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9 March 2009

ELLA BAY INTEGRATED RESORT

Groundwater Resource Evaluation

REPORT

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Executive Summary

In September of 2008, Satori Resorts Ella Bay Pty Ltd (Satori) commissioned Golder Associates Pty. Ltd. (Golder) to conduct a groundwater resource evaluation of the Ella Bay site for the purposes:

- To investigate groundwater supply feasibility; and
- To determine a sustainable yield that addresses conditions of the Environmental Impact Statement in regards to identifying potential impacts upon the Wet Tropics of Queensland World Heritage Area (WTQWHA), sensitive wetland areas and the Great Barrier Reef World Heritage Area (GBRWHA) that may result from changes in groundwater hydrology. Sensitive wetlands were identified as:
  - the dunal swale; and
  - the Ella Bay Swamp.

A groundwater investigation program was conducted in November to December 2008 at the Ella Bay site and involved the following field activities:

- Drilling of 11 groundwater exploration boreholes by air direct circulation to characterise the hydrogeology of the site and locate suitable sites for constructing test production bores;
- The completion of two test production bores: Northwest Production Bore (PB1B) and West Production Bore (PB3C);
- The completion of two monitoring bores: MB1B-01 and MB1B-02;
- Aquifer hydraulic testing by 3-day constant rate pumping test of PB01B at a flow rate of 3 L/s and rising and falling head tests of single boreholes;
- Monitoring of groundwater levels; and
- Groundwater sampling during the pumping test.

The greatest groundwater occurrence during drilling was identified within the colluvium aquifer unit with 2.5 L/s airlifted in PB3C and 2 L/s airlifted in PB1B. Several other boreholes which intersected the colluvium provided poor yields commonly below 0.5 L/s which indicate that the colluvium hydrogeology is highly variable in nature and layers may commonly have aquitard properties due to high silt/clay composition, poorly sorted or cementation properties. The drilling also indicated that the colluvium is characterised as slightly cemented on the slopes and loose on the lower flatter areas. The shallow aquifer sand units identified in the mid to lower parts of the Ella Bay site were absent on the upper slopes of the site and these units may be related to beach sands from sea level rise and/or channel/deltaic alluvial sands.

The 3-day constant rate pumping test of PB1B at 3 L/s was successful with the pumping bore water level drawing down approximately 7 m in the first few minutes due to a combination of well and aquifer loss and then drawdown rate easing off to provide a final drawdown of 8.4 m. A pumping rate greater than 3 L/s was not achievable during the test due to limiting specifications of the submersible pump. A greater pumping rate **may be possible** with a higher-yielding pump or alternately pumping from multiple bores with a combined yield of possibly 4 to 6 L/s. A greater extraction rate from the aquifer would require additional, long-term aquifer testing to prove (a) sustainability of the bore(s), and (b) that the higher extraction rate would not impact the dunal swale or Ella Bay Swamp.

The pumping test response behaviour indicated leaky aquifer conditions with some indication of dewatering of a more permeable upper layer or the expanding influence of drawdown meeting a lateral aquifer flow barrier after 69 minutes into the test. There is a cone of drawdown in the colluvium aquifer surrounding the pumping bore which presents a decrease in water level displacement with distance from the pumping bore. A summary of results from the test pumping programme is provided in the following table.

Bore	Distance from PB1B (m)	Drawdown (m) after 3 days	Residual drawdown after 21 hours recovery time (m)	% Recovery after 21 hours
PB1B	0	8.4	0.27	97
MB1B-01	25.5	0.87	0.27	70
MB1B-02	117.3	0.27	0.14	49

The pumping test data was analysed for hydraulic properties of the colluvium aquifer to provide the following estimates:-

- Transmissivity of 150 m^2/d to 185 m^2/d;
- Average hydraulic conductivity of 8.3 m/d for the colluvium aquifer with a thickness of 21 m at the bore; and
- Quasi – storativity estimate of 8 x 10^{-3}.

Four simplified units of conceptual hydrogeology of the site include:

- Sand; shallow aquifer;
- Clayey alluvium/wetland deposits; aquitard;
- Colluvium; aquifer; and
- Mixed metamorphic bedrock –basement – generally low permeability.

General direction of regional groundwater flow across the Ella Bay site is from southwest towards the northern resort area, from the Seymour Ranges to the ocean, and is strongly controlled by topographical elevation and hydraulic gradient between upper and lower slopes.

The groundwater quality is fresh with a very low Total Dissolved Solids concentration, slightly acidic and soft. Metal concentrations are within the 2004 National Drinking Water Guidelines. Staggered measurements of pH, electrical conductivity and temperature measured during the pumping test show no trend of aquifer mixing or deterioration in quality from saltwater intrusion.

The test production bore PB3C is carrying a high proportion of fines in the pumped water due to optimal bore construction conditions not been met. The aquifer zone in the bore may silt up over time from constant pumping which will lead to a substantially reduced yield. The western bore (PB3C) can be re-drilled by mud rotary method, possibly with a casing advancement system, to improve bore construction, which may improve water quality and groundwater yield.

A simple one-layered analytical model in the software package “Winflow” was developed to predict groundwater drawdown in the colluvium aquifer from pumping the bore PB1B) over extended periods of time at 3 L/s. The colluvium aquifer properties used in the model are based on drilling and test pumping results. Drawdown contours extending around PB1B were predicted for continuous pumping at a rate of 3 L/s for durations of 6 months, 1 year and 2 years.

