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REPORT
on

PRODUCTION BORE INSTALLATION & TESTING LONG BEACH AQUIFER, GREAT KEPPEL ISLAND

prepared for
Ozton Pty Ltd

Project 33976A
8 November 2007

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Douglas Partners Pty Ltd
ABN 75 053 980 117

439 Montague Road
WEST END QLD 4101
Phone (07) 3237 8900
Fax (07) 3237 8999
brisbane@douglaspartners.com.au

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REPORT ON
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1.0 INTRODUCTION

This report describes the results of the installation and test pumping of two productions within the Long Beach aquifer on Great Keppel Island. Douglas Partners Pty Ltd (DP) was commissioned by Sustainable Solutions International Pty Ltd (SSI) on behalf of Ozton Pty Ltd to carry out the work.

It is understood that a major redevelopment of Great Keppel Island is proposed, including an upgrade of the existing resort, construction of new resorts, golf courses, new tourist/ residential accommodation, construction of a new airstrip, and a 300 boat marina. Previously, the existing resort extracted groundwater from shallow sand deposits near the resort as well as from the Long Beach aquifer towards the south-western end of the island for potable water supply. However, over pumping has caused salt water intrusion and a decline in the quality of the groundwater around the resort. Resort Management installed a desalinisation plant in 2004 and ceased pumping from groundwater to improve the quality of the water supply.

In 2006, DP carried out a groundwater supply investigation over the entire island to identify viable groundwater resources which could be utilised to augment the Great Keppel Island water supply (DP, 2007). The investigation identified two potential viable aquifers; the north-eastern aquifer extending between Wreck Beach and Butterfish Bay, and the Long Beach aquifer. Both are unconfined aquifers comprised of dune sands.

The investigation found that the sustainable yield of the Long Beach aquifer was limited due to salt water intrusion from Long Beach, however it was viable as a supplementary water supply. The Long Beach aquifer is separated from the dune sand aquifer at the resort, which contains brackish quality water, by a basement high under the southern end of the airstrip. Groundwater modelling indicated that a supply of 100 kL/day would be sustainable from the aquifer if groundwater was extracted from two bores located near monitoring bore 10 (MB10).

DP's report (2007) recommended that two additional bores be installed in the Long Beach aquifer near MB10, an additional monitoring bore be installed between the pump house and Long Beach, and monitoring of groundwater levels and rainfall at the resort be continued.

This report describes the drilling, construction and installation of the two new production bores, test pumping and analysis, the long-term bore yields, and provides recommendations for a groundwater management plan for the borefield and Long Beach aquifer.

2.0 SCOPE AND OBJECTIVE

The objective of the program was to supervise the drilling and installation of two production bores, test pumping and analysis, to assess the hydraulic parameters of the Long Beach aquifer and to confirm the maximum long-term yields of the production bores.

The scope of work included:

- Locating and lithological logging of the two production bores;
- Supervision of the drilling and construction of the two production bores;
- Bore development using airlift surging techniques;
- Four-stage step drawdown tests on each production bore;
- A 24-hour constant rate pumping test on Production Bore 1 (PB1), and a water level recovery test;
- Field analysis of the groundwater quality from the new and existing bores;
- Groundwater sampling and laboratory analysis to establish baseline groundwater quality of each new production bore;
- Analysis of test pumping data; and
- Preparation of a report summarising the work carried out and providing recommendations for a groundwater management plan for the Long Beach Aquifer.

3.0 SITE LOCATION AND DESCRIPTION

Great Keppel Island is the largest island in the Keppel group of islands, lying approximately 12 km east of Yeppoon on the Central Queensland coastline. It is located within the Mackay/Capricorn region of the Great Barrier Reef Marine Park.

The Mercure Great Keppel Island Resort is located on a dune sand deposit on the south-western end of the island (Drawing 1) between Fisherman's Beach and Long Beach. The main accommodation and resort facilities are situated mainly near Fisherman's Beach where the topography is generally flat. Residential houses and the Keppel Haven Resort are also located on this dune sand deposit between Fisherman's Beach and Putney Beach. The topography becomes slightly undulating on the eastern side towards the surf beach.

The topography of Great Keppel Island is relatively steep and is dominated by two southeast-northwest trending ridges with a maximum elevation of 174 mAHD. Leeks, Putney, and Blackall creeks drain these ridges to the west. Other minor, perennial creeks are relatively short and flow directly to the ocean. A flat to undulating topography is present in the dune sand areas in the northeast and southwest regions of the island.

3.1 Climate & Rainfall

The climate for Great Keppel is subtropical with an annual mean daily maximum temperature of 26.1^{0}C and a minimum temperature of 20.9^{0}C, based on data from the Bureau of Meteorology for Heron Island. The hottest month is January. Mean annual rainfall for Heron Island was reported to be 1047 mm/year (Max Winders & Associates, 2006).

Rainfall data collected from Great Keppel Island Resort shows the annual rainfall for the island between 1995 and 2006 was 780 mm, well below the average for Heron Island. The total annual rainfall for the island is provided as a histogram in Appendix A. The data shows that the months with the highest average rainfall over the 11 year period are December, January and February.

A more complete climatic data set was previously obtained from the Bureau of Meteorology for the region surrounding Great Keppel Island between 1960 and 2006 (DP 2007). This data set comprised monthly totals for rainfall and evaporation. Total annual rainfall varied between 468 mm (2001) and 1686 mm (1990). The average annual rainfall between 1960 and 2006 was calculated to be approximately 1,040 mm. The data indicated the region receives the highest rainfall during the summer months. A good match was generally observed between the onsite rainfall records (between 1996 and 2006) and the data from the Bureau of Meteorology.

4.0 GEOLOGY AND HYDROGEOLOGY

4.1 Geology

Reference to the Rockhampton 1:100,000 Geological Sheet indicates that the island is primarily underlain by the Carboniferous aged Shoalwater Formation comprising metamorphic quartzose and lithic sandstones, with minor mudstone and schist. In three separate areas this Carboniferous sequence is overlain by thin veneers of Quaternary deposits.

The south-western area between Long Beach and Fisherman's Beach are mapped as Quaternary dune beach sand. The previous investigation (DP 2007) found that the Long beach aquifer comprises well-sorted fine to medium grained sand that is between 6 m and 17 m in thickness. Drilling of Production Bore 2 (PB2) indicated during this investigation that the sand is up to 22.5 m in thickness.

4.2 Hydrogeology

The Long Beach aquifer is an unconfined or water table aquifer within the dune sand. Groundwater quality varies from fresh at MB10 and Long Beach Bore 1 to saline at the Long Beach Pump House (Drawing 1). Over pumping in the past has caused excessive drawdown which has reveresd the natural hydraulic gradient along Long Beach resulting in salt water intrusion. Groundwater would naturally flow from the higher elevated areas, situated near the south-eastern end of the airstrip, towards Long Beach. The aquifer receives recharge over its entire surface area through the direct infiltration of rainfall.

5.0 DRILLING AND BORE CONSTRUCTION

Burnett & Gladstone Drilling Pty Ltd conducted the drilling and production bore construction between 22 and 25 October 2007 using a Mayhew 1000 truck-mounted drilling rig (refer Photos 1 and 2). The drilling and bore construction were carried out in accordance with the *'Minimum Construction Requirements for Water Bores in Australia'* (Land and Water Biodiversity Committee, 2003), which is accepted as the industry standard in Australia.

The bores were drilled within the Long Beach aquifer at the locations shown on Drawing 1, PB1 was located 3 m from the existing monitoring bore MB10, and PB2 was located approximately 70 m to the northwest, closer to the end of the airstrip and further away from the coastline. They were drilled with a 250 mm (10 inch) diameter hole to approximately 1.5 m below the base of the sands using conventional rotary mud drilling techniques. Biodegradable liquid polymer mud (Liquid Polymer and Bio-Viz) was used as drilling fluid to remove the cuttings from the borehole. Substantial fluid loss occurred below 10 m depth in both bores.

Carl Deegan, Hydrogeologist with DP, lithologically logged the drill cuttings from the bore on-site. The geological sequence encountered during drilling comprised fine grained sand to 18.5 m depth in PB1 and to 22.5 m depth in PB2, which was underlain by residual sand clay. A complete description of the subsurface profile is shown on the borelogs attached in Appendix B.

The bores were completed as production bores by installing an in-line string of screen and casing into the bore (Photo 2). The bore casing comprised Class 12 uPVC with an internal diameter of 150 mm (or six inch). A 152 mm diameter, stainless steel wire wound screen with an aperture of 0.5 mm was installed at the base of the sand. A filter pack comprised of 2 mm to 3 mm diameter gravel was placed in the annulus between the hole wall and casing/screen. A bentonite seal was placed above the gravel filter pack in the annulus between the borehole wall and the bore casing, along with cement in the top 6 m to prevent surface contamination from entering the bore.

Construction details for both production bores and survey information are summarised in Table 1 and are shown on the composite borelogs attached in Appendix B.

Table 1: Bore Construction Details

Bore	Survey Details		Total Depth (mbGL)[1]	Casing Diameter (mm)	Stainless Steel Screen Interval (mbGL)[1]	Gravel Pack (mbGL)[1]	Static Water Level (26/10/07)		
	GDA Coordinates	Elevation (mAHD)[3]					mbTOC[2]	mbGL	mAHD
PB1	289828 7434205	8.73	18.5	150	14.5 – 18.5	7 – 19.5	7.94	7.44	1.29
PB2	289776 7434244	12.81	22.0	150	18.0 - 22.0	7 – 24.0	11.88	11.48	1.33

Notes: 1. mbGL – metres below ground level
2. mbTOC – metres below top of casing or reference level
3. Elevation of ground surface at base of bore casing.

5.1 Bore Development

The bores were developed by jetting, chemical treatment and airlift surging until clean, visually sand-free water was produced. Bore development was undertaken in accordance with the *'Minimum Construction Requirements for Water Bores in Australia'* (2003) and comprised two hours of airlift surging to flush out the drilling mud. Chlorine was then jetted into the screened section of the bore and left overnight to break down any remaining drilling mud. This was followed the next day by approximately three hours of airlifting and surging of the bore (refer Photo 3).

The airlift yield from the bores after during the development was estimated at approximately 4 L/s for PB1 and 6 L/s for PB2.

