TECHNICAL NOTE 2012/04

Department for Environment, Water and Natural Resources

SOUTH EAST TOWN WATER SUPPLY – MILLICENT WASTE WATER TREATMENT PLANT - MILLICENT, SOUTH AUSTRALIA

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Government of South Australia

Department of Environment, Water and Natural Resources

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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 one production well for the Millicent Waste Water Treatment Plant (WWTP) in the South East region of South Australia (Fig. 1), 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 Mount Burr, Naracoorte, Lucindale, and Kalangadoo. This report discusses the drilling and construction of production well Millicent WWTP 6922-4727 which was drilled as a replacement well for the original investigation / production well 6922-4131 drilled by JC & FM Sims Well Drillers in 2001.

Diverse Resources Group Pty Ltd was contracted to drill and construct the new well. Drilling commenced on 19 April 2012 and was completed approximately three days later.

DFW Groundwater Technical Services conducted pumping tests in June 2012.

MILLICENT WASTE WATER TREATMENT PLANT

The SA Water Millicent WWTP services a population of about 5000 people (2011 census data). SA Water had an agreement with an adjacent irrigator to supply reclaimed water, which was also potentially supplemented with unconfined aquifer groundwater, for irrigation use and this is the reason the new well was drilled.

Waste is pumped through a series of tanks in which primary sedimentation takes place before the effluent gravitates to a series of three stabilisation lagoons. Water from Lagoon-3 was initially used for irrigation as it contained low salinity water (1300 mg/L). When Lagoon-3 was drained, effluent from Lagoon-2 was mixed with groundwater and supplied, but the salinity was too high. At times when the lagoons were unable to meet demand, groundwater became the primary source for irrigation but this was also too saline.

The original well 6922-4131 was drilled to 80 m and resulted in a groundwater salinity of 1820 mg/L, which was considered unacceptably high as this was greater than the salinity of the waste water. Close to the ponds is an area of elevated groundwater salinity in the unconfined aquifer. The ambient groundwater salinity in the surrounding area varies between 400 and 800 mg/L.

The reason for the high groundwater salinity at this site is unknown, however it may be related to the area being topographically low and perhaps having been a swamp or wetland in the past. In other parts of the South East it has been observed that higher groundwater salinity underlies wetland areas, where cycles of inundation followed by evaporation have occurred over long periods of time.

The decision to to drill and construct a new production well penetrating the Gambier Limestone to the basal marl, was made on the premise that the lowest salinity groundwater was most likely to occur at the base of the aquifer sequence. If lower salinity groundwater was intersected it could be used to dilute the lagoon water, providing a longer period of irrigation.

Figure 1. Location of Millicent WWTP

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.

Millicent WWTP 6922-4727 was drilled inside the existing Millicent Treatment Works compound 15 m west of the original well 6922-4131 (Fig. 2) targeting the unconfined Gambier Limestone aquifer system. The Digital Elevation Model surface indicates the well is sited at 14.5 m AHD.

Design changes were made (compared to the original well) in an attempt to access potentially lower salinity groundwater at the base of the aquifer:

- 100 m of casing was run into the well (the original well only had 1 m of casing to support unconsolidated surface sediments)
- The casing was pressure cemented in place
- The full aquifer thickess was penetrated during drilling.

Millicent WWTP was drilled as a production well under permit number 206964 (well unit number 6922–4727) and was completed on 13 May 2012.

The final design of the new well was based on information gathered during drilling. Strata samples were collected every two metres. The well construction diagram (Fig. 3) 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 12 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 12 m
- The pilot drillhole was mud drilled to the casing point at 102 m using a 347 mm (13.7 inch) blade bit
- A Class 12 PVC 253 mm (10 inch) ID casing string was run into the drillhole to a depth of 100 m
- The casing was pressure displacement cemented to surface
- Once the grout had set, the well was air drilled to total depth at 192 m using a 247 mm (9.7 inch) bit
- The well was completed with an open hole production zone 100–192 m
- The well was developed by airlifting until the groundwater produced was clear and free of suspended solids.

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 1.82 m and a yield estimated up of 100 L/s were recorded at the conclusion of drilling.

Groundwater salinity was 1600 mg/L (2830 uScm) based on the result of laboratory water chemisty 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.

GEOLOGY - HYDROGEOLOGY

The Gambier Limestone stratigraphy was determined for this well and is given in Table 1. The most transmissive zone in the open hole section of the well (between 100 and 192 m) occurs between 134 and 162 m and can clearly be observed in the neutron log.

Table 1. Stratigraphic units Millicent WWTP 6922-4727

Depth (m)	**Stratigraphic Unit**
0-4	Holocene sediments
4-10	Bridgewater Formation sandstone
10-43	Gambier Limestone -Green Point Member Unit 1
43-84	Gambier Limestone - Green Point Member Unit 2
84-105	Gambier Limestone - Green Point Member Unit 3
105-134	Gambier Limestone - Green Point Member Unit 4
134-162	Gambier Limestone - Camelback Member
162-192	Gambier Limestone - Greenways Member