A summary of the predicted drawdown amounts at PB1B, MB1B-01, MB1B-02 and two locations 994 m and 1538 m from the pumping bore after 6 months, 1 and 2 years pumping for most likely aquifer hydraulic properties (derived from pumping test data) are presented in the table below:

Time Since Pumping Commenced	Predicted Drawdown of Groundwater Levels (m)				
	PB1B	MB1B-01 (26m*)	MB1B-02 (117m*)	Ella Bay Swamp (994m*)	Dunal Swale (1538m*)
6 Months	2.55	1.13	0.77	0.27	0.18
1 Year	2.63	1.21	0.85	0.35	0.25
2 Years	2.71	1.29	0.93	0.42	0.33

Note * Distance from test production bore PB1B.

It is important to note that there is several limitations and assumptions of the analytical model which reduces the reliability of the results. Major limitations include:

- No rainfall recharge of colluvium aquifer or aquifer discharge features are taken into account in the model. The cone of drawdown around the pumping bore PB1B would contract during the wet season due to substantial recharge directly from intense rainfall events and leakage from surface flow;
- The simple model assumes a homogeneous uniform thickness 1 layered aquifer unit of infinite extent where in fact the aquifer has anisotropic hydraulic properties laterally and vertically due to changes in clastic grain size fraction. The aquifer has finite boundaries as colluvium distribution is associated with distance from Seymour Range.

POTENTIAL IMPACT ON WETLANDS NEAR NORTHERN CONSERVATION COVENANT FROM LONGTERM PUMPING OF THE NORTHWEST BORE

There is no direct evidence that the Ella Bay Swamp (southern extremity located 994 m from the production bore PB1B) is hydraulically connected to the colluvium aquifer. . From groundwater modelling results and extrapolating of test pumping data obtained from the 3-day constant rate pumping test, bore PB1B may be pumped continuously for at least 35 days at a flow rate of 3 L/s before potentially producing 0.1 m drawdown in the southern extremity of the Ella Bay Swamp.

The closest shallow monitoring bore near the Ella Bay Swamp (A-MW2) which is located 650 m northwest of bore PB1B showed no drawdown influence from pumping. The water level data from the monitoring bore exhibited tidal propagation characteristics.

Trigger groundwater levels have been calculated in the monitoring bores MB1B-01 and MB1B-02 for the influence of drawdown reaching the Ella Bay Swamp area from longterm pumping at a rate of 3 L/s The proposed trigger groundwater level for monitoring bore MB1B-01 is 1.45 m of drawdown from the static groundwater level. The proposed trigger groundwater level for monitoring bore MB1B-02 is 0.82 m of drawdown from the static groundwater level.

POTENTIAL IMPACT ON DUNAL SWALES NEAR EASTERN CONSERVATION COVENANT FROM LONGTERM PUMPING OF BORE PB1B

The 3 day pumping test did not influence groundwater levels in monitoring bores:

- A-MW3 located between pumping bore PB1B and the dunal swale (1040 m distant); and
- A-MW4 located in the vicinity of the dunal swale wetland (1540 m distant).
- The groundwater modelling results indicate bore PB1B may be pumped continuously for 35 days at flow rate of 3 L/s before potentially producing 0.1 m drawdown at bore A-MW3 and for 80 days before potentially producing 0.1 m drawdown at bore A-MW4. This is based on the limitations and assumptions of the simple model, particularly no recharge and the assumption there is a direct hydraulic connection between the colluvium and the sandy sediments in the wetlands,

RECOMMENDATIONS

Operational Management of Production Bores and Monitoring

To promote groundwater supply sustainability and to minimise potential environmental impacts, Golder recommends the following operational management measures for the production and monitoring bores:

- The discharge line from bore PB1B be fitted with a flow meter;
- Groundwater levels in production bore PB1B and affiliated monitoring bores MB1B-01 and MB1B-02 need to be monitored either manually with a water lever dipper or with electronic measuring equipment (i.e. Campbell Scientific pressure transducers and data loggers) prior to pumping and on a weekly basis throughout the duration of the pumping. Measurements from fixed point on casing and converted to metres Australian Height Datum (AHD) and also metres above ground level. Results to be entered in a log book.
- The installation of a weather station and data logger on site to record localised rainfall to assist groundwater recharge estimations.
- The production bore PB1B may be pumped at a maximum flow rate of 3 L/s for long periods of time up to 35 days and possibly up to flow rates of 4 to 6 L/s for shorter timeframes (a higher pumping rate or longer duration would need to be reviewed and approved by a senior level hydrogeologist);
- Allow for 80% recovery of the static water level between pumping durations; and
- Monitor groundwater levels in monitoring bores A-MW2, A-MW3 and AMW4 at weekly intervals during pumping. Suggest measurements obtained with a groundwater level dipper. Measurements from fixed point on casing and converted to metres Australian Height Datum and also metres above ground level. Results to be entered in a log book.
- The flow abstraction volumes from bore PB1B should be recorded in a log book at least on a monthly basis to quantify yields from the aquifer over time; and
- The stopping and starting times of the pump and flow meter readings at this point be recorded in a log book.
- The bore PB3C may be used as a backup emergency water supply for short periods of time. The bore is likely to silt up and choke the pump or dewater if used for an extended period of time of several days use. The pump should not be positioned at or near the bottom of the bore for this reason. The depth of the bore should be frequently dipped during operations to assess rate of siltation. This will require the removal of the pump prior to dipping the bottom depth of the bore.
- The water quality of production bore PB1B during pumping operations is monitored at least 3 monthly intervals for pH and electrical conductivity to evaluate trends indicating potential deterioration in water quality. If water is used for drinking purposes then possibly undertake a comprehensive potability analysis on an annual basis.
- The mode of operations for pumping bore PB1B is modified according to the groundwater response recorded in monitoring bores, for example, the drawdown influences in the vicinity of the wetlands near bore A-MW2 may take much longer than calculated from analytical modelling due to a poor hydraulic connection between colluvium and wetland sediments. This can only be confirmed by routine monitoring of water levels during pumping operations.
- The monitoring bores MB1B-01 and MB1B-02 should be monitored during the pumping of bore PB1B so they do not exceed the proposed, aforementioned trigger levels; shut off the pumping bore if proposed trigger levels are exceeded and allow for 80% recovery before pumping resumes.

