriology	1115
Inorganic Chemistry - Metals	1115
Inorganic Chemistry - Nutrients	1115
Organic Chemistry	1115
Inorganic Chemistry - Physical	1115
Protozoology	1115
Inorganic Chemistry - Waste Water	1115
Western Radiation Services	14174

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