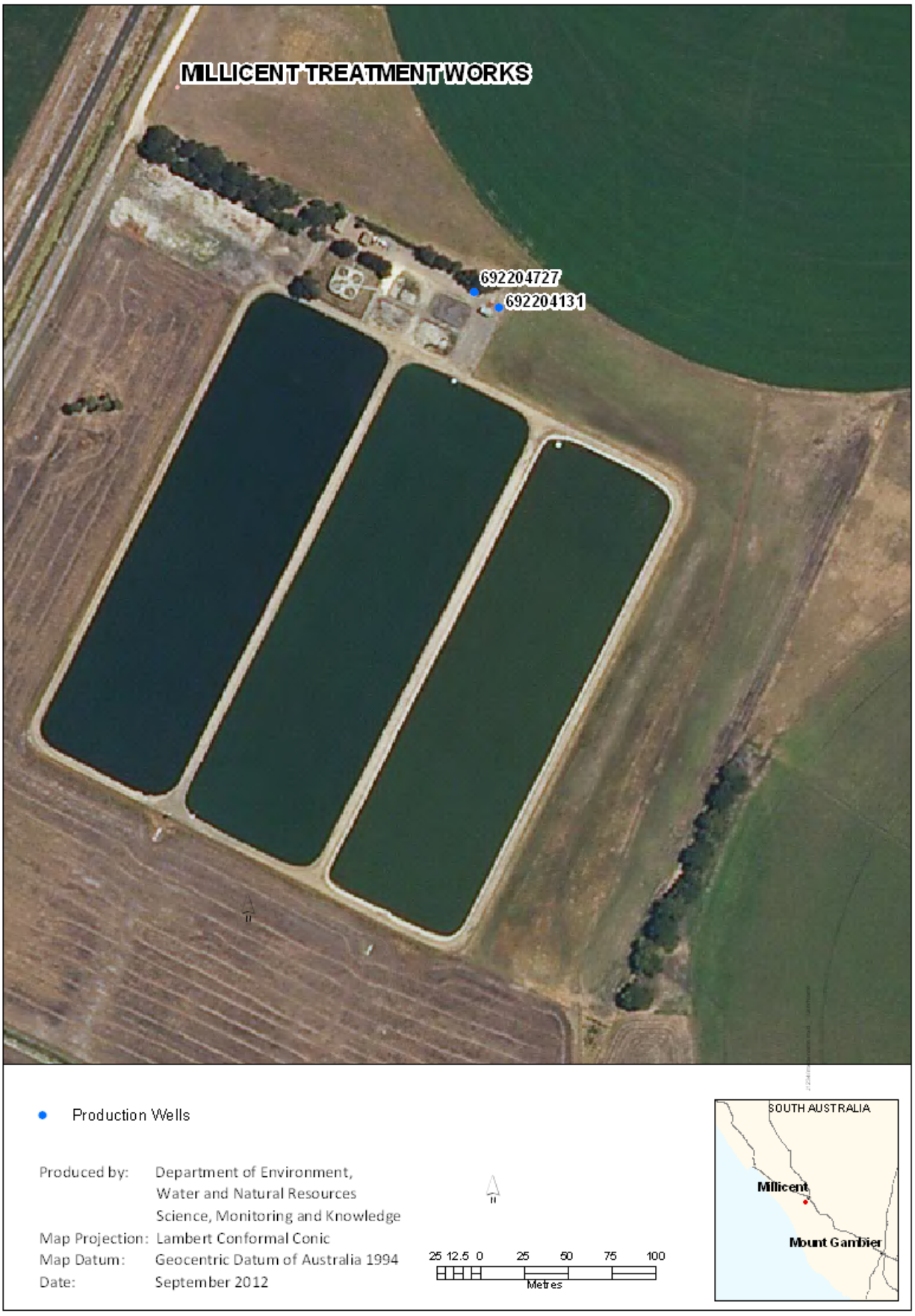


Figure 2. Location of Millicent WWTP production wells

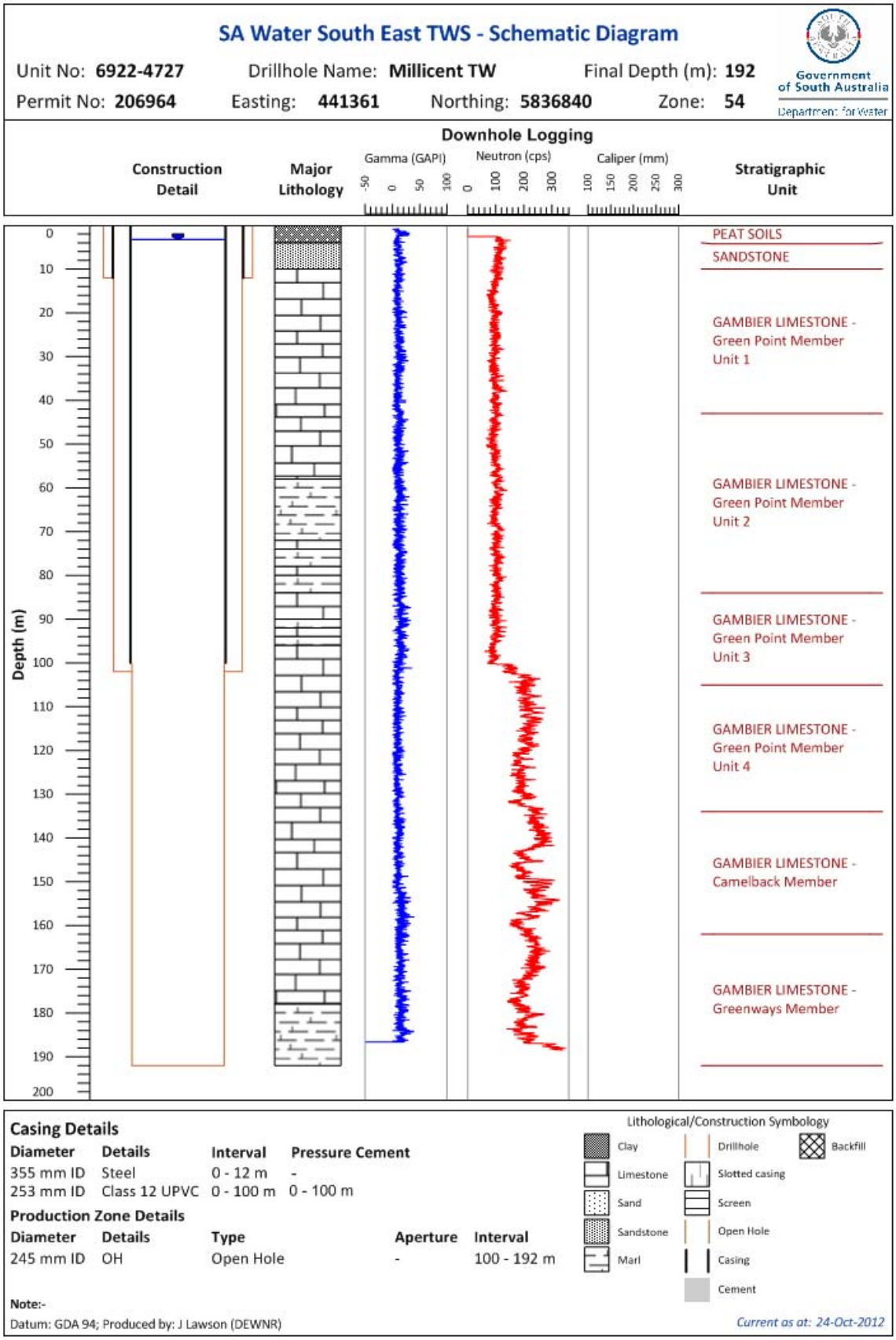


Figure 3. Well construction diagram and lithological sequence Millicent WWTP 6922-4727

GROUNDWATER SALINITY

GROUNDWATER SALINITY PROFILING

Downhole YSI sonde electrical conductivity (EC) profile results collected from the original well 6922-4131 in 2007 are given in Fig. 4. The EC increased after approximately 33 m depth and is constant from 36 m at around 3600 uScm. The temperature at 9 m was about 16.5 ^{0}C and warmed slightly to around 16.8 ^{0}C at 70 m.

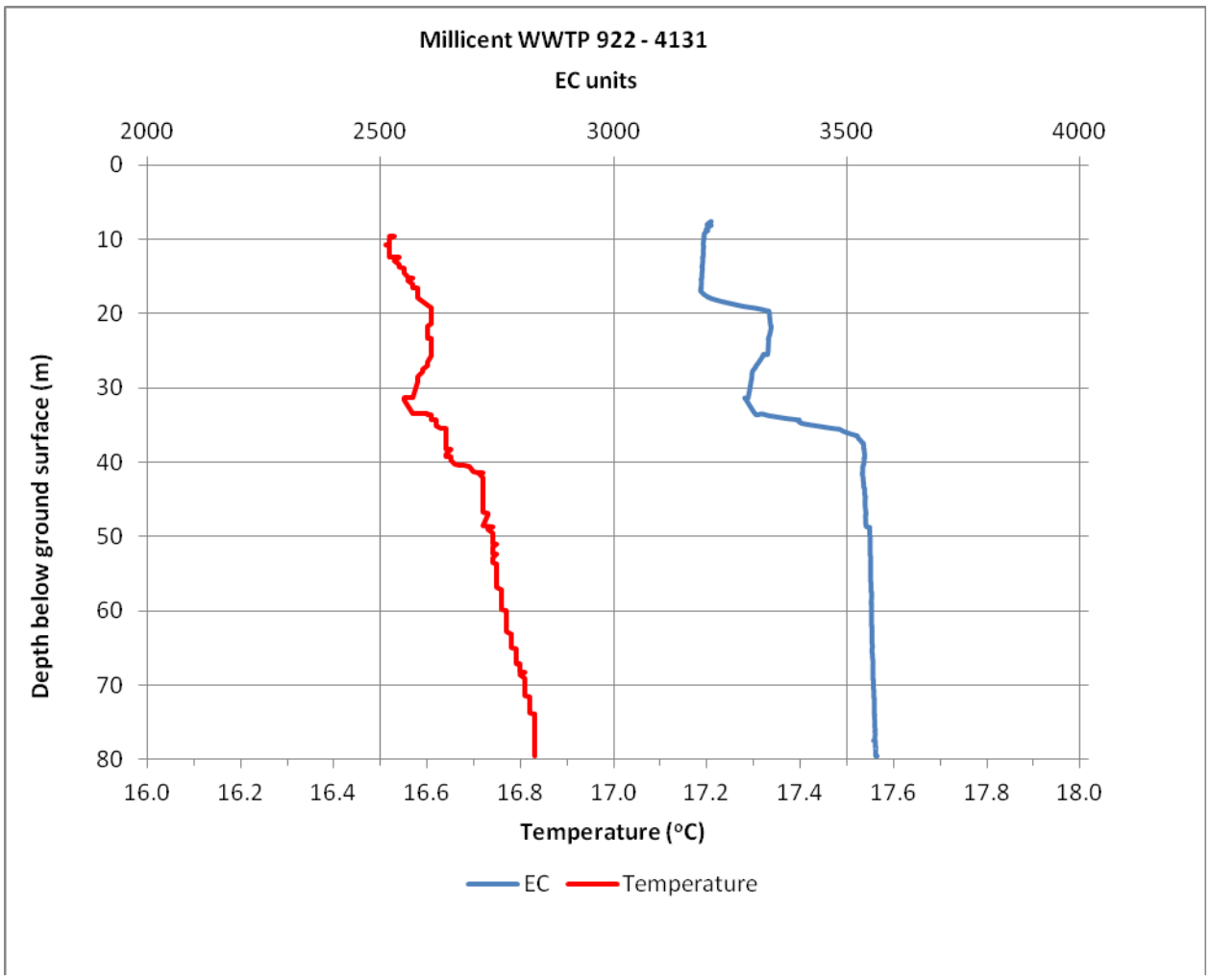


Figure 4. EC profile of original well 6922-4131

Two EC profiles were collected from Millicent WWTP 6922-4727 and are given in Fig. 5.:

- A downhole hydrolab DS4 EC profile around one week after drilling completion on 23 May 2012 before equilibrium groundwater salinity conditions were established in the well
- A downhole hydrolab DS4 EC profile on 27 July 2012 after equilibrium groundwater salinity conditions were established in the well.

The data for the initial profile indicated a large temperature increase from 17.5 ^{0}C degrees as the top of the open hole section at 100 m depth to nearly 22.5 ^{0}C at 188 m. The reason for the increasing temperature with depth is not known. The temperature change corresponded with a decrease in groundwater salinity from around 3600 uScm to around 2700 uScm.

The data from the second profile indicated a temperature increase from 17.5 ^{0}C at the top of the open hole section to 22.5 ^{0}C at 188 m depth. In contrast to the initial profile, groundwater salinity was reasonably constant at about 3400 uScm (except for the increase between 100 and 120 m) and this indicated higher salinity groundwater had permeated the entire aquifer.