6.0 PUMPING TESTS AND ANALYSIS

Pumping tests and analysis were carried out in accordance with Australian Standard AS2368-1990 on production bores PB1 and PB2 to assess the hydraulic parameters of the aquifer and long-term yields of each bore. Procedures and results of the tests are discussed in the following sub-sections.

6.1 Pumping Test Set-Up

A Davey JS250D, 1.5 kW, electric submersible pump powered by a 7.5 kVA generator was used for the step drawdown and constant rate pumping tests. The pump intake was set at 14.5 m below ground level (mbGL) in PB1 and 17.5 mbGL in PB2. Flow was controlled by an inline gate valve and was monitored manually by timing the flow into a 25 L bucket.

Water level drawdown was manually measured using electronic dipmeters.

6.2 Step Drawdown Tests

The step test was conducted to provide information on bore yield and efficiency in relation to the bore's construction and development. Data were analysed using the Eden and Hazel (1973) method which gives an equation for the bore, enabling drawdown for the chosen flow rate over a given time period to be calculated, viz:

$$S_{wt} = (a + b \log t)\, Q + cQ^2$$

where:

S_{wt} = drawdown of the water table at a given time (t)
Q = pumping rate (m^3/day)
t = time in minutes
a,b,c = bore constants assessed from the step drawdown data

An assessment of the efficiency of the bore was made using the equation:

$$\text{Bore Efficiency} = \frac{(a + b \log t)\, Q}{(a + b \log t)\, Q + cQ^2} \times 100$$

where:

$(a + b \log t) Q$ = drawdown due to formation loss
cQ^2 = drawdown due to bore loss

6.2.1 PB1 Analysis

The step drawdown test on PB1 comprising four one-hour steps was carried out on 24 October 2007. Prior to commencement of the test, the static water level was measured at 7.98 m below the top of casing (mbTOC) and 7.48 mbGL. Step drawdown test data are provided in Appendix C. The pumping rates were progressively increased as follows:

Step 1 = 51.8 m^3/day (0.6 L/s)
Step 2 = 129.6 m^3/day (1.5 L/s)
Step 3 = 285.1 m^3/day (3.3 L/s)
Step 4 = 432.0 m^3/day (5.0 L/s)

Step drawdown test data are summarised in Table 2.

Table 2: Step Test Analysis

Step	Q (m^3/day)	Δs (m)	Δs/Q (m/m^3/day)	S_w(1min) (m)	S_w(1min)/Q (m/m^3/day)
1	51.8	0.02	3.9×10^{-4}	0.46	8.88×10^{-3}
2	129.6	0.04	3.1×10^{-4}	1.14	8.80×10^{-3}
3	285.1	0.12	4.2×10^{-4}	2.20	7.72×10^{-3}
4	432.0	0.24	5.6×10^{-4}	3.35	7.75×10^{-3}

Values for the bore constants were obtained from graphical analysis as follows:

$$a = 7.5 \times 10^{-3}$$
$$b = 4.0 \times 10^{-4}$$
$$c = 1.5 \times 10^{-6}$$

Based on these values, the 'bore equation' for PB1 is assessed to be:

$$S_{wt} = (7.5 \times 10^{-3} + 4.0 \times 10^{-4} \log t)\, Q + (1.5 \times 10^{-6})\, Q^2$$

This equation predicts a drawdown of approximately 2.6 m after 24-hours pumping at a rate of 285 m^3/day (3.3 L/s). This compares well with a measured drawdown of 2.57 m at the end of the constant rate test using the same pumping rate.

The 'bore equation' indicates that PB1 is about 90% efficient, which is considered a high efficiency indicating the bore was well developed and little or no drawdown occurs from bore loss.

The bore equation also indicates that pumping the bore at a constant rate of 518 m^3/day (6 L/s) for one year would result in a drawdown of approximately 5.5 m, equivalent to a water level of about 13 mbGL.

Assuming the submersible pump is installed in the bore with the recommended intake level at 14 mbGL, then the maximum available drawdown is approximately 6.5 m. Therefore, 518 m^3/day (6 L/s) would be considered the maximum long-term yield for this bore based upon the analysis of the step drawdown test data and assuming there was no potential for salt water intrusion to occur as a result of pumping within the Long Beach aquifer.

6.2.2 PB2 Analysis

The step drawdown test on PB2 comprising four one-hour steps was carried out on 25 October 2007. Prior to commencement of the test, the static water level was measured at 12.05 mbTOC and 11.55 mbGL. Step drawdown test data are provided in Appendix C. The pumping rates were progressively increased as follows:

Step 1 = 60.5 m^3/day (0.7 L/s)
Step 2 = 155.5 m^3/day (1.8 L/s)
Step 3 = 285.1 m^3/day (3.3 L/s)
Step 4 = 432.0 m^3/day (5.0 L/s)

Step drawdown test data are summarised in Table 3.

Table 3: Step Test Analysis

Step	Q (m^3/day)	Δs (m)	Δs/Q (m/m^3/day)	S_w(1min) (m)	S_w(1min)/Q (m/m^3/day)
1	60.5	0.02	3.3×10^{-4}	0.38	6.28×10^{-3}
2	155.5	0.08	5.1×10^{-4}	0.95	6.10×10^{-3}
3	285.1	0.13	4.6×10^{-4}	1.74	6.10×10^{-3}
4	432.0	0.15	3.5×10^{-4}	2.36	5.46×10^{-3}

Values for the bore constants were obtained from graphical analysis as follows:

$$a = 5.0 \times 10^{-3}$$
$$b = 4.1 \times 10^{-4}$$
$$c = 8.0 \times 10^{-7}$$

Based on these values, the 'bore equation' for PB2 is assessed to be:

$$S_{wt} = (5.0 \times 10^{-3} + 4.1 \times 10^{-4} \log t)\, Q + (8.0 \times 10^{-7})\, Q^2$$

This equation predicts a drawdown of approximately 2.7 m after 100 minutes pumping at a rate of 432 m^3/day (5 L/s). This compares well with a measured drawdown of 2.62 m at the end of the step drawdown test using the same pumping rate.

The 'bore equation' indicates that PB2 is about 90% efficient, which is considered a high efficiency indicating the bore was well developed and little or no drawdown occurs from bore loss.

The bore equation also indicates that pumping the bore at a constant rate of 605 m^3/day (7 L/s) for one year would result in a drawdown of approximately 4.8 m, equivalent to a water level of about 16.3 mbGL.

Assuming the submersible pump is installed in the bore with the recommended intake level at 17.5 mbGL, then the maximum available drawdown is approximately 6 m. Therefore, 605 m^3/day (7 L/s) is would be considered the maximum long-term yield for this bore based upon the analysis of the step drawdown test data and assuming there was no potential for salt water intrusion to occur as a result of pumping within the Long Beach aquifer.

6.3 Constant Rate and Recovery Tests

A constant rate test was carried out on PB1 (Photo 4) to assess more accurately the hydraulic parameters of the aquifer and to assess the presence of boundary conditions, which may increase or decrease the rate of drawdown. Boundaries may be in the form of a barrier (impermeable) boundary, which would increase the rate of drawdown, or recharge boundary which would reduce the rate of drawdown. This information, together with the hydraulic parameters, allows a more accurate assessment of the long-term maximum yield of a bore or borefield. It was therefore

important to compare the hydraulic parameters obtained from the test pumping analysis to those used in the previous modelling (DP 2007) of the aquifer to confirm the accuracy of the predictive results.

The 24-hour constant rate pumping test was commenced at 900 hours on 26 October 2007 and was completed at 900 hours on 27 October 2007. PB1 was pumped continuously at a rate of 285 m^3/day (3.3 L/s), and at completion of pumping, a water level recovery test was carried out. Water level measurements were recorded manually within PB1 and an observation bore MB10 throughout the test. Water levels were also monitored less frequently within PB2 located approximately 70 m from the pumping well PB1.

The constant rate drawdown and recovery data (provided by NBD) were analysed using the *"Aquifer Test Version 3.5"* software package (Waterloo Hydrogeologic, 2002).

The constant rate drawdown data were analysed using the Cooper-Jacob straight line analysis, and curve matching techniques of the Hantush method for a leaky aquifer with no aquitard storage. The recovery data were analysed using the Theis recovery method. Details of these analysis methods are described in Kruseman & de Ridder (1994).

Analysis of the drawdown and recovery data provides an estimate of the hydraulic parameter of aquifer transmissivity. Transmissivity is the coefficient of hydraulic conductivity (permeability) multiplied by the aquifer thickness. The drawdown and recovery analysis sheets for PB1 and MB10 are provided in Appendix D, and a summary of the analysis is provided in Table 4.

Table 4: Summary of Analysis of Pumping Test Data

Bore	Pumping Rate (m^3/day)	SWL (mbGL)	Maximum Drawdown During Test (m)	Transmissivity (m^2/day)	Hydraulic Conductivity (m/day)	Method of Analysis
PB1	993.6 (11.5 L/s)	7.44	2.60	150 240	14 22	Cooper/Jacob Theis Recovery
MB10	-	7.52	0.45	190 350	17 30	Cooper/Jacob Theis Recovery
PB2	-	11.48	0.05	-	-	-

Note: mbGL – metres below ground level

The constant rate test data and analysis indicate that the aquifer is unconfined. The pumping test data indicate that the aquifer has a transmissivity of approximately 220 m^2/day and a hydraulic conductivity (ie. permeability) of 20 m/day at the drilling site. These parameters are similar to those used previously for modelling (DP 2007) suggesting the predictive simulated results are sound.

No barrier or impermeable boundaries were indicated from the data during the 24-hour constant rate test conducted on PB1.