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1.0 INTRODUCTION

Satori Resorts Ella Bay Pty. Ltd. (Satori) is planning to develop an integrated, eco-resort on their Ella Bay Property (the site) in Far North Queensland. The site is located on an active cattle station surrounded by pristine rainforest, wetland areas to the north and east, and coastal waters of the Great Barrier Reef National Park. The rainforest and the coastal waters that surround the site are under the jurisdiction of the Wet Tropics of Queensland World Heritage Area (WTQWHA) and the Great Barrier Reef World Heritage Area (GBRWHA).

The remote location of the site and environmentally sensitive areas create water supply challenges for the proposed resort. Primarily, water supply demands for the proposed resort will be met with rainwater harvesting, but groundwater resources are being considered as a possible option for supply augmentation. The option of using groundwater resources as part of an integrated and sustainable water supply system would be for the following purposes:

- Potable water;
- Development construction works; and
- Open space irrigation.

In September of 2008, Satori commissioned Golder Associates Pty. Ltd. (Golder) to conduct a groundwater resource evaluation of the Ella Bay site (Golder proposal number P87673038) with the following purposes:

- To investigate groundwater supply feasibility; and
- To determine a sustainable yield that addresses conditions of the Environmental Impact Statement in regards to identifying potential impacts upon the WTQWHA and GBRWHA that may result from changes in groundwater hydrology.

This report details the commissioned work conducted by Golder. Section Two through Section Five of this report discuss the field work, analyses, and modelling completed by Golder for the Ella Bay groundwater resource evaluation. **Section Seven pertains to Golder's analysis of the potential impacts upon the WTQWHA and GBRWHA that may result from groundwater abstraction.** Finally, Section Eight provides recommendations relating to operational management of pumping, and groundwater monitoring that supports sustainable groundwater management.

1.1 Scope of Work

The scope of work for the groundwater resource evaluation comprised the following tasks:

- Conduct a groundwater resource investigation which includes :
  - Groundwater exploration drilling;
  - Hydraulic testing of production bores and monitoring bores;
  - Sustainable yield assessment;
  - Groundwater quality assessment.
- Evaluate the possible impact of groundwater abstraction on World Heritage Areas (WHAs).
- Provide recommendations for:
  - Operational management of groundwater pumping systems;
  - Provide procedures for groundwater monitoring program.

2.0 BACKGROUND

Background information was compiled in a desktop study which included review of the physical environment and environmental concerns of the Ella Bay site.

2.1 Previous Reports/Studies

The following documents were reviewed and referenced for the desktop study:

- Golder letter addressed to Satori Resorts Pty Ltd, *Preconstruction Water Quality Monitoring Program – October 2008: Proposed Ella Bay Integrated Resort* (reference no. 087673031-R0, dated 29 October 2008).
- Golder report, *Water Quality Monitoring Strategy: Ella Bay Integrated Resort* (report no. 087673008-001-R2, May 2008).
- Golder report, *Conceptual Surface Water and Groundwater Hydrology Models: Ella Bay Integrated Resort* (report no. 001-077673018-R3, July 2007).
- Golder report, *Preliminary Environmental and Geotechnical Investigation: Ella Bay Development Far North Queensland* (report no. 001-06673041-R1, November 2006).

2.2 Proposed Development

The proposed development site is located at Ella Bay north of Flying Fish Point and approximately 6 km northeast of the township of Innisfail (Figure 1). The property is 450 hectares in size and current land use is for cattle grazing within a series of fenced paddocks.

The master plan for the Ella Bay Integrated Resort includes the following key elements:

- Low to medium density resorts, units and a day spa facility located along the eastern boundary adjacent to Ella Bay over a distance of approximately 1.7 km.
- A community recreation centre, sports academy and international school.
- An 18-hole golf course surrounded by residential house lots and 3 to 4 storey unit blocks.
- An on-site sewerage treatment plant.
- A new public access road to bypass Flying Fish Point and upgrading of the existing public roadway from Flying Fish Point to Ella Bay.

2.3 Environmental Values of Site

The Ella Bay site is surrounded by environmentally sensitive areas on all boundaries. The rainforest and wetland communities (Ella Bay Swamp) of the Ella Bay National Park skirt the property on the north, west and south side and are part of the Wet Tropics and Queensland World Heritage Area. The off-shore boundary that fronts the site to the east of the site falls under the jurisdiction of the Great Barrier Reef Marine Park Authority as a world heritage area. .

Beachfront dunal swales are considered to play an important role in maintaining a natural groundwater divide between seawater and freshwater shallow aquifers beneath the site.