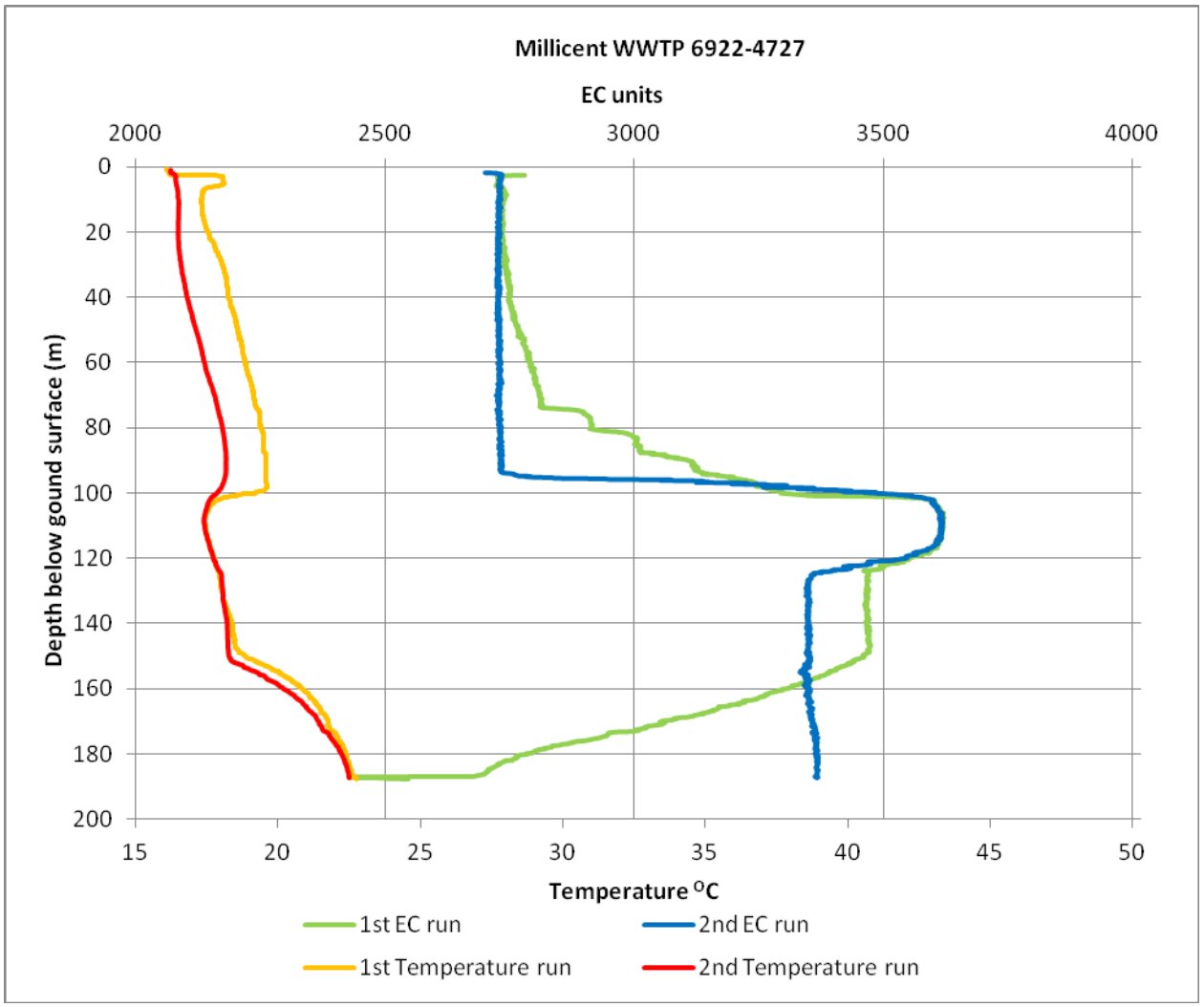


Figure 5. EC profiles of Millicent WWTP 6922-4727

GROUNDWATER SAMPLING

Millicent WWTP 6922-4727 was pumped to collect water samples for chemical analysis on 21 August 2012. A calibrated field instrument was used to record EC and temperature which stabilised after about 210 minutes. Water samples were collected at 240 minutes. The field results are given in Fig. 6 which indicates that after column evacuation had occurred the groundwater salinity stabilised at approximately 2900 uScm.

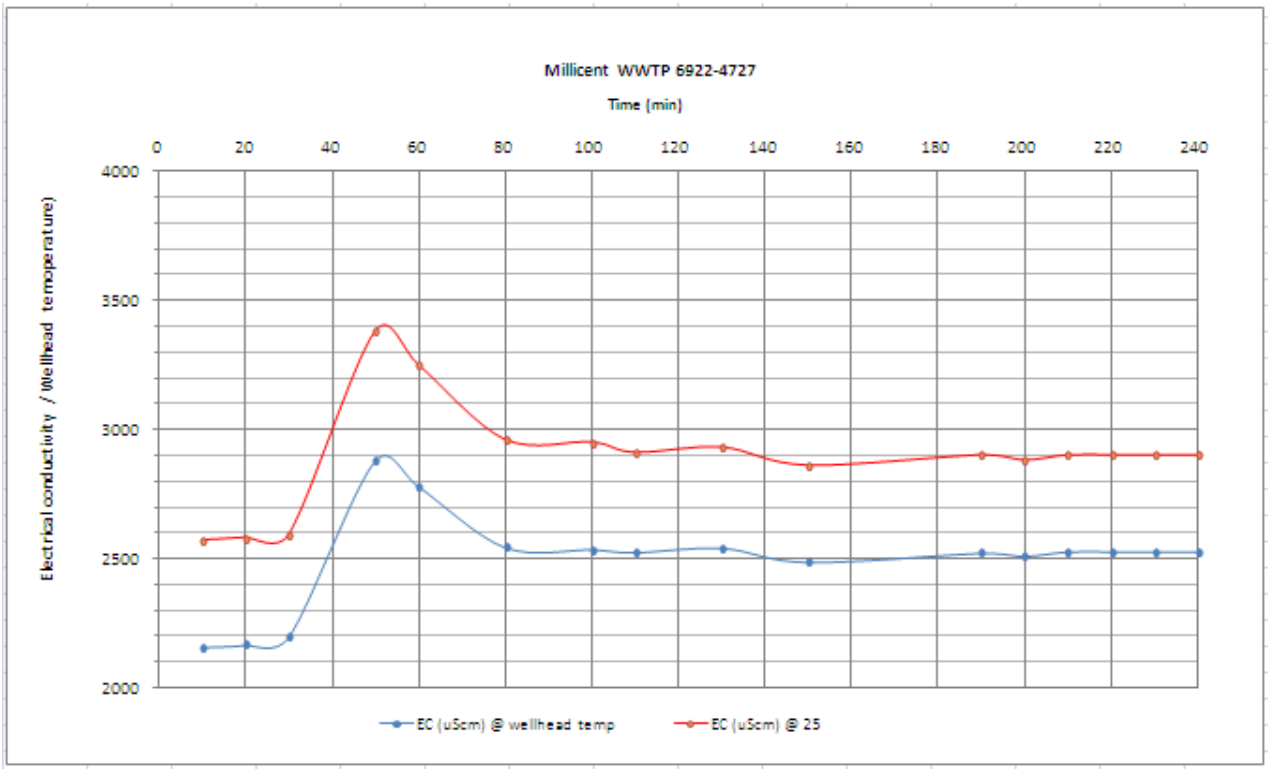


Figure 6. Wellhead EC Millicent WWTP 6922-4727

GROUNDWATER SALINITIES

Because of the elevated groundwater salinity in the original well 6922-4131 it was important to understand if Millicent WWTP 6922-4727 could supply lower salinity groundwater to supplement water from Lagoon-3 for irrigation. The EC values collected from both the original well and new well are given in Table 2.

Three samples were collected from the new well:

- After completion of drilling the new well was air drilled from 100 to 190 m resulting in effective development. The final water sample was analysed in the Primary Industries and Resources Core Library at 25 ^{0}C
- During an initial sampling run a water sample was collected after 240 minutes pumping when groundwater salinity and temperature stabilised. The field meter corrected the sample EC to 25 ^{0}C
- During a final sampling run a water sample was collected and analysed by SA Water at 25 ^{0}C.

Table 2. Comparison of conductivities original well 6922-4131 and Millicent WWTP 6922-4727

Sample	EC (uScm) 25 ^{0}C	Comment
Original well 6922- 4131	3280	Sample from completed well laboratory result
Millicent WWTP 6922- 4727	2730	Airlifted sample from completed well field meter
	2900	Pumped sample field instrument results
	2530	Pumped sample salinity at well head temperature
	2830	Pumped sample laboratory result

The results of the samples, allowing for machine error, are effectively the same and indicate an improvement in the final groundwater quality of the Millicent WWTP 6922-4727 compared to the original well 6922-4131 of approximately 450 uScm. The final pumped sample was about 100 uScm higher than the

initial airlift sample, and can be considered a more accurate representation of the aquifer salinity due to time since well completion and the various pumping events that occurred.

The final laboratory results give a salinity of 2830 EC (1600 mg/L), and this is marginally acceptable to contribute for irrigation purposes.

A further consideration is relevant to the new well due to the marginal groundwater salinity. Salinity results are normally given at a common temperature datum of 25 ^{0}C to enable comparisons between different samples and different regions. In this case it is useful to calculate the groundwater salinity at well head temperature. The well head temperature was 18.6 ^{0}C and when the EC is corrected it reduces to 2530 uScm (1391 mg/L using a conversion factor of 0.55). This salinity is comparable with that of Lagoon-3.

Comment is required on the results of the downhole hydrolab DS4 EC profiling conducted on the new well compared to the laboratory results. The EC profilea are considered an accurate representation of the downhole conditions but the individual values should not be considered completely accurate. The EC profile indicates the highest salinity groundwater water occurs between 100 and 120 m. If this section was cased off the overall salinity of the well would probably improve. This important information was unknown until drilling was completed because of the well construction methodology.

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.

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

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 the 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 (G Dworak and J West (SA Water) 2011, pers. comm., 5 May):

- 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 new Millicent WWTP 6922-4727 consisted of a step drawdown test and a constant rate discharge test and recovery test over the period 7–9 June 2012. Test details are given in Table 3 and the results are given in Appendix C.

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 D).

Table 3. Pumping test details Millicent WWTP 6922-4727

Test type	Test date	Step	Duration (min)	Pumping Rate (L/s)
Step drawdown	7 June 2012	1	100	30
		2	100	40
		3	70	50
Constant rate discharge	8–9 June 2012	1	1440	40
Recovery	9 June 2012	–	500	0

STEP DRAWDOWN TEST

Analysis of the step drawdown results for Millicent WWTP 6922-4727 (Fig. 7), using a conservative fit for step-3, leads to the following well equation:

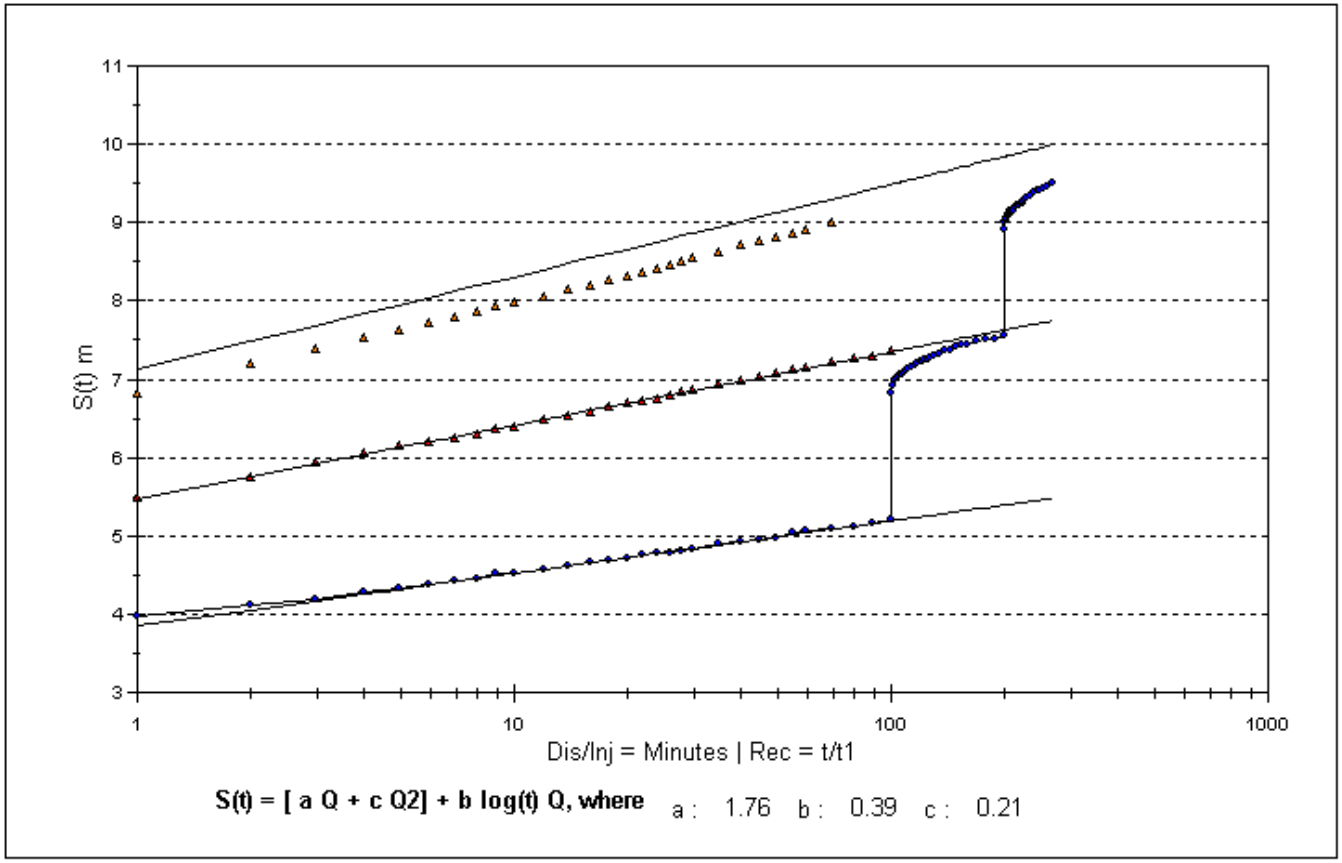
$$s(t) = 1.76\,Q + 0.21\,Q^2 + 0.39 \log (t)\,Q \qquad \text{Equation (2)}$$

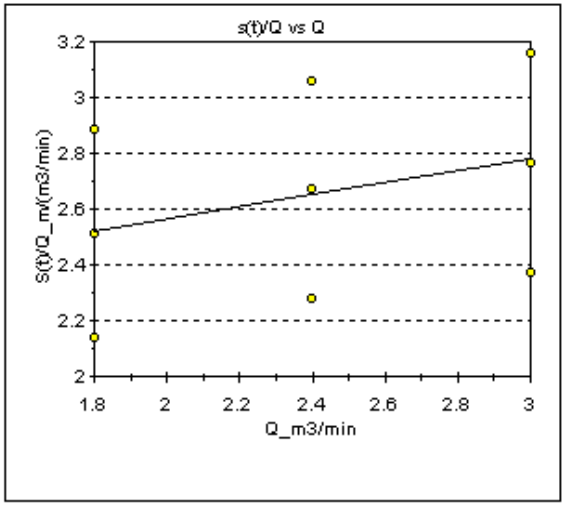
The well equation can be used as a predictive tool. Table 4 gives predicted drawdown after 1 000 000 minutes (approximately 2 years) of continuous pumping at a range of pumping rates. While the theoretical available drawdown is 97 m, drawdowns are very small and this would obviously never be utilised.

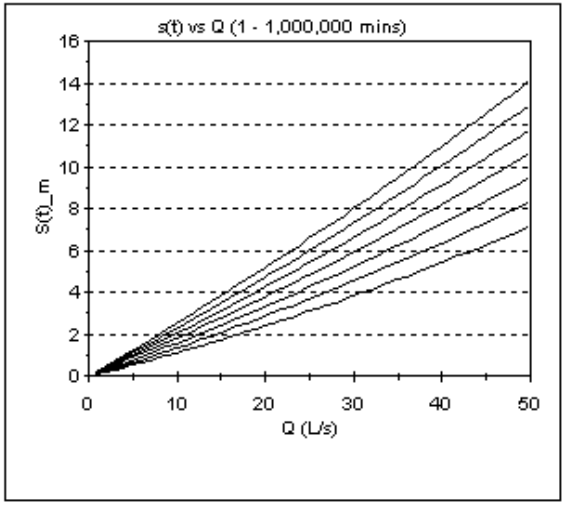
Table 4. Predicted drawdown Millicent WWTP 6922-4727

Pumping rate (L/s)	DTW (m)*	Casing length (m)	Theoretical Available DD (m)	Duration (min)	Predicted DD (m)
10	3	100	97	1 000 000	2.52
20	3	100	97	1 000 000	5.19
30	3	100	97	1 000 000	8.02
40	3	100	97	1 000 000	11.00
50	3	100	97	1 000 000	14.13

*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	30.00	1.80	100	3.86	2.14	4.53	2.52	5.20	2.89	0.67	0.37	708
2	40.00	2.40	100	5.48	2.28	6.42	2.67	7.36	3.07	0.94	0.39	673
3	50.00	3.00	70	7.14	2.38	8.32	2.77	9.50	3.17	1.18	0.39	670
maintest	40.00	2.40	1440									

Figure 7. Step drawdown test analysis of drawdown using Hazel method Millicent WWTP 6922-4727

CONSTANT RATE DISCHARGE TEST

Production Well

Drawdown (residual drawdown) were recorded during the constant rate discharge test and recovery (Fig. 8).

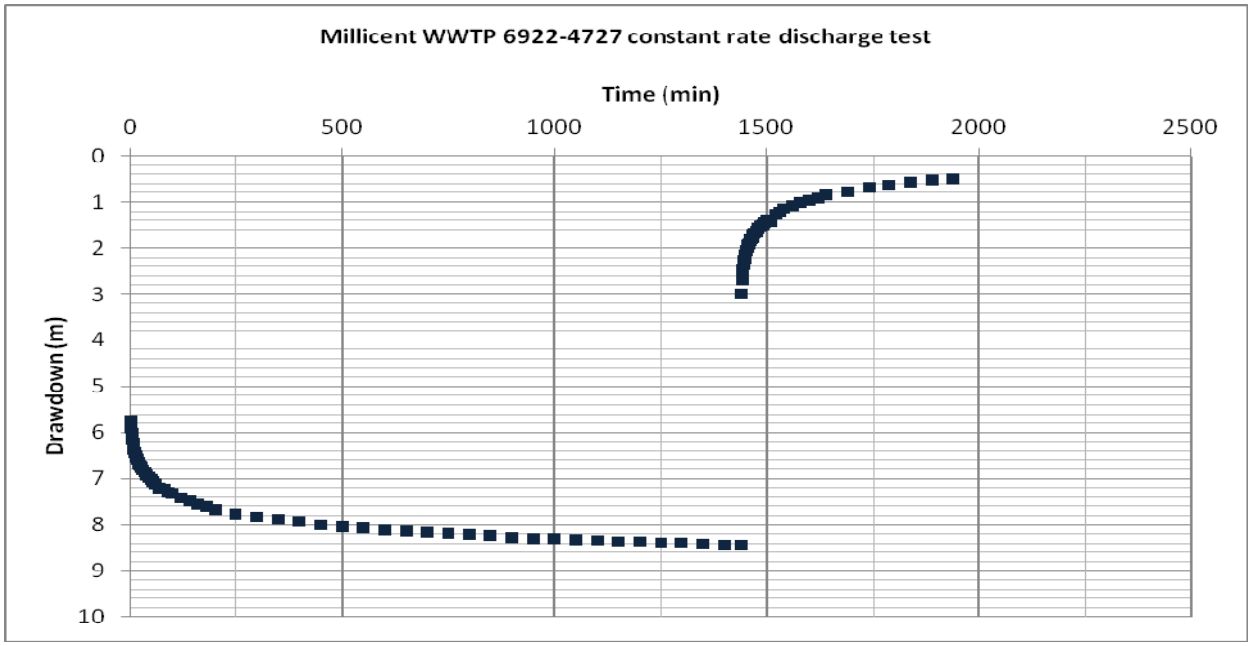


Figure 8. **Linear-linear plot of drawdown Millicent WWTP 6922-4727 constant rate discharge test**

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. 9.