7.0 GROUNDWATER QUALITY

7.1 Field Analysis During 24 hour Pumping Test on PB1

Groundwater samples were collected regularly throughout the 24-hour pumping test, and on-site measurements of water electrical conductivity (EC), salinity, pH and temperature were analysed using calibrated hand-held equipment. Results of the field measurements are summarised in Table 5 below:

Table 5: Results of Field Water Quality Analysis for PB1

Date	Elapsed Time of Constant Rate Test (hour)	Field Analysis			
		pH	EC (µS/cm)	Salinity/TDS (mg/L)	Temp (^{0}C)
26/10/07	0.5	5.7	450	190	25.5
26/10/07	2	5.7	440	190	26.1
26/10/07	4	5.7	460	200	26.5
26/10/07	10	5.8	420	180	25.0
27/10/07	24	5.7	430	190	25.9

Note: µS/cm - micro siemens per centimetre
mg/L - milligrams per litre (parts per million)
TDS - total dissolved salts
Shaded cells exceed the drinking water guideline (NHMRC/ARMCANZ 2004)

The test results showed the relatively low EC levels, ie. the groundwater has a very low salt content, remained constant throughout the 24 hour test. For comparison, the World Health Organisation (WHO) guideline for total dissolved solids of 1,000 mg/L in drinking water is approximately equal to an EC of 2,200 µS/cm. The pH of the groundwater is acidic and exceeds the Australian Drinking Water Guidelines (NHMRC/ARMCANZ 2004) range of 6.5 to 8.5.

7.2 Field Analysis of Existing Bores

Groundwater samples were collected from the new production bores and existing monitoring bores within the Long Beach aquifer, and analysed in the field for pH, EC and temperature. In addition, a water sample from one of the resort rooms was analysed. Sampling locations are shown on Drawing 1, and the results are provided in Table 6, along with water levels and previous results for the same locations from July 2006.

Table 6: Groundwater Field Monitoring Results

Bore	Date Sampled	pH	EC (µS/cm)	Temp	Groundwater Level (mbgl)	Groundwater Level (mbtoc)	Groundwater Level (mAHD)
New Bores:							
PB1	26/10/07	5.8	430	26.1	7.44	7.98	1.29
PB2	25/10/07	5.7	490	25.1	11.88	11.48	1.33
Existing Bores:							
MB10	26/07/06	6.3	450	27.5	7.35	7.78	1.48
MB10	26/10/07	5.7	430	26.1	7.52	8.02	1.31
Long Beach Bore 1	12/07/06	6.8	510	27.4	5.00	5.26	1.16
Long Beach Bore 1	26/10/07	5.9	430	26.6	5.12	5.38	1.04
Long Beach Pump House	12/07/06	8.0	10,100	28	7.95	8.25	0.87
Long Beach Pump House	26/10/07	7.1	14,450	26.4	8.07	8.37	0.75
Room 115	14/07/06	8.0	890	24.3	-	-	-
Room 315	27/10/07	6.6	1890		-	-	-
Drinking Water Guideline		6.5-8.5	<2,200	-	-	-	-

8.0 CONCLUSIONS AND RECOMMENDATIONS

The drilling and bore construction program was successful in locating two new productions bores, PB1 and PB2, within the Long Beach aquifer at the locations shown on Drawing 1. GDA coordinates (eastings and northings) for the bores are given in Table 1. PB1 was installed to 18.5 m depth below ground level with a stainless steel screen section between 14.5 m and 18.5 m. PB2 was installed to 22.0 m depth below ground level with a stainless steel screen section between 18.0 m and 22.0 m.

Test pumping and analysis indicate that the Long Beach aquifer intersected by the bores is an unconfined aquifer with a transmissivity of approximately 220 m^2/day and a hydraulic conductivity of approximately 20 m/day. The constant rate test carried out on PB1 indicated there were no barrier (very low permeability) boundaries affecting the drawdown of the new production bores. Water quality monitored in the field throughout the test indicated the groundwater is fresh, with salinity levels remaining constant throughout the 24 hour test. The groundwater is acidic with a pH of 5.7.

The maximum yield is assessed using step drawdown tests results to be 518 m^3/day (6 L/s) for PB1 and 605 m^3/day (or 7 L/s) for PB2. These yields would be considered sustainable or the recommended maximum long-term yields for the bores if the aquifer had a greater areal extent providing higher volumes of recharge and there was no potential for salt water intrusion to occur as a result of pumping within the Long Beach aquifer. The bore equation indicated that both bores are highly efficient in extracting groundwater from the aquifer, indicating the bores had been fully developed resulting in little or no drawdown from bore loss. This is important as the less drawdown created through pumping from the bores or borefield will reduce the potential for the salt water to intrude further into the aquifer.

The pump intake should be set at least 0.5 m above the top of the screens to prevent possible deterioration of bore efficiency due to iron bacteria over time. By installing the pump intake within the screens it may induce turbulence, which introduces oxygen and potential for iron bacterial growth. The bacterial growth and precipitation of iron will slowly block the screen, thereby decreasing the bore efficiency, causing a greater drawdown and possibly the pumps to burn out. The greater drawdown may adversely affect the groundwater quality as well. It is strongly recommended that the pumps are set no lower than 14 mbGL in PB1 and 17.5 mbGL in PB2.

The hydraulic parameters obtained from the test pumping and analysis are similar to those used in the numerical groundwater modelling previously carried out by DP (DP 2007), which confirm the previous modelling results were accurate. The modelling predicted that pumping at rates greater than 100 kL/day from the two new bores would create a cone of depression within the water table that would reach the Long Beach pump house. The natural hydraulic gradient between the bores and the pump house would then be reversed, leading to the saline water in this part of the aquifer to migrate towards the borefield impacting upon the water quality. If this occurs, it would take a considerable length of time (> 15 years) without any extraction to flush out the salt water through infiltration of rainfall. Therefore, it is recommended that the maximum long-term yield of the borefield is 100 kL/day, i.e. 50 kL/day from each bore.

It is recommended that:

- Submersible pumps capable of supplying approximately 50 kL/day or ~0.5 L/s for the design pumping head are installed into PB1 and PB2;
- The intake of the submersible pumps be installed above the top of the stainless steel screens, i.e. no lower than 14.0 mbGL in PB1 and 17.5 mbGL in PB2;
- A water level monitoring tube of at least 25 mm internal diameter be installed with the pumps. The base of the tube should be approximately 0.5 m above the top of the pump. Water level within the bore should be monitored every month for the first six months of operation, and every three months thereafter;
- Flow meters should be installed on the discharge line at each bore;

- Flow rate should be regulated and monitored regularly to ensure the flow rate is maintained at or below the design rate (i.e. 50 kL/day from each bore); and

- Monitoring is carried out according to the groundwater management plan in Section 8.1.

8.1 Groundwater Management Plan

The following management practices and monitoring program should be adopted to appropriately manage the groundwater resource within the Long Beach aquifer:

- Decommissioning of the old water bores by a licenced water driller. This should comprise cementing the bores from the total depth to the surface. Four bores are located in the corners of the Long Beach Pump house compound, two along the road to the compound after it separates from the man track to Long Beach, and four at the long Beach Bore 1 location (Drawing 1). Two of the latter group are still currently used by the resort. It is recommended that one of these bores be kept as a standby or backup bore for PB1 and PB2. In total, 9 old water bores should be decommissioned to prevent contamination of the resource and possible future over extraction;

- Existing monitoring bores at the Long Beach Bore 1 and pump house locations should be kept for future monitoring purposes. These comprise of 50 mm diameter PVC casing and should be protected by installing steel protective, lockable covers over the PVC casing;

- An additional monitoring bore should be installed half way between the pump house and Long Beach Bore 1 location;

- Steel protective covers and a fence should be installed around each bore location to restrict general public access, potential vandalism, and protect the quality of the groundwater resource;

- Flow rates should be regulated and monitored regularly to ensure the maximum long term yield of the borefield of 100 kL/day is not exceeded for any length of time;

- Preventing any future land use development with a potential to contaminate the groundwater over the surface of the Long Beach aquifer. The groundwater is vulnerable to any surface spills of chemicals and contaminants due to the high permeability of the sand and shallow depth to the groundwater;

- Groundwater level monitoring within PB1, PB2, MB10, Long Beach Bore 1 monitoring bore, and Long Beach pump house monitoring bore on a fortnighlty basis for the first 6 months of borefield operation, and then every 2 months thereafter;

- Monitoring of groundwater pH and EC using hand held calibrated meters within PB1, PB2, MB10, Long Beach Bore 1 monitoring bore, and Long Beach pump house monitoring bore on a monthly basis for the first 12 months of borefield operation, and then every 3 months thereafter;

- Monitoring of groundwater quality (at least EC, pH, ammonia, total nitrogen, nitrate, heavy metals and *E.coli*) within the production bores should be carried out every six months; and

- Current rainfall monitoring should be continued.

The monitoring data should be recorded into excel spreadsheets and reviewed by a qualified hydrogeologist every 12 months.

9.0 LIMITATIONS OF THIS REPORT

DP has provided investigation and consulting services for this project in accordance with current professional and Australian industry standards for hydrogeological assessments. DP's assessment is necessarily based on the results of limited site investigations and upon the restricted program of subsurface sample screening, geophysical logging and analysis of pump test data. Neither DP, nor any other reputable consultant, can provide unqualified warranties, nor does DP assume any liability for site or bore conditions not observed or accessible, during the time of the investigation.

Despite all reasonable care and diligence, the groundwater quality and bore conditions encountered may change over time in response to variations in natural conditions, chemical reactions and other events, eg. groundwater recharge, iron bacteria infestation and/or spillage of contaminating sub-stances. These changes may occur after DP's investigation and assessment.

This report and associated documentation and the information herein have been prepared solely for the use of Ozton Pty Ltd and SSI, and any reliance assumed by third parties on this report shall be at such parties' own risk. Any ensuing liability resulting from use of the report by third parties cannot be transferred to DP.

For and on behalf of
DOUGLAS PARTNERS PTY LTD

Reviewed by

Carl Deegan
Associate / Hydrogeologist

Iain Hair
Senior Associate / Hydrogeologist

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Photo 1: View of PB1 drilling site, mixing drilling mud and preparing to start drilling.

Photo 2: Installing the stainless steel screen into PB1.

Photo 3: View of PB2 drilling site during the bore development and airlift flow test.

Photo 4: Pumping test carried out on PB1, Monitoring carried out in MB10 on the left and PB1 on the right.