The Ella Bay Swamp to the north of the site is buffered by the Northern Conservation Covenant, and the beachfront dunal swales are protected by the Eastern Conservation Covenant. The conservation covenants are delineated on Figure 2.

2.4 Site Physical Characteristics

2.4.1 Geomorphology

The site is located on a coastal fringe plain positioned between the Seymour Range and the sea. The plain comprises colluvium and alluvium outwash (basin deposits) originating from the ranges with some marine transgression deposits (sands and clay lenses) closer towards the shore. A wetland dunal swale zone occurs between the plain deposits and the dune beachfront. The extensive wetland referred to as the Ella Bay swamp occurs on the north to north-western extremities of the site.

The Seymour Range comprises a series of relatively steep hills with incised creeks flowing towards the plain. At the foot of the range are gentle slopes of < 5° which grade into a relatively flat plain area prior to reaching wetland swale zone near the sea.

2.4.2 Geology

The site comprises three main geological units as shown in Figure 3 as follows:

- The western portion of the site is dominated by mixed metamorphic rocks that make up the Seymour Range;
- Alluvial/colluvial outwash (basin) deposits comprising cobble, gravel, sand, silt, and clay and possibly some marine transgression deposit make up the central portion of the site; and
- The eastern side of the site consists of well sorted, fine to medium, quartz sand deposits (beach deposits), clay swale deposits and marine transgression (sand/clay) deposits

The Seymour Range comprises sequences of schist, quartzite, arenite, phyllite, greenstone, and gneiss rocks. These metamorphic rocks comprise the bedrock beneath the sediments in the basin and have been recorded at depths greater than 60 m during this groundwater investigation.

The basin-fill deposits of alluvium and colluvium are interbedded with some marine transgression sequences (from period of higher sea level) of sand to clay lenses becoming more frequent closer to the beach. There is a shallow sand layer widespread across the lower part of the plain and wetlands which is considered to be beach sands deposited during incursion of the coastline and has been noted from drilling at thicknesses greater than 5m.

The colluvium comprises unconsolidated, poorly sorted scree and fine deposits originating from the ranges and bought principally downslope by the forces of gravity. The colluvium on the site is predominately loose on the flat plain and is cemented and matrix supported (semi-lithified, clastic) on the slopes ramping in the direction of the Seymour Range. The alluvium is generally comprised of (sub) rounded grains or clasts from stream transportation processes.

The geological units within a typical coastal-basin are depicted in Figure 4. The colluvium is deposited down gradient in a wedge shaped deposit that is overlain with alternating sand and clay lenses. The thickness and distance inland of the alternating sand/clay lenses is dependent on time periods and depth of marine transgression sequences or tidal surges. The thickness of the colluvium deposits in places maybe expected to be up to 30 – 40 m thick.

2.5 Hydrology

2.5.1 Climate

Ella Bay experiences tropical weather conditions comprising a wet hot humid “wet season” and mild conditions with some rain during the drier months. The “wet season” occurs between December and May and milder conditions experienced from May to November. The Ella Bay site is located within the wettest region of Australia and has a long-term yearly average of 3.5 metres precipitation. For the last 5 years from 2004 to 2008 there has been three years which have experienced rainfall quantities greater than the long-term mean yearly average (refer to Table 1).

Table 1: Monthly Rainfall Totals from 2004 to 2008 and the Longterm Monthly Average

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2004	372.8	606.2	1085.6	516.6	222.4	95.2	151.8	14.0	54.8	55.5	245.1	375.2	3795.2
2005	522.1	114.9	689.8	488.8	111.1	235.4	286.7	318.6	10.7	69.3	47.4	151.1	3045.9
2006	479.7	248.2	1205.0	466.5	239.1	348.5	226.5	50.0	140.1	127.5	38.8	363.8	3933.7
2007	360.2	1193.0	360.5	137.4	472.0	181.5	76.8	81.4	21.8	95.2	231.4	506.5	3717.7
2008	337.2	667.6	788.4	182.0	347.3	62.4	192.0	33.0	185.4	80.0	127.5	162.4	3165.2
Long Term Monthly Average	503.6	596.2	662.6	461.1	301.1	189.3	135.3	118.2	85.4	83.1	154.9	264.9	3552.4

Rainfall values in millimetres; Records from Bureau of Meterology weather station SN 32025 in Innisfail. Long-term monthly average data span timeframe of 1881 to 2008.

2.5.2 Surface Water

The site occurs within a relatively small coastal catchment area bounded by the Seymour Range. During rainfall events surface runoff is directed into the creeks which flow out of the Seymour Range onto the plain. The creeks outflow is within a wetland swale system behind the beach which flows into Ella Bay during the wet season. There are two main creek drainage systems which capture the majority of surface drainage in the Development Area of the site and which converge in the northern central area of the plain before flowing into the wetland dunal swale system. There is permanent flow along major creeks, however the flow is much diminished during the drier months.

There are no permanent drainage pathways for surface water within the Southern Ella Bay Beach Dune system.

The salt content of water in the dunal swale area would be expected to be highly variable. The salt content of water in the dunal swale area is higher than in the feeder creeks off the plain as this water receives sea water inundation during king tides and storm surges. However, the dunal swale area during the wet season would receive regular flushing into Ella Bay from catchment runoff during high intensity rainfall events. This flushing would dilute the salt content to a brackish - fresh water quality.

3.0 GROUNDWATER EXPLORATION FIELD PROGRAM

The objectives of the groundwater exploration field program were to characterise the groundwater resources at the site, and evaluate a sustainable yield for exploitation that would not affect the surrounding WHAs.