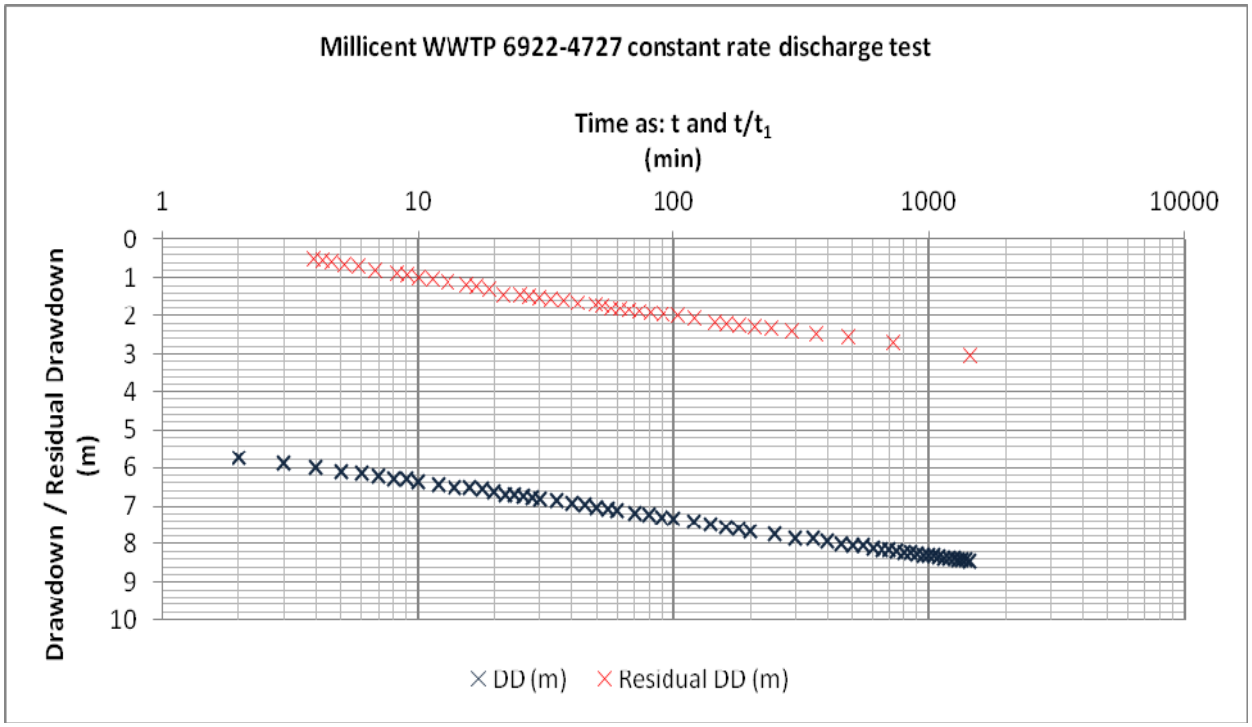


Figure 9. **Log-linear plot of drawdown / residual drawdown Millicent WWTP 6922-4727 constant rate discharge test**

The following general comments can be made:

- A drawdown of 8.45 m developed during the test
- The well equation slightly under-predicts the observed drawdown at the end of the constant rate discharge test by -1.9% (Fig. 10)
- The specific capacity at 100 minutes was 5.41 L/s per metre of drawdown
- Well loss was approximately 65% of drawdown at the end of the test
- Recovery was monitored until residual drawdown was within 6% of the total drawdown developed. Monitoring of recovery was terminated after 500 minutes and the data are insufficient to make any conclusive comments in relation to the aquifer. It should be noted that Gambier Limestone is a thick regional unconfined aquifer and its capacity to meet demand does not present a problem.

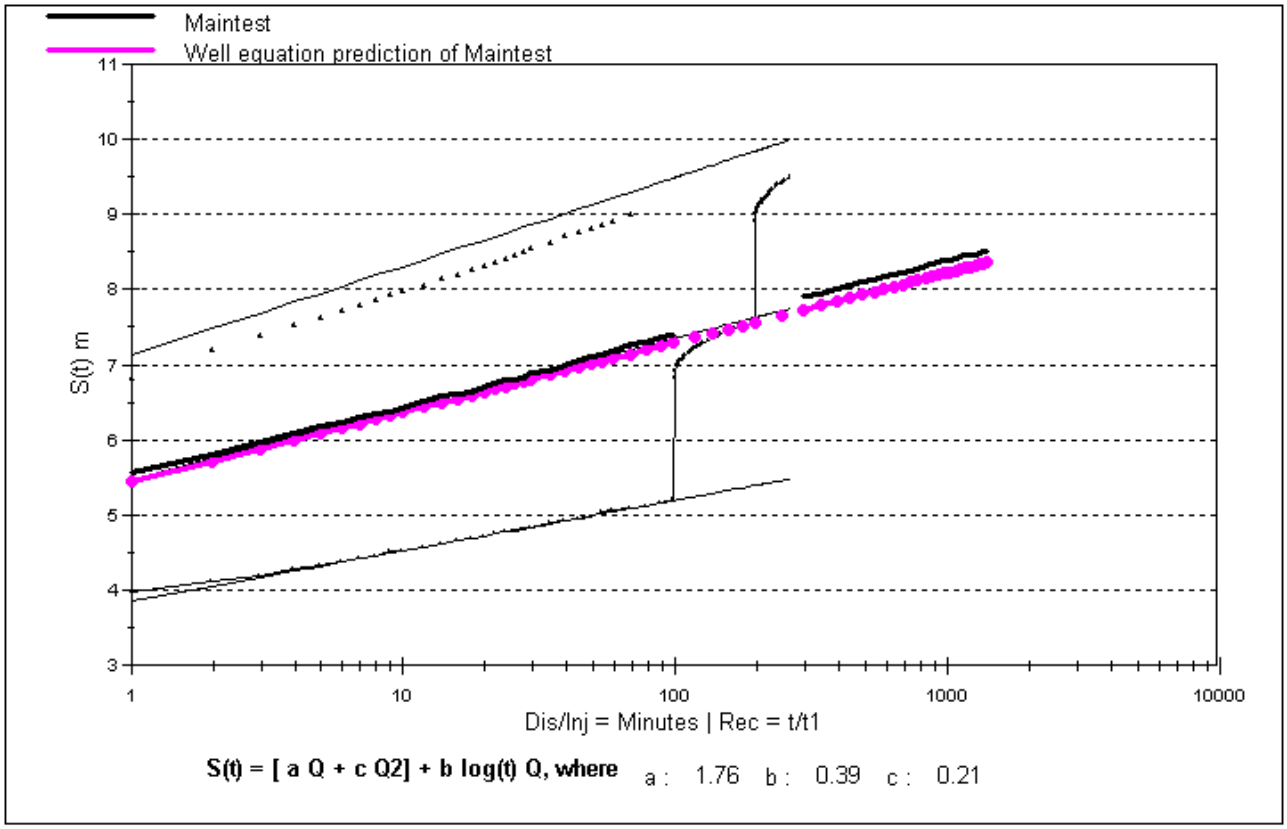


Figure 10. Well equation prediction of constant rate discharge test for Millicent WWTP 6922-4727

Observation Wells

The data from the observation well (6922-4131) at a radial distance of 15.5 m from the production well were analysed using the Cooper Jacob method (Fig. 11). The following general comments can be made:

- A drawdown of 0.77 m developed during the test
- The Gambier Limestone exhibited a drawdown signature at the observation well consistent with an unconfined aquifer
- The hydraulic parameters of Gambier Limestone are given in Table 5. The storage coefficient is consistent with a confined aquifer. This anomaly may be due to the short duration of the test
- There appears to be evidence of a lower permeability aquifer zone inducing slightly more drawdown after 100 minutes. This anomaly may also be due to the close proximity of the observation well to the production well.

Table 5. Analysis results observation well 6922-4131

Obs. Well	Radial distance (m)	Transmissivity (m^2/day)	Storage coefficient	Hydraulic resistance (day)	Method
6922–4131	15.5	3700	7.00 x 10-3	N / A	Cooper Jacob

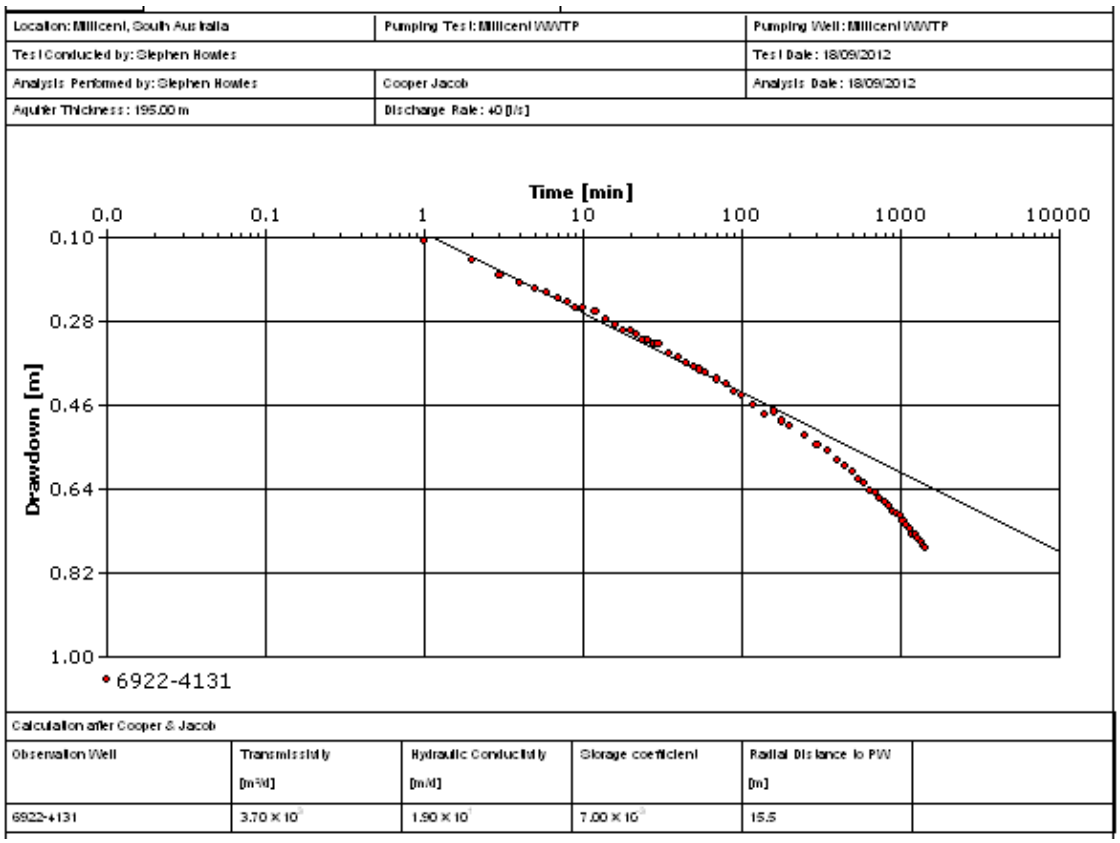


Figure 11. Cooper Jacob analysis of drawdown observation well 6922-4131

GROUNDWATER SALINITY

Groundwater salinity recored during the constant rate discharge test has not been reported as the FL90 proble was not reading correctly.