PRODUCTION BORE INSTALLATION & TESTING
LONG BEACH AQUIFER, GREAT KEPPEL ISLAND

N
W E
S

0 100 200 300

Douglas Partners
Geotechnics · Environment · Groundwater

Sydney, Newcastle, Brisbane, Melbourne, Perth, Darwin

Campbelltown, Townsville, Cairns, Wollongong, Wyong

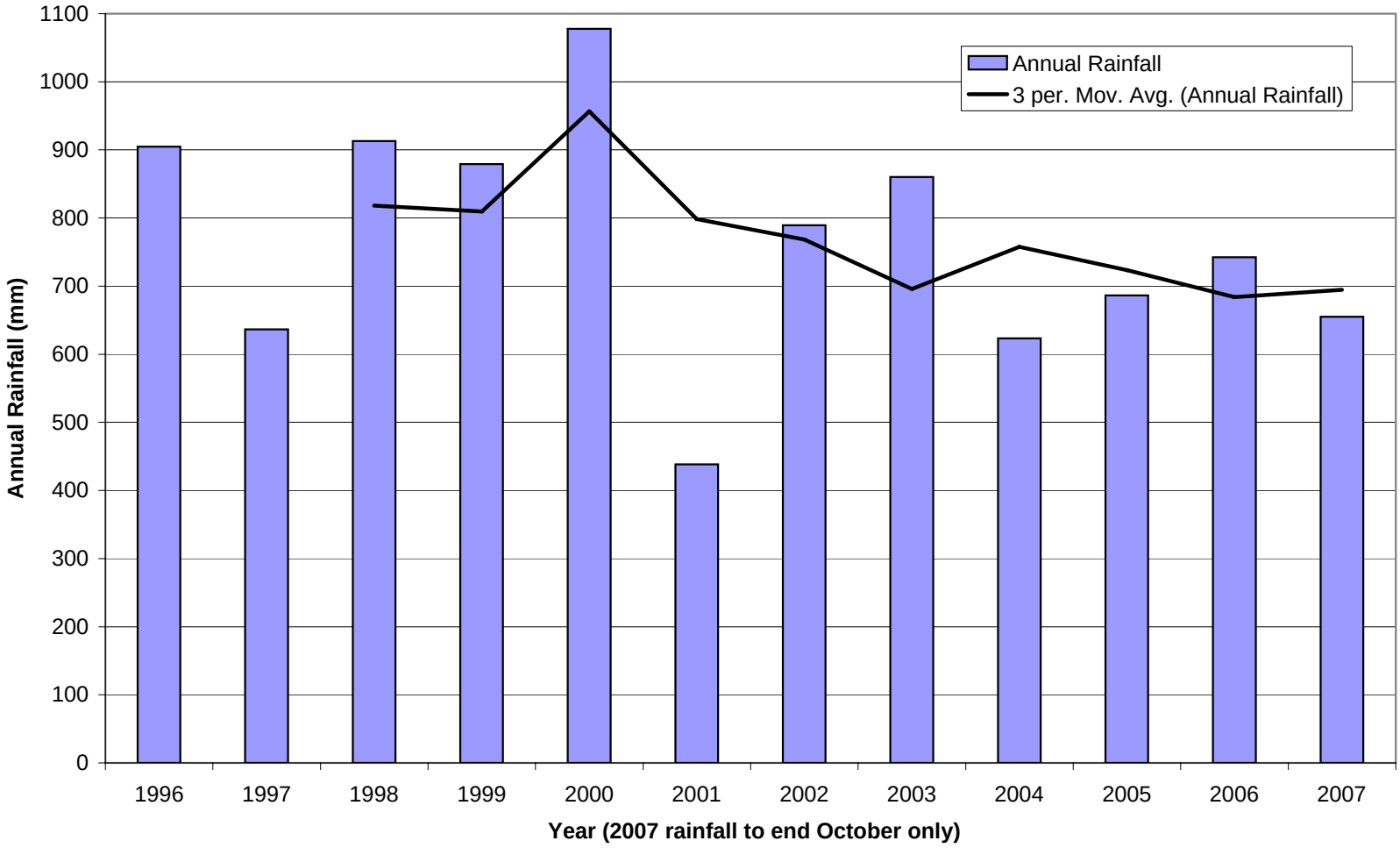
TITLE **PRODUCTION BORE INSTALLATION & TESTING**
LONG BEACH AQUIFER, GREAT KEPPEL ISLAND
Bore Location Plan

CLIENT: OZTON PTY LTD			OFFICE: BRISBANE
DRAWN BY: CD	SCALE: 1:4,000	PROJECT NO: 33796A	Drawing No.: 1
APPROVED BY: CD		DATE: Nov 2007	

APPENDIX A

Great Keppel Island Rainfall Chart

Great Keppel Island Annual Rainfall
1996 - October 2007



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APPENDIX B

Borehole Logs – PB1 & PB2

BOREHOLE LOG

CLIENT: Ozton Pty Ltd
PROJECT: Production Bore Installation and Testing
LOCATION: Long Beach, Great Keppel Island

SURFACE LEVEL: 8.73m
EASTING: 289829
NORTHING: 7434205
DIP/AZIMUTH: 90°/--

BORE No: PB1
PROJECT No: 33976A
DATE: 23.10.2007
SHEET 1 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0	SAND - grey-brown fine to medium grained sand with some silt and organic matter							
	0.5	- dark orange-brown fine grained sand							
	1								
	2								
	2.5	- light orange-brown fine grained sand							
	3								Concrete
	4								
	5								
	6								Bentonite Seal
	7							▼	
	8								
	9								Class 12 PVC 150mm casing

RIG: Mayhew 1000 **DRILLER:** Geoff Bird **LOGGED:** CD **CASING:** Nil

TYPE OF BORING: Rotary mud to 19.5m

WATER OBSERVATIONS: Not possible whilst drilling

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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BOREHOLE LOG

CLIENT: Ozton Pty Ltd
PROJECT: Production Bore Installation and Testing
LOCATION: Long Beach, Great Keppel Island

SURFACE LEVEL: 8.73m
EASTING: 289829
NORTHING: 7434205
DIP/AZIMUTH: 90°/--

BORE No: PB1
PROJECT No: 33976A
DATE: 23.10.2007
SHEET 2 OF 2

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	10.0	SAND - as before							
	11								
	12								
	13								Sand Filter Pack
	14								
	15								
	16								Stainless Steel Screen 150mm
	17								
	17.5	- orange-brown fine grained sand							
	18								
	18.5	SANDY CLAY - orange-brown mottled grey sandy clay							
	19								
	19.5	Bore discontinued at 19.5m							

RIG: Mayhew 1000 **DRILLER:** Geoff Bird **LOGGED:** CD **CASING:** Nil

TYPE OF BORING: Rotary mud to 19.5m

WATER OBSERVATIONS: Not possible whilst drilling

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧗ Water level

CHECKED
Initials:
Date:

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BOREHOLE LOG

CLIENT: Ozton Pty Ltd
PROJECT: Production Bore Installation and Testing
LOCATION: Long Beach, Great Keppel Island

SURFACE LEVEL: 12.81m
EASTING: 289776
NORTHING: 7434244
DIP/AZIMUTH: 90°/--

BORE No: PB2
PROJECT No: 33976A
DATE: 24.10.2007
SHEET 1 OF 3

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	0	SAND - light grey-brown fine grained sand with some silt and organic matter							
	0.5	- light yellow-brown fine grained sand							
	4.5	- dark orange-brown and red fine grained sand							
	6.5	- light orange-brown fine grained sand							

Well Construction Details: 3 Concrete; Bentonite; 8 Class 12 PVC Casing

RIG: Mayhew 1000 **DRILLER:** Geoff Bird **LOGGED:** CD **CASING:** Nil

TYPE OF BORING: Rotary mud to 24.0m

WATER OBSERVATIONS: Not possible whilst drilling

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧗ Water level

CHECKED
Initials:
Date:

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BOREHOLE LOG

CLIENT: Ozton Pty Ltd
PROJECT: Production Bore Installation and Testing
LOCATION: Long Beach, Great Keppel Island

SURFACE LEVEL: 12.81m
EASTING: 289776
NORTHING: 7434244
DIP/AZIMUTH: 90°/--

BORE No: PB2
PROJECT No: 33976A
DATE: 24.10.2007
SHEET 2 OF 3

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	10.0	- light yellow-brown fine grained sand							
	11							▼	Sand Filter Pack
	12								
	13								
	14								
	15								
	16								
	17								
	18								150mm diameter stainless steel screen
	19								

RIG: Mayhew 1000 **DRILLER:** Geoff Bird **LOGGED:** CD **CASING:** Nil

TYPE OF BORING: Rotary mud to 24.0m

WATER OBSERVATIONS: Not possible whilst drilling

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ▼ Water level

CHECKED
Initials:
Date:

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BOREHOLE LOG

CLIENT: Ozton Pty Ltd
PROJECT: Production Bore Installation and Testing
LOCATION: Long Beach, Great Keppel Island

SURFACE LEVEL: 12.81m
EASTING: 289776
NORTHING: 7434244
DIP/AZIMUTH: 90°/--

BORE No: PB2
PROJECT No: 33976A
DATE: 24.10.2007
SHEET 3 OF 3

RL	Depth (m)	Description of Strata	Graphic Log	Sampling & In Situ Testing: Type	Depth	Sample	Results & Comments	Water	Well Construction Details
	20.0	SAND - as before							
	22.5	SANDY CLAY - light grey mottled orange-red sandy clay							
	24.0	Bore discontinued at 24.0m							

RIG: Mayhew 1000 **DRILLER:** Geoff Bird **LOGGED:** CD **CASING:** Nil

TYPE OF BORING: Rotary mud to 24.0m

WATER OBSERVATIONS: Not possible whilst drilling

REMARKS:

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	pp	Pocket penetrometer (kPa)
D	Disturbed sample	PID	Photo ionisation detector
B	Bulk sample	S	Standard penetration test
U_x	Tube sample (x mm dia.)	PL	Point load strength Is(50) MPa
W	Water sample	V	Shear Vane (kPa)
C	Core drilling	▷	Water seep ⧗ Water level

CHECKED
Initials:
Date:

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APPENDIX C

Step Drawdown Test Data

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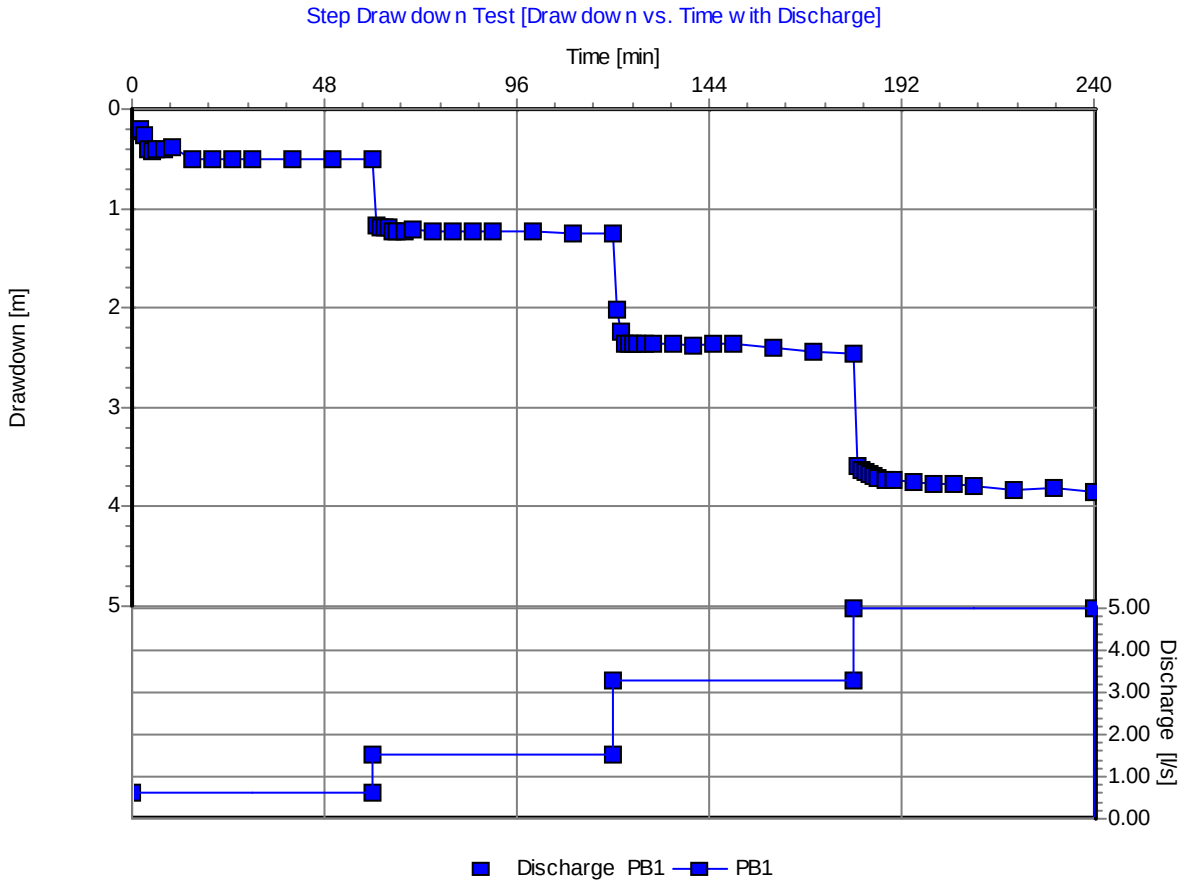
Pumping Test Analysis Report

Project: Production Bore Installation & Testing

Number: 33976A

Client: Ozton Pty Ltd



Pumping Test: **Step Drawdown Test - PB1**

Analysis Method: **Drawdown vs. Time with Discharge**

Analysis Results:

Test parameters:				
	Pumping Well:	PB1	Aquifer Thickness:	11 [m]
	Casing radius:	0.075 [m]		
	Screen length:	4 [m]		
	Boring radius:	0.125 [m]		
	Discharge Rate:	2.5990833 [l/s]		

Comments:

Evaluated by: CMD

Evaluation Date: 26/10/2007

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Pumping Test Data Report

Project: Production Bore Installation & Testing

Number: 33976A

Client: Ozton Pty Ltd

Data observed at:	**PB1**	**Pumping Test:**	**Step Drawdown Test - PB1**
Distance from PW:	0 [m]	Pumping Well:	PB1
Depth to Static WL:	7.98 [m]	Casing radius:	0.075 [m]
Location:	Great Keppel Island	Boring radius:	0.125 [m]
Recorded by:	Watervation Pty Ltd	Screen length:	4 [m]
Date:	26/10/2007	Aquifer Thickness:	11 [m]

	Time [min]	Depth to WL [m]	Drawdown [m]
1	1	8.20	0.22
2	2	8.19	0.21
3	3	8.25	0.27
4	4	8.38	0.40
5	5	8.40	0.42
6	6	8.38	0.40
7	8	8.38	0.40
8	10	8.37	0.39
9	15	8.49	0.51
10	20	8.49	0.51
11	25	8.49	0.51
12	30	8.49	0.51
13	40	8.49	0.51
14	50	8.49	0.51
15	60	8.49	0.51
16	61	9.15	1.17
17	62	9.16	1.18
18	63	9.16	1.18
19	64	9.16	1.18
20	65	9.21	1.23
21	66	9.21	1.23
22	68	9.21	1.23
23	70	9.19	1.21
24	75	9.20	1.22
25	80	9.20	1.22
26	85	9.20	1.22
27	90	9.20	1.22
28	100	9.21	1.23
29	110	9.22	1.24
30	120	9.22	1.24
31	121	10.00	2.02
32	122	10.21	2.23
33	123	10.33	2.35
34	124	10.34	2.36

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Pumping Test Data Report

Project: Production Bore Installation & Testing

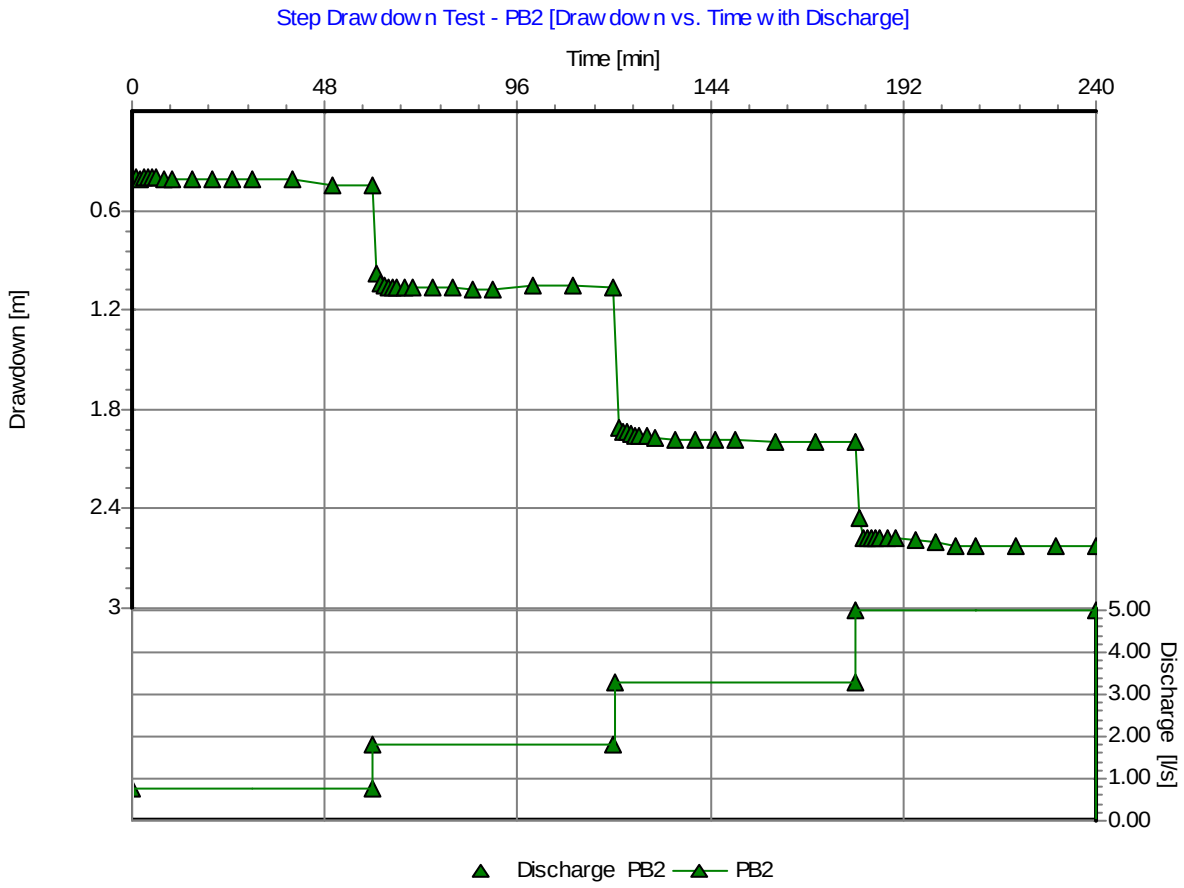
Number: 33976A

Client: Ozton Pty Ltd

Data observed at:	**PB1**	**Pumping Test:**	**Step Drawdown Test - PB1**
Distance from PW:	0 [m]	Pumping Well:	PB1
Depth to Static WL:	7.98 [m]	Casing radius:	0.075 [m]
Location:	Great Keppel Island	Boring radius:	0.125 [m]
Recorded by:	Watervation Pty Ltd	Screen length:	4 [m]
Date:	26/10/2007	Aquifer Thickness:	11 [m]

	Time [min]	Depth to WL [m]	Drawdown [m]
35	125	10.34	2.36
36	126	10.34	2.36
37	128	10.34	2.36
38	130	10.34	2.36
39	135	10.34	2.36
40	140	10.35	2.37
41	145	10.34	2.36
42	150	10.34	2.36
43	160	10.38	2.40
44	170	10.41	2.43
45	180	10.44	2.46
46	181	11.57	3.59
47	182	11.61	3.63
48	183	11.63	3.65
49	184	11.64	3.66
50	185	11.67	3.69
51	186	11.69	3.71
52	188	11.71	3.73
53	190	11.71	3.73
54	195	11.73	3.75
55	200	11.75	3.77
56	205	11.76	3.78
57	210	11.77	3.79
58	220	11.82	3.84
59	230	11.80	3.82
60	240	11.83	3.85

Douglas Partners Geotechnics • Environment • Groundwater	**Pumping Test Analysis Report**
	Project: Production Bore Installation & Testing
	Number: 33976A
	Client: Ozton Pty Ltd



Pumping Test: **Step Drawdown Test - PB2**

Analysis Method: **Drawdown vs. Time with Discharge**

Analysis Results:

Test parameters:				
	Pumping Well:	PB2	Aquifer Thickness:	11 [m]
	Casing radius:	0.075 [m]		
	Screen length:	4 [m]		
	Boring radius:	0.125 [m]		
	Discharge Rate:	2.7091125 [l/s]		

Comments:

Evaluated by: CMD

Evaluation Date: 6/11/2007

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Pumping Test Data Report

Project: Production Bore Installation & Testing

Number: 33976A

Client: Ozton Pty Ltd

Data observed at:	**PB2**	**Pumping Test:**	**Step Drawdown Test - PB2**
Distance from PW:	0 [m]	Pumping Well:	PB2
Depth to Static WL:	12.05 [m]	Casing radius:	0.075 [m]
Location:	Great Keppel Island	Boring radius:	0.125 [m]
Recorded by:	Watervation Pty Ltd	Screen length:	4 [m]
Date:	26/10/2007	Aquifer Thickness:	11 [m]

	Time [min]	Depth to WL [m]	Drawdown [m]
1	1	12.45	0.40
2	2	12.46	0.41
3	3	12.45	0.40
4	4	12.45	0.40
5	5	12.45	0.40
6	6	12.45	0.40
7	8	12.46	0.41
8	10	12.46	0.41
9	15	12.46	0.41
10	20	12.46	0.41
11	25	12.46	0.41
12	30	12.46	0.41
13	40	12.46	0.41
14	50	12.50	0.45
15	60	12.50	0.45
16	61	13.03	0.98
17	62	13.09	1.04
18	63	13.10	1.05
19	64	13.11	1.06
20	65	13.11	1.06
21	66	13.11	1.06
22	68	13.11	1.06
23	70	13.11	1.06
24	75	13.12	1.07
25	80	13.12	1.07
26	85	13.13	1.08
27	90	13.13	1.08
28	100	13.10	1.05
29	110	13.10	1.05
30	120	13.12	1.07
31	121	13.96	1.91
32	122	13.99	1.94
33	123	13.99	1.94
34	124	14.00	1.95

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Pumping Test Data Report

Project: Production Bore Installation & Testing

Number: 33976A

Client: Ozton Pty Ltd

Data observed at:	**PB2**	**Pumping Test:**	**Step Drawdown Test - PB2**
Distance from PW:	0 [m]	Pumping Well:	PB2
Depth to Static WL:	12.05 [m]	Casing radius:	0.075 [m]
Location:	Great Keppel Island	Boring radius:	0.125 [m]
Recorded by:	Watervation Pty Ltd	Screen length:	4 [m]
Date:	26/10/2007	Aquifer Thickness:	11 [m]

	Time [min]	Depth to WL [m]	Drawdown [m]
35	125	14.01	1.96
36	126	14.01	1.96
37	128	14.01	1.96
38	130	14.02	1.97
39	135	14.03	1.98
40	140	14.03	1.98
41	145	14.03	1.98
42	150	14.03	1.98
43	160	14.04	1.99
44	170	14.04	1.99
45	180	14.04	1.99
46	181	14.50	2.45
47	182	14.63	2.58
48	183	14.63	2.58
49	184	14.63	2.58
50	185	14.63	2.58
51	186	14.63	2.58
52	188	14.63	2.58
53	190	14.63	2.58
54	195	14.64	2.59
55	200	14.65	2.60
56	205	14.67	2.62
57	210	14.67	2.62
58	220	14.67	2.62
59	230	14.67	2.62
60	240	14.67	2.62

APPENDIX D

Constant Rate and Recovery Test Analysis Sheets

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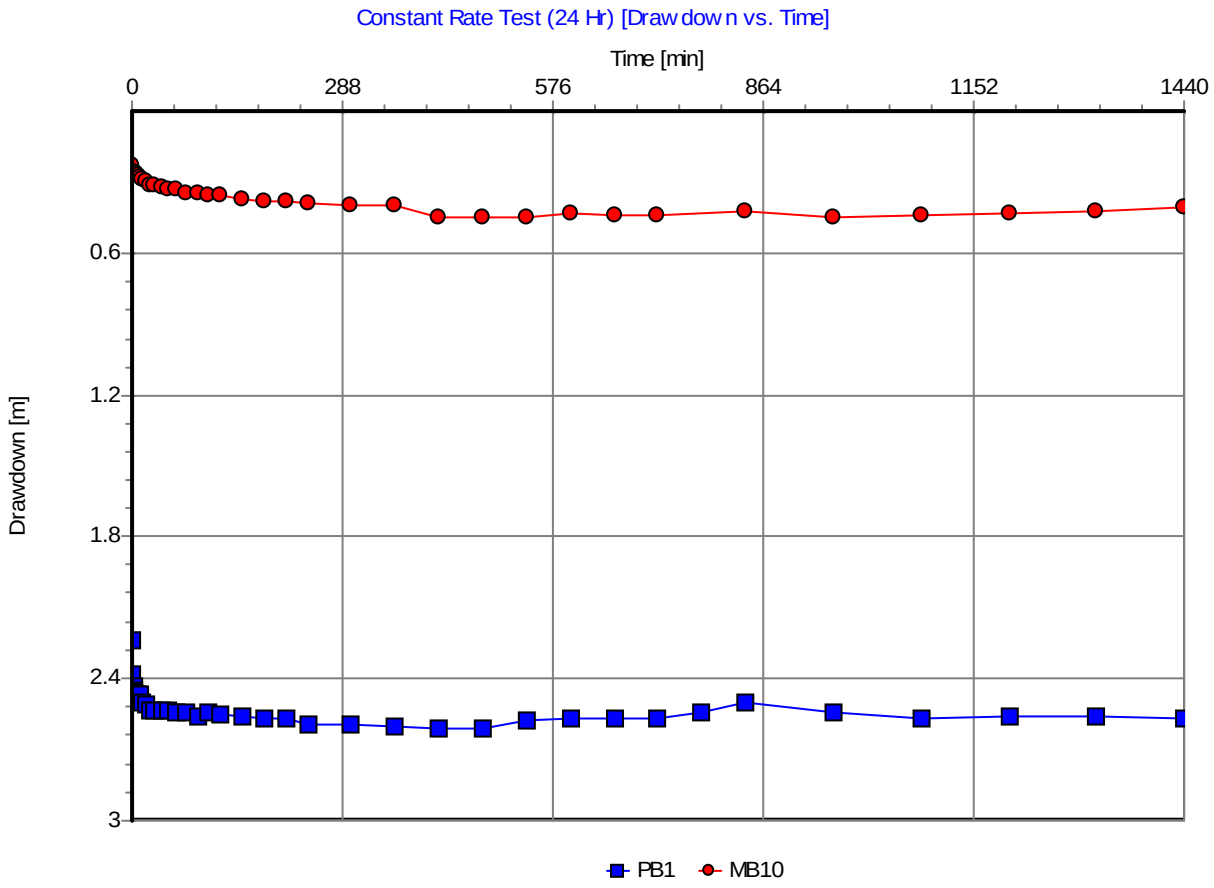
Pumping Test Analysis Report	
Project:	Production Bore Installation & Testing
Number:	33976A
Client:	Ozton Pty Ltd



Pumping Test: **Constant Rate Test (24 Hr)**

Analysis Method: **Drawdown vs. Time**

Analysis Results:

Test parameters:				
	Pumping Well:	PB1	Aquifer Thickness:	11 [m]
	Casing radius:	0.075 [m]		
	Screen length:	4 [m]		
	Boring radius:	0.125 [m]		
	Discharge Rate:	3.3 [l/s]		

Comments:

Evaluated by:

Evaluation Date: 6/11/2007

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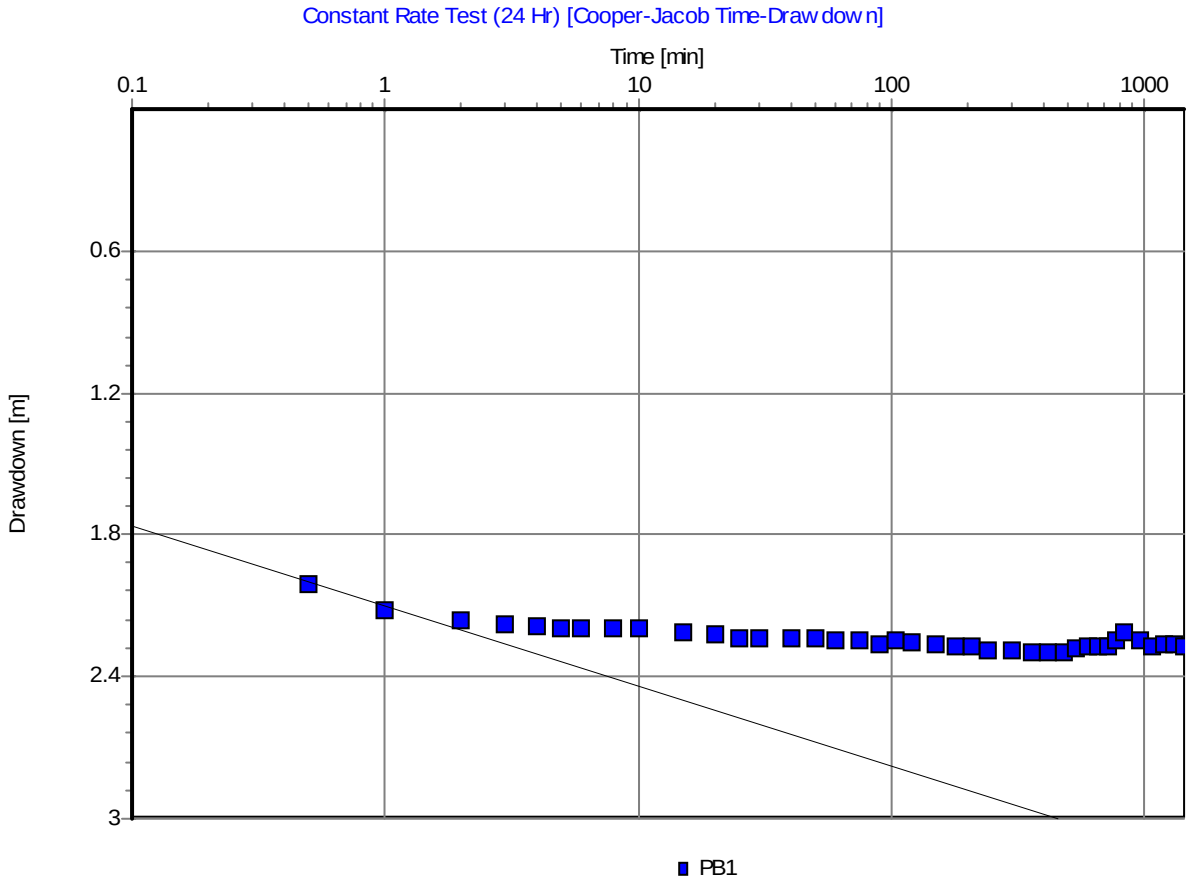
Pumping Test Analysis Report	
Project:	Production Bore Installation & Testing
Number:	33976A
Client:	Ozton Pty Ltd