Activities for the field program commenced on 24 November 2008 and ceased on 22 December 2008. The sequence of events was the following:

- Site selection for groundwater exploration drilling;
- Groundwater exploration drilling;
- Production bore installations;
- Monitoring bore installations;
- Hydraulic testing of the installed bores (pumping test and single well testing); and
- Groundwater quality sampling (integrated within the pumping test program).

3.1 Methodology

Methods for undertaking each of the aforementioned field activities were planned during the early stages of the project. The methods for each field activity are discussed below.

- **Site selection for groundwater exploration drilling**: Exploration drilling sites were chosen on the following five criteria:
  - The odds of finding exploitable groundwater. Aerial photos and geology maps of the site were analysed for vegetation patterns, water crossings, geology and lineaments.
  - Access to the drilling sites for the drill rig. A preliminary site visit was conducted to ascertain access issues.
  - Suitable distance from WHAs to prevent or minimise impacts.
  - Suitable distance from the ocean to prevent saltwater intrusion.
  - An elevation to assist gravity-fed infrastructure works.
- **Groundwater exploration drilling**: The drilling method for the groundwater exploration drilling was air rotary direct circulation. This method was chosen over mud rotary techniques for the following reasons:
  - Appreciation of groundwater yield by airlifting techniques;
  - Evaluate depth of groundwater occurrence; and
  - Obtain water quality measurements during drilling operations.
- **Test Production bore installations**: Intentions were to ream out the most suitable exploration borehole(s) from review of airlift yield, aquifer thickness and depth and water quality for the construction of test production bores. Test Production bores were constructed and installed to the design criteria found in the *Minimum Construction Requirements for Water Bores in Australia, Ed. 2, September 2003*.
- **Monitoring bore installations**: Monitoring bores were constructed and installed to the design criteria found in the *Minimum Construction Requirements for Water Bores in Australia, Ed. 2, September 2003*. Additionally the monitoring bores were constructed and installed to serve as pumping test observation bores.
- **Hydraulic testing of the installed bores**: Single well testing (slug tests), step test and the pumping test were conducted to the Australian Standard of *Test Pumping of Water Wells* in document AS 2368-1990.
- **Groundwater quality sampling**: Groundwater sampling was carried out during the 3-day constant rate pumping test and was tested at an SGS accredited NATA laboratory. The range of chemical parameters analysed included the drinking (potable) water suite.

3.1.1 Drilling Activities

Numac Drilling Services Pty. Ltd. (Numac) were engaged to conduct the exploration drilling and bore construction using a Boart Longyear, track-mounted, DB520 drill rig with direct air circulation capabilities. The drilling was carried out by a licensed, class-2 driller (Shane Rowlands) and was supervised by a Golder field hydrogeologist (Robin Davis).

Numac drilled 11 groundwater exploration boreholes and installed 2 test production bores and 2 monitoring bores. A down the hole hammer with a 200mm diameter bit was used to drill the boreholes. The depth of boreholes ranged between 9 and 60.5 metres below ground level (m bgl). A summary of the drilling activities is provided in Table 2. The locations of all boreholes drilled are provided in Figure 2. All boreholes drilled on the site were logged by a Golder field hydrogeologist and the individual borehole logs are provided in Appendix A.

Difficult drilling conditions were experienced with the air-rotary drilling method in loose wet, unconsolidated formations due to unstable bore wall conditions and blockage of down-hole hammer by fines and gravel. Several boreholes could not be advanced in depth past 10 – 12 m due to collapsing ground conditions. Blocking of the hammer occurred in boreholes GB3C, GB3C-01, GB3C-02, GB3C-03, GB4B, GB4C, and GB1A.

3.1.2 Groundwater Exploration Drilling

Groundwater exploration was carried out by direct air-rotary drilling so as to allow for airlift testing of the bores. Airlift testing produces an approximation of groundwater yield from a borehole. Additionally the production water can be sampled for basic water quality parameters (i.e. pH, electrical conductivity, and temperature). Airlift testing of the bores entails jetting compressed air down the drill string into the borehole at choice intervals. The compressed air forces the groundwater, if there is any, from the selected interval's formation to the surface via the borehole annulus. The flow of the production water can be measured with a bucket of a known volume and a stop watch.

Site plans, aerial photos, previous Golder reports, and the regional geology map were assessed for areas to conduct exploration drilling. Seven exploration areas were identified and are shown on Figure 5. An initial site visit was undertaken to appraise these areas following the site selection criteria outlined in Section 3.1 of which areas GB3 and GB4 were most favourable.

Eleven exploration boreholes in total were drilled in the field program and a summary of the results are provided in Table 3. The drilling results indicated that the colluvium aquifer provided the best yields and is characterised as loose or slightly cemented depending on the depositional environment (unconsolidated on plains, and cemented on slopes). Several other boreholes which intersected the colluvium provided poor yields commonly below 0.5 L/s which indicate that the colluvium hydrogeology is highly variable in nature and areas may commonly have aquitard properties due to high silt/clay composition or cementation properties. The few boreholes which intersected the bedrock (GB4A and GB4B and possibly GB3B) did not strike water inflows with the exception of minor flow in GB4A at the weathered interface of the bedrock and overlying sediments.