RECOMMENDATIONS

It is recommended that Millicent WWTP 6922-4727 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 6.

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 6. Well completion details and pumping test summary Millicent WWTP 6922-4727

	Parameter Description	Mount Burr TWS 5
Well Design	Target aquifer	Gambier Limestone
	Assumed depth to water (m)	4 [1]
	Casing inner diameter (mm) nominal	250
	Casing length (m)	100
	Available drawdown (m)	96
SA Water Specification	Required pumping rate (L/s)	N / A
	Required pumping duration	N / A
	Modelled pumping rate (L/s)	40
	Modelled pumping duration	24 h (1440 min)
	Predicted drawdown (m)	8.4
DFW Recommendation	Pumping rate (L/s)	40
	Pumping duration	24 h (1440 min)
	Predicted drawdown (m)	8.4
	Pump intake depth (m)	18 [2]
	Resultant available drawdown safety factor (m)	5.6

Note:

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

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

APPENDIXES

A. WELL CONSTRUCTION REPORT

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

1. PERMIT NO: 20696 4 Site

NAME OF DRILLER PAUL JOISTI Licence No: 3123
Contact Phone/Mobile No.: 0427 901761
Name of plant operator if under supervision: CHRIS JOISTI

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 13/5/12 Surveyed by RT Method GPS
GPS COORDINATES AND DATUM USED
S 37° 06.817'
E 140° 20.135'
☐ GDA 94/WGS84
☐ AGD 66/84 ☐ ZONE 52 ☐ ZONE 53 ☐ ZONE 54

3. WELL NAME MILLICENT
4. LAND IDENTIFICATION
Pastoral Lease or Hundred: MAYURRA
Title or Plan and Parcel: CT 5561/156
Name of Property:

5. SUMMARY *(Please tick appropriate boxes and complete all relevant details)*
Date work Commenced 10/5/12 Date work Completed 13/5/12
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 192 (m) Final Depth 192 (m) Final Standing Water Level 1.52 (m) Final Yield 100+ (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	12	450	BLADE	MUD
12	102	347	BLADE	MUD
102	192	247	HAMMER	AIR

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
12/5	9	192	152	100+	192	100	AIR	1510 ppm

7. CASING LEFT IN WELL

7.1 Dimensions / 7.2 Type

From (m)	To (m)	Internal Diam (mm)	Swell Joint, Welded Collar, Steel, FRP, PVC, etc.
0	12	350	STEEL
0	100	250	PVC

7.3 Casing Cemented

Yes	No	From (m)	To (m)	Cement (bags)	Water (litres)	Other Additives	Cementing Method Used	Comments
☑	☐	0	12	18	270	-	AUGER	
☑	☐	0	100	63	1755	5% BENT	PUMPED	SAMPLE

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

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	4	

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 13/5/12

Driller to deliver this copy together with water samples collected and well location map within 14 days of completion to any of the locations below:
Department of Water Land and Biodiversity Conservation
Science Monitoring & Information, GPO Box 2834 Adelaide SA 5001 (reports only)
Water Laboratory and Geophysical Services, 23 Conyngham Street GLENSIDE SA 5065 or
Mount Gambier Regional Office, 11 Helen Street MOUNT GAMBIER SA 5290 or
Naracoorte Regional Office, 101 Cedar Avenue, NARACOORTE SA 5271

13. FORMATION LOG

From (m)	To (m)	Description of Material
0	1	TOPSOIL
1	8	SAND
8	184	LIMESTONE.
184	192	MARL.

UNIT NUMBER

B. WATER WELL LOG

Project**: MILLICENT TREATMENT WORKS**

Permit Number: **206964**
Date Completed: **13/5/2012**
Unit No: **6922 - 4727**
Drillhole Name: **Millicent Treatment works**
Logged By: **Jeff Lawson**

Backfilled (Y/N): **N**
Total Depth (m): **192**
Drill Method: **Rotary mud, air and water**
Drilling Company: **Diverse Resource Group**
Driller: **Paul Juett**

Coordinates
Easting: **441361**
Northing: **5836840**
Zone: **54**
Datum: **GDA94**

Ground Elevation (m AHD): **14.5 (DEM)**
Reference Elevation (m AHD): **TBD**
Reference Point Type: **TOC**

General Comments: After pressure cementing the casing the cement inside the casing set at 92 m. The well was drilled with air from 114 m which resulted in large volumes of water to the surface estimated at 60 L/sec. The Lithological log has been adjusted to the downhole geophysics. From the base of the casing the hole was air drilled meaning large quantities of water were evacuated from the well. It is suspected that wall washing occurred biasing the samples.

Lithological Description

Depth (m)		Major Lith Unit(s)	Lithology	Formation
From	To			
0	4	PEAT	Black peat soil, slightly clayey. Mixed with unconsolidated calcareous shell material. Some strongly cemented fine grained chips.	RECENT
4	6	SHELL	Loosely sorted shell material in a weak marl. Minor peat clay.	BRIDGEWATER FORMATION
6	10	SHELL	Loosely sorted conical shells.	
10	12	LIMESTONE	White, unconsolidated, good quality fossils. Fine to medium grained.	
12	14	SHELL BED	Unconsolidated large fractured shells to >1cm. Bivalve and conical shells. Strongly cemented fragments of ironstone.	
14	18		Varies from weakly cemented fine grained limestone to coarse unconsolidated bryozoa. Medium grained. 20 – 30% Flint. Minor ironstone.	
18	20		Essentially coarse grained unconsolidated bryozoal limestone.	GAMBIER LIMESTONE
20	22		Off white, weakly cemented fine grained limestone to uncemented medium grained bryozoal limestone. 10 - 15% Flint.	Green Point Member Unit 1
22	26		Increasing flint content to 30 – 40%, brown and	

Depth (m)		Major Lith Unit(s)	Lithology	Formation
From	To			
		LIMESTONE	angular.	
26	28		Off white to pale grey. Fine weakly cemented fragments to medium grained unconsolidated limestone. Medium to coarse grained. 30% Flint – black to grey.	
28	30		Flint increasing to 40%.	
30	32		Off white, unconsolidated. Essentially a coarse grained limestone. 20% Flint – brown to grey.	
32	36		Coarse. Echinoid spines to 2cm. 5% flint.	
36	40		Off white, weakly cemented to uncemented. Fine to medium grained. Overall medium grained. Minor flint.	
40	43		Off white, weakly cemented to uncemented. Fine to medium grained. Overall coarse grained limestone. 5 – 10% Flint.	
43	48		Increasing flint content to about 20 to 30%.	
48	50		Off white, weakly cemented to uncemented. Some coarse shell fragments. Overall fine to medium grained. 5 to 10% Flint – grey, partially silicified.	
50	52	LIMESTONE	Flint increasing to 20 to 30%.	
52	54		35 to 40% flint.	
54	58		Off white, weakly cemented to uncemented. Medium grained content but probable uphole. Overall fine grained. 35 – 45% Flint – brown to grey.	
58	62	FLINT	Dark to light grey, angular fragments. Minor partially silicified fragments. 40% limestone – off white, weakly cemented to uncemented.	GAMBIER LIMESTONE
62	64	FLINT	30% limestone, fine grained.	Green Point Member Unit 2
64	72	MARLY LIMESTONE	Pale grey. Limestone contained in very weakly bounded marl. Strongly cemented fine grained fragments of limestone. 20 - 30% Flint – dark to light grey.	
72	74	LIMESTONE	Off white, essentially uncemented bryozoa. Medium grained limestone.	
74	78	FLINT	Black to grey, angular fragments. 30 – 40% strongly cemented fine grained limestone.	
78	80	LIMESTONE	Off white, weakly cemented limestone. Fine grained. 20% flint.	

Depth (m)		Major Lith Unit(s)	Lithology	Formation
From	To			
80	82	FLINT	Black to grey, angular fragments. 30% grey limestone, fine grained weakly to strongly cemented.	
82	84		Minor % of calcareous silt.	
84	86	LIMESTONE	White, weakly cemented to uncemented. Good quality bryozoa. Medium grained. 30 – 40% flint, grey brown. Some partially silicified fragments.	GAMBIER LIMESTONE Green point Member Unit 3
86	88		20 to 30% flint.	
88	90		Fine to medium grained limestone.	
90	92	MARLY LIMESTONE	Ratio of about 40:60 marl: limestone. Unconsolidated fossils, finer to medium grained in weakly bounded marl.	
92	94	LIMESTONE	Weakly cemented. Minor uncemented component. Occasional echinoid spine. 20 to 30% flint – grey, large % of partially silicified fragments. Minor marl component.	
94	96	FLINT	Brown, dark to light grey colouration. Some fragments partially silicified. 20 to 30% limestone – white, weakly cemented, fine grained.	
96	98	LIMESTONE	White to off white, unconsolidated. Medium to coarse fossil content. Overall coarse grained. Minor flint.	
98	102		Finer grained limestone. Weakly cemented to uncemented. 5 to 10% flint.	
102	105		Off white, weakly to strongly cemented, fine grained fragments. Occasional coarse bryozoal echinoid fossils. 10 to 15% brown flint.	
105	110		Off white but with a green glauconitic tinge. Weakly cemented to uncemented. Higher % of medium grained fossils. Overall fine grained. Minor flint.	GAMBIER LIMESTONE Green point Member Unit 4
110	116		Off white, strong glauconitic staining. Numerous echinoid fragments to >1cm. Medium grained limestone.	
116	122		Off white, strong glauconitic staining. Unconsolidated with occasional weakly cemented fragments. Fine to medium grained limestone. Overall medium grained.	
122	126		White, weakly, moderately cemented to uncemented. Medium grained bryozoal limestone.	
126	130		Glauconitic stained limestone. Varies from pale grey to white. Essentially unconsolidated medium grained limestone.	
130	132		Medium to coarse grained limestone.	
132	134		Medium grained.	
134	136		Medium to fine grained.	GAMBIER LIMESTONE
136	138		Medium grained.	
138	140		Fine grained limestone.	