Pumping Test: **Constant Rate Test (24 Hr)**

Analysis Method: **Cooper-Jacob Time-Drawdown**

Analysis Results:				
	Transmissivity:	1.54E+2 [m²/d]	Conductivity:	1.40E+1 [m/d]

Test parameters:				
	Pumping Well:	PB1	Aquifer Thickness:	11 [m]
	Casing radius:	0.075 [m]	Unconfined Aquifer	
	Screen length:	4 [m]		
	Boring radius:	0.125 [m]		
	Discharge Rate:	3.3 [l/s]		

Comments:

Evaluated by: CMD

Evaluation Date: 26/10/2007

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Pumping Test Data Report

Project: Production Bore Installation & Testing

Number: 33976A

Client: Ozton Pty Ltd

Data observed at:	**PB1**	**Pumping Test:**	**Constant Rate Test (24 Hr)**
Distance from PW:	0 [m]	Pumping Well:	PB1
Depth to Static WL:	8.06 [m]	Casing radius:	0.075 [m]
Location:	Great Keppel Island	Boring radius:	0.125 [m]
Recorded by:	Watervation Pty Ltd	Screen length:	4 [m]
Date:	26/10/2007	Aquifer Thickness:	11 [m]

	Time [min]	Depth to WL [m]	Drawdown [m]
1	0.5	10.30	2.24
2	1	10.44	2.38
3	2	10.49	2.43
4	3	10.51	2.45
5	4	10.52	2.46
6	5	10.53	2.47
7	6	10.53	2.47
8	8	10.53	2.47
9	10	10.53	2.47
10	15	10.56	2.50
11	20	10.57	2.51
12	25	10.59	2.53
13	30	10.59	2.53
14	40	10.59	2.53
15	50	10.59	2.53
16	60	10.60	2.54
17	75	10.60	2.54
18	90	10.62	2.56
19	105	10.60	2.54
20	120	10.61	2.55
21	150	10.62	2.56
22	180	10.63	2.57
23	210	10.63	2.57
24	240	10.65	2.59
25	300	10.65	2.59
26	360	10.66	2.60
27	420	10.67	2.61
28	480	10.67	2.61
29	540	10.64	2.58
30	600	10.63	2.57
31	660	10.63	2.57
32	720	10.63	2.57
33	780	10.60	2.54
34	840	10.56	2.50

Data observed at:	**PB1**	**Pumping Test:**	**Constant Rate Test (24 Hr)**
Distance from PW:	0 [m]	Pumping Well:	PB1
Depth to Static WL:	8.06 [m]	Casing radius:	0.075 [m]
Location:	Great Keppel Island	Boring radius:	0.125 [m]
Recorded by:	Watervation Pty Ltd	Screen length:	4 [m]
Date:	26/10/2007	Aquifer Thickness:	11 [m]

	Time [min]	Depth to WL [m]	Drawdown [m]
35	960	10.60	2.54
36	1080	10.63	2.57
37	1200	10.62	2.56
38	1320	10.62	2.56
39	1440	10.63	2.57

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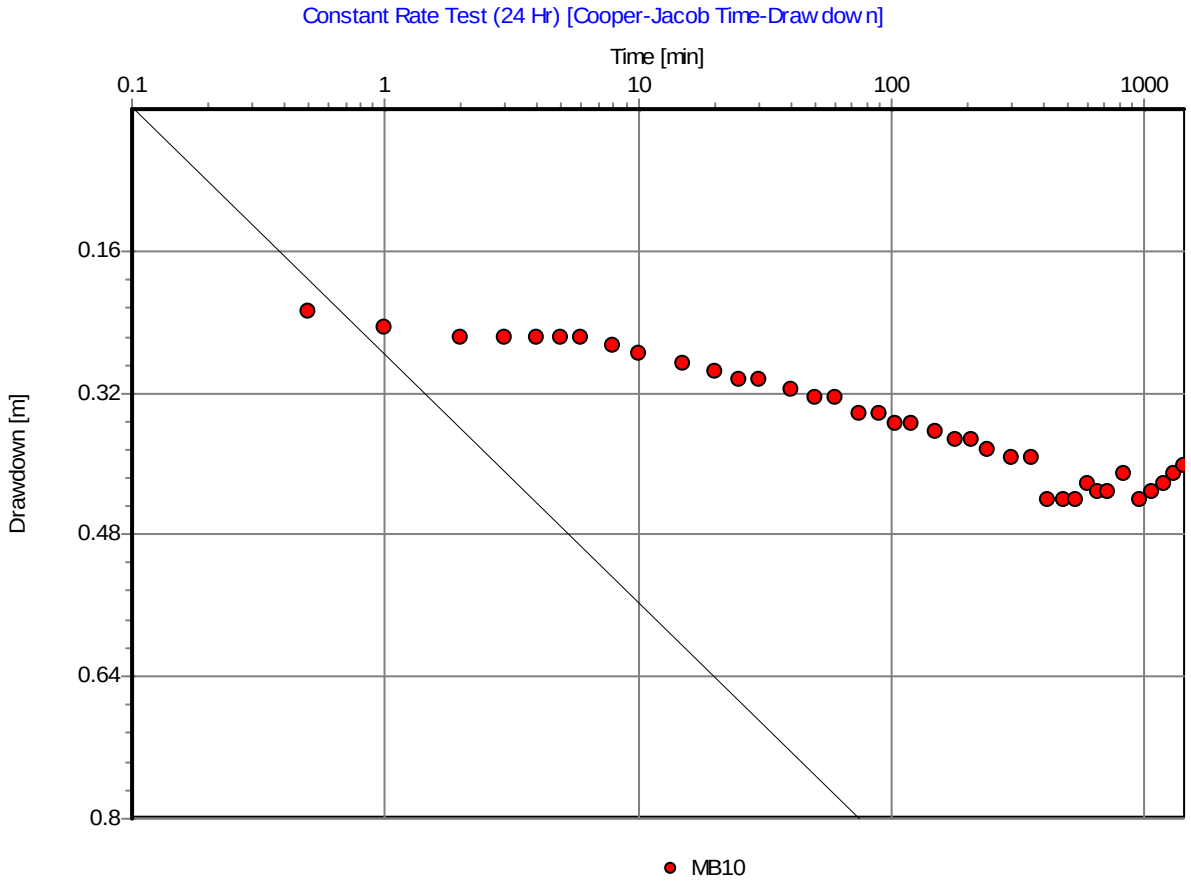
Pumping Test Analysis Report

Project: Production Bore Installation & Testing

Number: 33976A

Client: Ozton Pty Ltd



Pumping Test: **Constant Rate Test (24 Hr)**

Analysis Method: **Cooper-Jacob Time-Drawdown**

Analysis Results:	Transmissivity:	1.87E+2 [m²/d]	Conductivity:	1.70E+1 [m/d]

Test parameters:	Pumping Well:	PB1	Aquifer Thickness:	11 [m]
	Casing radius:	0.075 [m]	Unconfined Aquifer	
	Screen length:	4 [m]		
	Boring radius:	0.125 [m]		
	Discharge Rate:	3.3 [l/s]		

Comments:

Evaluated by: CMD

Evaluation Date: 26/10/2007

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Pumping Test Data Report

Project: Production Bore Installation & Testing

Number: 33976A

Client: Ozton Pty Ltd

Data observed at:	**MB10**	**Pumping Test:**	**Constant Rate Test (24 Hr)**
Distance from PW:	3.16 [m]	Pumping Well:	PB1
Depth to Static WL:	8.02 [m]	Casing radius:	0.075 [m]
Location:	Great Keppel Island	Boring radius:	0.125 [m]
Recorded by:	Watervation Pty Ltd	Screen length:	4 [m]
Date:	26/10/2007	Aquifer Thickness:	11 [m]

	Time [min]	Depth to WL [m]	Drawdown [m]
1	0.5	8.25	0.23
2	1	8.27	0.25
3	2	8.28	0.26
4	3	8.28	0.26
5	4	8.28	0.26
6	5	8.28	0.26
7	6	8.28	0.26
8	8	8.29	0.27
9	10	8.30	0.28
10	15	8.31	0.29
11	20	8.32	0.30
12	25	8.33	0.31
13	30	8.33	0.31
14	40	8.34	0.32
15	50	8.35	0.33
16	60	8.35	0.33
17	75	8.37	0.35
18	90	8.37	0.35
19	105	8.38	0.36
20	120	8.38	0.36
21	150	8.39	0.37
22	180	8.40	0.38
23	210	8.40	0.38
24	240	8.41	0.39
25	300	8.42	0.40
26	360	8.42	0.40
27	420	8.47	0.45
28	480	8.47	0.45
29	540	8.47	0.45
30	600	8.45	0.43
31	660	8.46	0.44
32	720	8.46	0.44
33	840	8.44	0.42
34	960	8.47	0.45

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Data observed at:	**MB10**	**Pumping Test:**	**Constant Rate Test (24 Hr)**
Distance from PW:	3.16 [m]	Pumping Well:	PB1
Depth to Static WL:	8.02 [m]	Casing radius:	0.075 [m]
Location:	Great Keppel Island	Boring radius:	0.125 [m]
Recorded by:	Watervation Pty Ltd	Screen length:	4 [m]
Date:	26/10/2007	Aquifer Thickness:	11 [m]

	Time [min]	Depth to WL [m]	Drawdown [m]
35	1080	8.46	0.44
36	1200	8.45	0.43
37	1320	8.44	0.42
38	1440	8.43	0.41