An account of sequential events during the drilling program is as follows:

1) Initially 6 exploration boreholes were drilled in the GB3 and GB4 area (GB3A, GB3B, GB3C, GB4A, GB4B, and GB4C) of which only GB3C drilled to a depth of 22.5 m produced an encouraging yield of 2.5 L/s within the colluviums. However the water in GB3C recorded a pH of 4.6 and carried a high proportion of fines (slurry-like consistency).
2) The borehole GB3C was reamed out and production bore casing installed with difficulty due to collapsing conditions from loose colluvium at depth. The completed bore produced a high proportion of fines during air development. It was decided that further exploration drilling would be required to complete a second test production bore with better performance.
3) An additional 3 exploration boreholes (GB3C-01, GB3C-02 and GB3C-03) were drilled in the vicinity of GB3C in an attempt to locate a second borehole with similar airlift yield, less fines and better ground conditions for test production bore construction. However in all three cases the boreholes could not be advanced greater than 12 m due to collapsing loose wet sands.
4) At this stage it was decided through collusion between Golder and Satori that an additional 2 boreholes (GB1A and GB1B) were to be drilled in the GB1 area near a promising area that showed broad surface groundwater seepage. The first borehole (GB1A) was unable to be drilled past 12 m due to loose collapsing wet sand. The second borehole GB1B was drilled to 29 m and produced a yield of 2.0 L/s sourced from cemented colluvium with less entrained fines and a pH of 5.1. This borehole was reamed and converted into a successful test production bore.

Table 2: Drilling Activities Summary

Borehole ID	Bore ID	Bore Type	Total Depth (mbgl)	Coordinates (MGA 94)		Comments
				mS	mE	
GB3A	--	Exploration	60.5	3991157	8068918	Low yield.
GB3B	--	Exploration	60.5	399080	8068820	Dry borehole.
GB3C	PB3C	Production bore	22.5	399374	8069070	Water is extremely silty, and has a low pH.
GB4A	--	Exploration	55	399353	8068510	Low yield.
GB4B	--	Exploration	39	399631	8068453	Low yield.
GB4C	--	Exploration	24	399526	8068849	Low yield.
GB3C-01	--	Exploration	12	399359	8069085	Unable to advance borehole past unconsolidated wet sand.
GB3C-02	--	Exploration	9	399365	8069072	Unable to advance borehole past unconsolidated wet sand.
GB3C-03	--	Exploration	12	399379	8069082	Unable to advance borehole past unconsolidated wet sand.
GB1A	--	Exploration	12	399279	8069696	Unable to advance borehole past unconsolidated wet sand.
GB1B	PB1B	Production bore	29	399008	8069553	Production bore used for test pumping.
MB1B-01	MB1B-01	Monitoring bore	29	399026	8069572	
MB1B-02	MB1B-02	Monitoring bore	18	399088	8069640	

Table 3: Drilling Hydrogeological Details

Bore ID	Tested Depth (mbgl)	Airlift Yield (L/s)	EC (µS/cm)	pH	Interpreted Groundwater Occurrence
GB3A	10	<0.25	--	--	Perched water in sand lens.
	19	2	--	--	Inflow of water between contact of silty-sandy clay and cemented colluvium.
	38.5	1.09	--	--	Inflow of water in cemented colluvium
	49	0.41	--	--	Inflow of water in cemented colluvium, possible weathered/fracture zone.
GB3B	--	--	--	--	Dry borehole. Water bearing unit (cemented colluvium) appears to "pinch-out" at base of the Seymour Range.
GB3C (PB3C)	10	<0.25	--	--	Perched water in sand lens.
	19	0.25	--	--	Inflow of water from unconsolidated colluvium, water is extremely silty.
	24	**2.5**	75.5	**4.75**	Inflow of water from unconsolidated colluvium, water is extremely silty.
	25	**2**	40.5	**4.64**	Inflow of water from unconsolidated colluvium, water is extremely silty.
GB3C-01	5	<0.25	--	--	Inflow from unconsolidated sand (shallow aquifer).
GB3C-02	9	<0.25	90.7	**4.7**	Inflow from unconsolidated sand (shallow aquifer).
GB3C-03	5	<0.25	--	--	Inflow from unconsolidated sand (shallow aquifer).
GB4A	31	<0.25	--	--	Inflow of water between contact of sandy clay and cemented colluvium.
	38	<0.25	45.2	5.4	Inflow from contact between cemented colluvium and bedrock. Possible fracture zone.
GB4B	15	<0.25	--	--	Inflow of water from cemented colluvium.
	27	0.5	40.6	5.36	Inflow of water from cemented colluvium.
GB4C	2.5	0.33	40.4	5.39	Inflow from shallow alluvial aquifer (waterway in close proximity).
	14	<0.25	--	--	Inflow from shallow alluvial aquifer (waterway in close proximity).
	21	0.5	42.7	5.37	Inflow from unconsolidated colluvium.
GB1A	6	<0.25	--	--	Inflow from unconsolidated sand (shallow aquifer).
GB1B (PB1B)	15	0.5	50.5	5.1	Inflow of water in cemented colluvium.
	20	0.5	--	--	Inflow of water in cemented colluvium.
	22	1	--	--	Inflow of water in cemented colluvium.
	28.5	**2**	40.6	5.68	Inflow of water in cemented colluvium, possible weathered/fracture zone.

3.1.3 Production Bore Installations

Two production bores of 125 mm (5 inch) nominal diameter casing (ND) were installed at sites GB3C and GB1B. Construction details are summarised below and the construction logs are located in Appendix A. Refer to Figure 2 for the locations of the production bores.