Depth (m)		Major Lith Unit(s)	Lithology	Formation
From	To			
140	150		Off white, slightly glauconitic stained. Weakly cemented to uncemented. Fine to medium grained.	Camelback Member
150	156		White with minor glauconite staining. Weakly to strongly cemented, fine grained limestone.	
156	162		Off white to pale grey, essentially unconsolidated. Medium to coarse grained limestone. Overall medium grained.	
162	178		Fossil content a little finer. Medium to fine grained.	GAMBIER LIMESTONE Greenways Member
178	180	MARLY LIMESTONE	Off white, weakly bounded limestone with strongly cemented and unconsolidated limestone. Fine to medium grained.	
180	192		Samples are unconsolidated medium grained limestone. Suspect wall washing due to air drilling.	

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)
3.4	192	3.36	40	1440	Pump	N/A	N/A	1600/2830

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	100	253	Class 12 PVC		Y	0	100
Prod zone	100	192	245	Open hole				

C. PUMPING TEST DATA

C.1 MILLICENT WWTP 6922-4727 STEP DRAWDOWN TEST

MILLICENT WWTP 6922-4727

Start date	Start time	Step	Duration (min)	Q (L/s)	Well Name	Well Type	r (m)	Aquifer	Ref Elev. (m AHD)
07/06/2012	08:30	1	100	30	Millicent WWTP 6922-4727	Prod.	0	Gambier Limestone	Not surveyed
"		2	100	40	"	"	"	"	"
"		3	70	50	"	"	"	"	"

MILLICENT WWTP 6922-4727

Step No.	Q (L/s)	Time (min)	DTW (m)	DD (m)
1	30	0	3.28	0.00
1	30	1	7.26	3.98
1	30	2	7.40	4.12
1	30	3	7.48	4.20
1	30	4	7.57	4.29
1	30	5	7.62	4.34
1	30	6	7.67	4.39
1	30	7	7.71	4.43
1	30	8	7.75	4.47
1	30	9	7.80	4.52
1	30	10	7.81	4.53
1	30	12	7.85	4.57
1	30	14	7.90	4.62
1	30	16	7.95	4.67
1	30	18	7.97	4.69
1	30	20	8.01	4.73
1	30	22	8.05	4.77
1	30	24	8.07	4.79
1	30	26	8.08	4.80
1	30	28	8.10	4.82
1	30	30	8.13	4.85
1	30	35	8.18	4.90
1	30	40	8.21	4.93
1	30	45	8.25	4.97
1	30	50	8.27	4.99
1	30	55	8.33	5.05
1	30	60	8.36	5.08
1	30	70	8.38	5.10
1	30	80	8.41	5.13

Step No.	Q (L/s)	Time (min)	DTW (m)	DD (m)
1	30	90	8.46	5.18
1	30	100	8.50	5.22
2	40	101	10.12	6.84
2	40	102	10.20	6.92
2	40	103	10.27	6.99
2	40	104	10.30	7.02
2	40	105	10.33	7.05
2	40	106	10.34	7.06
2	40	107	10.34	7.06
2	40	108	10.35	7.07
2	40	109	10.38	7.10
2	40	110	10.39	7.11
2	40	112	10.42	7.14
2	40	114	10.44	7.16
2	40	116	10.46	7.18
2	40	118	10.49	7.21
2	40	120	10.51	7.23
2	40	122	10.51	7.23
2	40	124	10.53	7.25
2	40	126	10.55	7.27
2	40	128	10.57	7.29
2	40	130	10.59	7.31
2	40	135	10.62	7.34
2	40	140	10.65	7.37
2	40	145	10.67	7.39
2	40	150	10.70	7.42
2	40	155	10.72	7.44
2	40	160	10.73	7.45
2	40	170	10.78	7.50
2	40	180	10.81	7.53
2	40	190	10.81	7.53
2	40	200	10.85	7.57
3	50	201	12.20	8.92
3	50	202	12.29	9.01
3	50	203	12.33	9.05
3	50	204	12.35	9.07
3	50	205	12.36	9.08
3	50	206	12.39	9.11
3	50	207	12.39	9.11
3	50	208	12.42	9.14
3	50	209	12.44	9.16
3	50	210	12.44	9.16

Step No.	Q (L/s)	Time (min)	DTW (m)	DD (m)
3	50	212	12.45	9.17
3	50	214	12.48	9.20
3	50	216	12.49	9.21
3	50	218	12.51	9.23
3	50	220	12.52	9.24
3	50	222	12.53	9.25
3	50	224	12.54	9.26
3	50	226	12.56	9.28
3	50	228	12.59	9.31
3	50	230	12.6	9.32
3	50	235	12.63	9.35
3	50	240	12.67	9.39
3	50	245	12.69	9.41
3	50	250	12.71	9.43
3	50	255	12.73	9.45
3	50	260	12.75	9.47
3	50	270	12.79	9.51

C2 MILLICENT WWTP 6922-4727 CONSTANT RATE DISCHARGE TEST

MILLICENT WWTP 6922-4727

Start date	Start time	Step	Duration (min)	Q (L/s)	Well Name	Well Type	r (m)	Aquifer	Ref Elev. (m AHD)
08/06/2012	08:30	1	Pumping 1440 Recovery 500	40	Millicent WWTP 6922-4727	Prod.	0	Gambier Limestone	Not surveyed
					6922–4131	Obs.	15.5	Gambier Limestone	Not surveyed

MILLICENT WWTP 6922-4727 MANUAL DATA

Q (L/s)	Time (min)	DTW (m)	DD (m)
40	0	3.36	0.00
40	1	8.86	5.50
40	2	9.10	5.74
40	3	9.26	5.90
40	4	9.37	6.01
40	5	9.47	6.11
40	6	9.51	6.15
40	7	9.58	6.22
40	8	9.64	6.28
40	9	9.67	6.31
40	10	9.72	6.36
40	12	9.80	6.44
40	14	9.87	6.51
40	16	9.89	6.53
40	18	9.93	6.57
40	20	10.00	6.64
40	22	10.05	6.69
40	24	10.08	6.72
40	26	10.10	6.74
40	28	10.12	6.76
40	30	10.18	6.82
40	35	10.22	6.86
40	40	10.29	6.93
40	45	10.34	6.98
40	50	10.39	7.03
40	55	10.43	7.07
40	60	10.48	7.12
40	70	10.56	7.20
40	80	10.60	7.24
40	90	10.66	7.30
40	100	10.68	7.32

Q (L/s)	Time (min)	DTW (m)	DD (m)
40	120	10.78	7.42
40	140	10.85	7.49
40	160	10.92	7.56
40	180	10.97	7.61
40	200	11.03	7.67
40	250	11.12	7.76
40	300	11.20	7.84
40	350	11.23	7.87
40	400	11.29	7.93
40	450	11.35	7.99
40	500	11.40	8.04
40	550	11.42	8.06
40	600	11.47	8.11
40	650	11.50	8.14
40	700	11.52	8.16
40	750	11.55	8.19
40	800	11.57	8.21
40	850	11.60	8.24
40	900	11.63	8.27
40	950	11.65	8.29
40	1000	11.67	8.31
40	1050	11.68	8.32
40	1100	11.71	8.35
40	1150	11.72	8.36
40	1200	11.74	8.38
40	1250	11.75	8.39
40	1300	11.76	8.40
40	1350	11.77	8.41
40	1400	11.79	8.43
40	1440	11.81	8.45
0	1441	6.36	3.00
0	1442	6.04	2.68
0	1443	5.90	2.54
0	1444	5.82	2.46
0	1445	5.73	2.37
0	1446	5.67	2.31
0	1447	5.63	2.27
0	1448	5.58	2.22
0	1449	5.55	2.19
0	1450	5.51	2.15
0	1452	5.42	2.06
0	1454	5.35	1.99

Q (L/s)	Time (min)	DTW (m)	DD (m)
0	1456	5.31	1.95
0	1458	5.27	1.91
0	1460	5.21	1.85
0	1462	5.17	1.81
0	1464	5.16	1.80
0	1466	5.13	1.77
0	1468	5.08	1.72
0	1470	5.04	1.68
0	1475	5.00	1.64
0	1480	4.94	1.58
0	1485	4.88	1.52
0	1490	4.85	1.49
0	1495	4.81	1.45
0	1500	4.77	1.41
0	1510	4.78	1.42
0	1520	4.63	1.27
0	1530	4.57	1.21
0	1540	4.51	1.15
0	1560	4.45	1.09
0	1580	4.38	1.02
0	1600	4.33	0.97
0	1620	4.27	0.91
0	1640	4.22	0.86
0	1690	4.13	0.77
0	1740	4.04	0.68
0	1790	3.99	0.63
0	1840	3.93	0.57
0	1890	3.88	0.52
0	1940	3.85	0.49

6922–4131 MANUAL DATA

Q (L/s)	Time (min)	DTW (m)	DD (m)
	0	2.34	0.00
	1	2.45	0.11
	2	2.49	0.15
	3	2.52	0.18
	4	2.54	0.2
	5	2.55	0.21
	6	2.56	0.22
	7	2.57	0.23
	8	2.58	0.24
	9	2.59	0.25
	10	2.59	0.25
	12	2.60	0.26
	14	2.62	0.28
	16	2.63	0.29
	18	2.64	0.30
	20	2.64	0.30
	22	2.65	0.31
	24	2.66	0.32
	26	2.66	0.32
	28	2.67	0.33
	30	2.67	0.33
	35	2.69	0.35
	40	2.7	0.36
	45	2.71	0.37
	50	2.72	0.38
	55	2.73	0.39
	60	2.73	0.39
	70	2.75	0.41
	80	2.76	0.42
	90	2.77	0.43
	100	2.78	0.44
	120	2.80	0.46
	140	2.82	0.475
	160	2.815	0.475
	180	2.835	0.495
	200	2.845	0.505
	250	2.865	0.525
	300	2.885	0.545
	350	2.90	0.56
	400	2.92	0.58
	450	2.93	0.59