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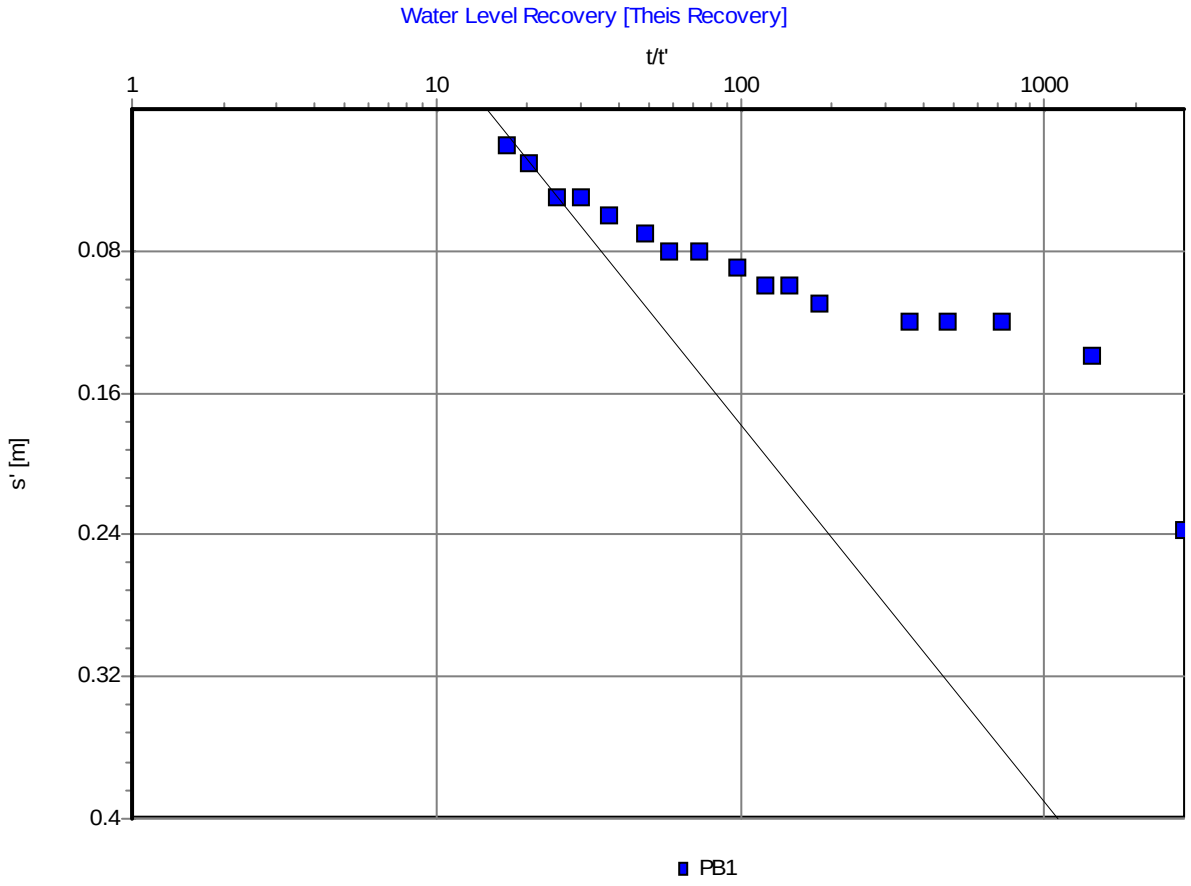

Pumping Test: **Water Level Recovery - PB1**

Analysis Method: **Theis Recovery**

Analysis Results:				
	Transmissivity:	2.44E+2 [m²/d]	Conductivity:	2.22E+1 [m/d]

Test parameters:				
	Pumping Well:	PB1	Aquifer Thickness:	11 [m]
	Casing radius:	0.075 [m]	Unconfined Aquifer	
	Screen length:	4 [m]		
	Boring radius:	0.125 [m]		
	Discharge Rate:	3.3 [l/s]		
	Pumping Time	1440 [min]		

Comments:

Evaluated by: CMD

Evaluation Date: 28/10/2007

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Pumping Test Data Report

Project: Production Bore Installation & Testing

Number: 33976A

Client: Ozton Pty Ltd

Data observed at:	**PB1**	**Pumping Test:**	**Water Level Recovery - PB1**
Distance from PW:	0 [m]	Pumping Well:	PB1
Depth to Static WL:	8.06 [m]	Casing radius:	0.075 [m]
Location:	Great Keppel Island	Boring radius:	0.125 [m]
Recorded by:	Watervation Pty Ltd	Screen length:	4 [m]
Date:	28/10/2007	Aquifer Thickness:	11 [m]

	Time [min]	Depth to WL [m]	Drawdown [m]
1	0.5	8.30	0.24
2	1	8.20	0.14
3	2	8.18	0.12
4	3	8.18	0.12
5	4	8.18	0.12
6	8	8.17	0.11
7	10	8.16	0.10
8	12	8.16	0.10
9	15	8.15	0.09
10	20	8.14	0.08
11	25	8.14	0.08
12	30	8.13	0.07
13	40	8.12	0.06
14	50	8.11	0.05
15	60	8.11	0.05
16	75	8.09	0.03
17	90	8.08	0.02

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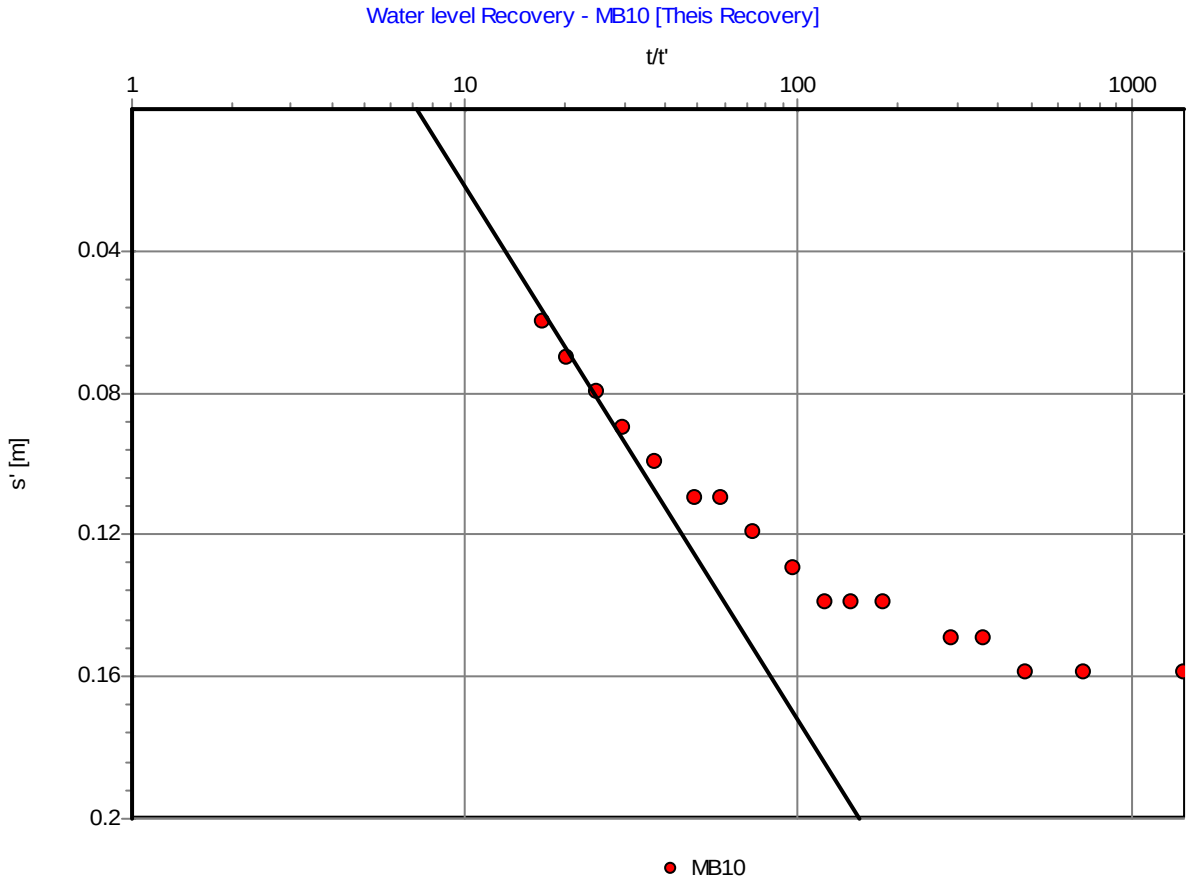

Pumping Test: **Water level Recovery - MB10**

Analysis Method: **Theis Recovery**

Analysis Results:	Transmissivity:	3.47E+2 [m²/d]	Conductivity:	3.02E+1 [m/d]

Test parameters:	Pumping Well:	PB1	Aquifer Thickness:	11.5 [m]
	Casing radius:	0.075 [m]	Unconfined Aquifer	
	Screen length:	4 [m]		
	Boring radius:	0.125 [m]		
	Discharge Rate:	3.3 [l/s]		
	Pumping Time	1440 [min]		

Comments:

Evaluated by: CMD

Evaluation Date: 28/10/2007

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Pumping Test Data Report

Project: Production Bore Installation & Testing

Number: 33976A

Client: Ozton Pty Ltd

Data observed at:	**MB10**	**Pumping Test:**	**Water level Recovery - MB10**
Distance from PW:	3.16 [m]	Pumping Well:	PB1
Depth to Static WL:	8.02 [m]	Casing radius:	0.075 [m]
Location:	Great Keppel Island	Boring radius:	0.125 [m]
Recorded by:	Watervation Pty Ltd	Screen length:	4 [m]
Date:	28/10/2007	Aquifer Thickness:	11 [m]

	Time [min]	Depth to WL [m]	Drawdown [m]
1	1	8.18	0.16
2	2	8.18	0.16
3	3	8.18	0.16
4	4	8.17	0.15
5	5	8.17	0.15
6	8	8.16	0.14
7	10	8.16	0.14
8	12	8.16	0.14
9	15	8.15	0.13
10	20	8.14	0.12
11	25	8.13	0.11
12	30	8.13	0.11
13	40	8.12	0.10
14	50	8.11	0.09
15	60	8.10	0.08
16	75	8.09	0.07
17	90	8.08	0.06