Production Bore PB3C: Bore casing is 125 mm ND, class 12 PVC casing. The total depth of the bore is 22.5 mbgl, and is screened from 13.5 to 22.5 mbgl. The screened PVC casing is machine slotted with 1mm horizontal aperture slots, spaced 10 mm apart. The bore is partial penetrating and is screened in the unconsolidated colluvium. Due to poor drilling conditions the borehole collapsed around the bore casing and attempts at installing filter pack down the annulus were unsuccessful. A bentonite seal was installed from 3 mbgl to 13.5 mbgl, and grouted to the surface with cement. PB3C was developed for two hours by air-purging and the production water maintained an extremely silty consistency at the end of the development due to absence of graded filter pack.

Production Bore PB1B: Bore casing is 125 mm, class 12 PVC. The total depth of the bore is 29 mbgl, and is screened from 13 to 28 mbgl (1m sump at the bottom of the bore). The screen is machine slotted with 1mm horizontal aperture slots, spaced 10 mm apart. The bore is fully penetrating and is screened across the cemented colluvium. A 5/2 grade, sand, filter-pack was installed from 12 to 29 mbgl. A bentonite seal was installed from 10 to 12 mbgl, and grouted to the surface with cement. The bore PB1B was developed for one hour by air-purging and the production water was clear with no fines.

3.1.4 Monitoring Bore Installations

Two, 50 mm (2 inch) monitoring bores were installed to serve as observation bores for the pumping test. Once test production bore PB1B was successfully constructed, the first monitoring bore MB1A-01 was installed at a distance of 25.5 m from bore PB1B. The second monitoring bore MB1B-02 was installed at a distance of 117.5 m from bore PB1B. Construction details are summarised below and the construction logs are located in Appendix A. Refer to Figure 2 for the locations of the monitoring bores.

MB1B-01: Bore casing is 50 mm ND, class 12 PVC. The total depth of the bore is 29 m bgl, and is screened from 13 to 28 m bgl (1m sump at the bottom of the bore). The screen is machine slotted with 1mm horizontal aperture slots, spaced 10mm apart. The bore is fully penetrating and is screened across the cemented colluvium. A 5/2 grade, sand, filter-pack was installed from 12 to 29 m bgl. A bentonite seal was installed from 10 to 12 m bgl, and grouted to the surface with cement. The bore MB1B-01 was developed by bailing 10 bore volumes and the final production water was clear.

MB1B-02: Bore casing is 50 mm ND, class 12 PVC. The total depth of the bore is 18 m bgl, and is screened from 9 to 18 m bgl. The screen is machine slotted with 1mm horizontal aperture slots, spaced 10mm apart. The bore is partially penetrating and is screened in the unconsolidated colluvium. A 5/2 grade, sand, filter-pack was installed from 8 to 18 m bgl. A bentonite seal was installed from 6 to 8 m bgl, and grouted to the surface with cement. The bore MB1B-02 was developed by bailing 10 bore volumes and the final production water was clear.

3.2 Hydraulic Testing

Hydraulic testing was performed by Golder on the installed bores during the field program to determine essential aquifer characteristics. The hydraulic tests were conducted to obtain aquifer properties such as Transmissivity (T), Hydraulic conductivity (K), Storativity (S), and Safe Yield. The following types of hydraulic testing were conducted:

- Single well rising and falling head (slug) tests conducted on bores PB3C, PB1B, MB1B-01, MB1B-02;
- Step rate pumping test (SRPT) conducted on bore PB1B; and
- 3-day constant rate pumping test (CRPT) conducted on bore PB1B.

Slug testing results provide a “local” estimate of K while the constant rate pumping test provides a “regional” estimate of K for the colluvium aquifer. The estimates of K obtained from slug testing are heavily influenced by drilling disturbances such as the blocking or infilling of pore spaces by drilling muds which reduces K.

From these two observations the results from pumping tests provide greater accuracy of characterising bulk K values for the aquifer than results from slug testing. The K estimates derived from these tests are considered to be conservative compared to pumping test results

3.2.1 Step Rate Pumping Test

In a step rate pumping test (SRPT) the production bore is pumped at three successively higher pumping rates for a fixed duration and the drawdown for each rate, or step, is recorded. The drawdown data from the SRPT is used to determine a suitable pumping rate for pumping tests.

On 13 December 2008, the Golder field hydrogeologist conducted a SRPT on bore PB1B. A submersible pump was used to pump the bore at three successive rates of 1 L/s, 2 L/s, and 3 L/s for 60 minute duration at each rate. The flow rate of the submersible pump was controlled with a gate-valve attached to the discharge manifold. Drawdown in bore PB1B during the SRT was measured in real-time by an electronic water-level measuring device (In-situ® 300 Level Troll pressure transducer) installed in the bore prior to testing. Bore PB1B was allowed to recover overnight at the completion of the step rate test.

3.2.2 3-Day Constant Rate Pumping Test

In a constant rate pumping test (CRPT) a production bore is pumped at a constant rate over a fixed duration to stress an aquifer. The drawdown response of the aquifer is recorded during the CRPT and the analysis (mathematical solution and curve matching) of the results characterise the aquifer in terms of Transmissvity and Storativity. Additionally the results of a CRPT can assist in determining the Safe Yield of the production bore.

On 18 December 2008 at 10 am, a CRPT was started on bore PB1B at a rate of 3 L/s and lasted 71 hours and 40 minutes. Drawdown was observed and recorded with electronic water-level measuring devices installed in bores PB1B, MB1B-01, and MB1B-02. The recovery of the bores was also recorded for 8-hour duration. The drawdown data from the constant rate pumping and recovery tests were analysed using the software package AQTESOLVE by HydroSolve.