Q (L/s)	Time (min)	DTW (m)	DD (m)
	500	2.945	0.605
	550	2.96	0.62
	600	2.97	0.63
	650	2.985	0.645
	700	2.99	0.65
	750	3.00	0.66
	800	3.01	0.67
	850	3.02	0.68
	900	3.03	0.69
	950	3.04	0.70
	1000	3.04	0.7
	1050	3.05	0.71
	1100	3.06	0.72
	1150	3.07	0.73
	1200	3.08	0.74
	1250	3.08	0.74
	1300	3.09	0.75
	1350	3.10	0.76
	1400	3.11	0.77
	1440	3.11	0.77
	1441	2.97	0.63
	1442	2.94	0.60
	1443	2.92	0.58
	1444	2.90	0.56
	1445	2.89	0.55
	1446	2.89	0.55
	1447	2.88	0.54
	1448	2.87	0.53
	1449	2.86	0.52
	1450	2.85	0.51
	1452	-	-
	1454	2.84	0.50
	1456	2.83	0.49
	1458	2.82	0.48
	1460	2.81	0.47
	1462	2.80	0.46
	1464	2.79	0.45
	1466	2.79	0.45
	1468	2.79	0.45
	1470	2.78	0.44
	1475	2.77	0.43
	1480	2.75	0.41

Q (L/s)	Time (min)	DTW (m)	DD (m)
	1485	2.75	0.41
	1490	2.74	0.40
	1500	2.73	0.39
	1510	2.71	0.37
	1520	2.70	0.36
	1530	2.69	0.35
	1540	2.68	0.34
	1560	2.67	0.33
	1580	2.65	0.31
	1600	2.64	0.30
	1620	2.63	0.29
	1640	2.62	0.28
	1690	2.59	0.25
	1740	2.58	0.24
	1790	2.57	0.23
	1840	2.55	0.21
	1890	2.54	0.20
	1940	2.53	0.19

D. WATER CHEMISTRY

PO Box 1751 Adelaide SA 5001 | 250 Victoria Square 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

25/09/2012

Dear Tim

Please find attached the Final Analytical Report for

Customer Service Request: 105296-2012-CSR-40
Account: 105296
Project: AWQC-63622 SAW Infrastructure -Millicent Reuse Bore 12/13

This report has also been sent to: Maree Shephard

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: 108864

Report Information

Project Name	AWQC-63622
Customer	SAW Infrastructure
CSR_ID	105296-2012-CSR-40

Analytical Results

Customer Sample Description	Millicent WWTP New Reuse Bore
Sampling Point	70004-SAW General Request South East
Sampled Date	21/08/2012 12:00:00AM
Sample Received Date	21/08/2012 8:18:23PM
Sample ID	*2012-005-6442
Status	Endorsed
Collection Type	Customer Collected

Inorganic Chemistry - Metals	LOR	Result
Aluminium - Acid Soluble TIC-003 W09-023		
Aluminium - Acid Soluble	0.001	<0.001 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	0.002 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	<0.0003 mg/L
Arsenic - Total TIC-003 W09-023		
Arsenic - Total	0.0003	<0.0003 mg/L
Barium - Soluble TIC-003 W09-023		
Barium - Soluble	0.0005	0.0020 mg/L
Barium - Total TIC-003 W09-023		
Barium - Total	0.0005	0.0018 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
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	429 mg/L
Calcium TIC-003 W09-023		
Calcium	0.04	172 mg/L
Carbonate Hardness as CaCO3 T0203-01 W09-023		

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Carbonate Hardness as CaCO3 T0203-01 W09-023		
Carbonate hardness as CaCO3	2	533 mg/L
Chlorides - Total as NaCl W09-023		
Chlorides - Total as NaCl	7	1020 mg/L
Chromium - Soluble TIC-003 W09-023		
Chromium - Soluble	0.0001	0.0005 mg/L
Chromium - Total TIC-003 W09-023		
Chromium - Total	0.0001	0.0005 mg/L
Copper - Soluble TIC-003 W09-023		
Copper - Soluble	0.0001	0.0001 mg/L
Copper - Total TIC-003 W09-023		
Copper - Total	0.0001	0.0010 mg/L
Dissolved Solids by Calculation W09-023		
Dissolved solids by calculation	0	1630 mg/L
Ion Balance W09-023		
Ion balance		-3.5 %
Iron - Soluble TIC-003 W09-023		
Iron - Soluble	0.0005	0.0085 mg/L
Iron - Total TIC-003 W09-023		
Iron - Total	0.0005	0.0093 mg/L
Langelier Index W09-023		
Langelier Index		0.36
Lead - Soluble TIC-003 W09-023		
Lead - Soluble	0.0001	<0.0001 mg/L
Lead - Total TIC-003 W09-023		
Lead - Total	0.0001	<0.0001 mg/L
Magnesium Hardness as CaCO3 W09-023		
Magnesium Hardness as CaCO3	2	282 mg/L
Magnesium TIC-003 W09-023		
Magnesium	0.04	68.4 mg/L
Manganese - Soluble TIC-003 W09-023		
Manganese - Soluble	0.0001	0.0011 mg/L
Manganese - Total TIC-003 W09-023		
Manganese - Total	0.0001	0.0011 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

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Molybdenum - Soluble TIC-003 W09-023		
Molybdenum - Soluble	0.0001	<0.0001 mg/L
Molybdenum - Total TIC-003 W09-023		
Molybdenum - Total	0.0001	<0.0001 mg/L
Nickel - Soluble TIC-003 W09-023		
Nickel - Soluble	0.0001	0.0003 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	178 mg/L
Potassium TIC-003 W09-023		
Potassium	0.040	12.0 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		5.25
Sodium TIC-003 W09-023		
Sodium	0.04	322 mg/L
Sodium/Total Cations Ratio W09-023		
Sodium/Total cations ratio	1	49.1 %
Sulphur TIC-004 W09-023		
Sulphate	1.5	122 mg/L
Tin - Soluble TIC-003 W09-023		
Tin - Soluble	0.0005	<0.0005 mg/L
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	711 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

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Zinc - soluble TIC-003 W09-023		
Zinc - Soluble	0.0003	0.0015 mg/L
Zinc - Total TIC-003 W09-023		
Zinc - Total	0.0003	0.0126 mg/L

Inorganic Chemistry - Nutrients	LOR	Result
Ammonia as N T0100-01 W09-023		
Ammonia as N	0.005	0.908 mg/L
Bromide T0114-01 W09-023		
Bromide	0.025	1.06 mg/L
Chloride T0104-02 W09-023		
Chloride	4.0	616 mg/L
Fluoride W09-023		
Fluoride	0.10	1.4 mg/L
Iodide T0117-01 W09-023		
Iodide	0.01	<0.01 mg/L
Nitrate + Nitrite as N T0161-01 W09-023		
Nitrate + Nitrite as N	0.003	0.004 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	0.019 mg/L
Phosphorus - Total T0109-01 W09-023		
Phosphorus - Total	0.005	0.014 mg/L
Silica - Reactive T0111-01 W09-023		
Silica - Reactive	1	50 mg/L
TKN as N T0112-01 W09-023		
TKN as Nitrogen	0.05	1.50 mg/L

Organic Chemistry	LOR	Result
Dissolved Organic Carbon W09-023		
Dissolved Organic Carbon	1.0	23.4 mg/L
GCMS Scan - Dichloromethane T1072-01 W09-023		

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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.

Inorganic Chemistry - Physical	LOR	Result
Alkalinity Carbonate Bicarbonate and Hydroxide T0101-01 W09-023		
Alkalinity as Calcium Carbonate		533 mg/L
Bicarbonate		651 mg/L
Carbonate		0 mg/L
Hydroxide		0 mg/L
Carbon Dioxide - Free W09-023		
Carbon Dioxide - Free	0	103 mg/L
Colour - True (456nm) Filtered T0029-01 W09-023		
Colour - True (456nm)	1	51 HU
Conductivity & Total Dissolved Solids T0016-01 W09-023		
Conductivity	1	2830 µScm
Total Dissolved Solids (by EC)	1.0	1600 mg/L
pH T0010-01 W09-023		
pH		7.0 pH units
Turbidity T0018-01 W09-023		
Turbidity	0.1	0.82 NTU

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.		WRS-7058
Gross Alpha Activity	0.005	0.052 Bq/L
Gross Beta Activity (K-40 corrected) W09-023		
!External Lab Report No.		WRS-7058
Gross Beta Activity (K-40 corrected)	0.010	0.367 Bq/L

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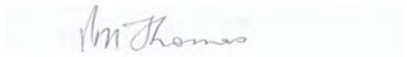
NATA Signatories

Thuy Diep - Inorganic Chemistry Technical Officer

Krys Garstka - Organic Chemistry Technical Officer

Roger Kennedy - Inorganic Chemistry Process Coordinator



Phil Thomas - Inorganic Chemistry Manager

Boutsaba Vorakoumane - Organic Chemistry Scientific Officer

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Incidents

Sample ID	S.Point	Description	Sampled Date	Analysis (where Applicable)	Incident Description
2012-005-6442	70004	Millicent WWTP New Reuse Bore	21/08/2012	Phosphorus - Filterable Reactive as P	Dependent results are within acceptable analytical uncertainty

Analytical Method

Analytical Method Code	Description	Reference Method
T0010-01	Determination of pH	
T0016-01	Determination of Conductivity	
T0018-01	Turbidity - Nephelometric Measurement	
T0029-01	Colour, True - Spectrophotometric Measurement	APHA 2120C
T0100-01	Ammonia/Ammonium - Automated Flow Colorimetry	APHA 4500-NH3 G
T0101-01	Alkalinity - Automated Acidimetric Titration	
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	APHA 4500-Si02 F
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	
T1072-01	Fullscan by GCMS	In House
TIC-003	Elemental Analysis - ICP Mass Spectrometry	
TIC-003	Elemental Analysis - ICP Mass Spectrometry	EPA method 200.8
TIC-004	Determination of Metals - ICP Spectrometry by ICP2	
W-052	Preparation of Samples for Metal Analysis	

Laboratory Information

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

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