3.2.2.1 Design

A 4-inch submersible pump, rising main, discharge manifold and gate valve was installed in PB1B prior to the step rate test and the constant rate pumping test. The submersible pump was set at 26 m bgl. The static water level in bore PB1B at the time of installation was 5.5 m bgl. Allowing for 2 m of required head above the submersible pump, available drawdown in bore PB1B was 18.5 m.

Plumbing was attached to the discharge manifold to allow the production water to be discharged into a large, open, plastic basin (child play pool). The open plastic basin allowed for water quality sampling, and flow measurement taken with a bucket and stop-watch. Attached to the plastic basin was approximately 200 meters of 125 mm PVC. The 200 meters of PVC conveyed the production water down gradient into an open paddock.

Electronic water level measuring devices (In-situ® 300 Level Troll pressure transducer) were installed in bores PB1B, MB1B-01, MB1B-02 and measured the depth at a logging interval of 30 seconds. An additional three Trolls were installed a week prior to the pumping test in the shallow monitoring bores (A-MW2, A-MW3, and A-MW4) located near the wetlands and swales and measured the depth in 10 minute intervals.

3.2.2.2 Equipment

A single-phase, 1.5 kW, 4-inch, STA-RITE® submersible pump (model no. 5L50P4GH-03, S/N 07K6222-0739) was used for the SRPT and CRPT tests. At 26 m bgl the submersible pump was capable of pumping 3.2 L/s with the gate-valve completely open. The submersible pump was powered by a portable diesel generator.

3.2.2.3 *Water Quality Monitoring*

During the 3-day constant rate pumping test, the production water's quality was monitored using a field meter (TPS 90-FLMN Mobile Field Lab). The field meter provided readings of temperature, electrical conductivity, and pH. The purpose of the water quality monitoring was to check for source water mixing and saltwater intrusion.

3.2.2.4 *Issues*

The following two issues were encountered during the constant rate pumping test:

- The CRPT initially commenced on the 14 December but was terminated after 31 hours by Golder project management due to health and safety concerns (fatigue management) with field personnel. The CRPT was restarted on 18 December allowing for sufficient recovery time from the first constant rate pumping test attempt.
- On 21 December, after 71 hours and 40 minutes (71.76 hours), the submersible pump stopped for unknown reasons. The duration of pumping and data collected were adequate for analyses.

3.2.3 Rising and Falling Head Tests

Rising and falling head (slug) tests involve the instantaneous displacement of water-levels in a bore by the rapid injection or removal of a slug of water with a cylinder or a, "slug" of water. The displacement is measured in real-time by an electronic water-level measuring device (In-situ® 300 Level Troll pressure transducer) installed in the bore prior to testing. A mathematical solution is used to analyse the plot of the measured displacement versus time to obtain estimates of K in the immediate vicinity of the bore. The K estimates are used to support results from the pumping tests

On 12 December 2008, slug tests were performed on bores PB3C, PB1B, MB1B-01, and MB1B-02. The field data was analysed by a Golder hydrogeologist utilising the software package AQTESOLVE by HydroSolve.

3.3 Groundwater Quality Sampling

The water quality of the colluvium aquifer was sampled twice at bore PB1B during the pumping test program. The first sample was collected two hours into the initial pumping test on the 14 December before it was terminated after 31 hours. The second water sample was collected at the termination of the 3-day pumping test on the 21 December. The field records of groundwater sampling are provided in Appendix C.

Samples were sent within 24 hours of collection to SGS analytical laboratory (NATA accredited) for the analysis of the following parameters (drinking water suite):

- major parameters – filtered anions and cations, pH, electrical conductivity (EC), total dissolved solids (TDS), alkalinity, acidity, hardness, filtered silica and total fluoride and turbidity;
- filtered metals – manganese, aluminium, iron, lead, arsenic, cadmium, copper, zinc, barium, mercury, molybdenum, antimony, selenium, silver, nickel and chromium;
- nutrients – ammonia, total oxidised nitrogen, total kjeldahl nitrogen, total nitrogen, total phosphorous, nitrite and nitrate; and
- coliforms – *Escherichia Coli*, faecal coliforms and total coliforms.

4.0 HYDRAULIC TESTING RESULTS

4.1 Step Rate Pumping Test Results

The results of the SRPT are presented as a plot of water level drawdown versus log time in Figure 6. At a pumping rate of 1 L/s, the rate of drawdown is close to zero and pumping is near steady-state during the 60 minute duration. At 2 L/s and 3 L/s, the rate of drawdown increases. The drawdown curve for 3 L/s was extrapolated for the duration of the 3-day CRPT and was ascertained not to exceed 2 m above the depth of the pumping inlet of the submersible pump. It was decided that 3 L/s would be used during the CRPT.

4.2 3-Day Constant Rate Pumping Test Results

4.2.1 Groundwater Response to Pumping

A plot of water level drawdown versus logarithmic time at the pumping bore is provided graphically in Figure 7. At the pumping bore the aquifer comprises “weakly” cemented colluvium of 21 m thickness (8 m to 29 m below ground level). The static water level in the production bore prior to the test was 5.5 meters below ground level (allowing for 18.5 m of available drawdown).

The drawdown of about 7 m in water levels in the first few minutes of the test is due to a combination of aquifer loss and well loss at the bore. The well loss relates to inefficiencies of flow into the bore due to turbulence and restriction of flow through the bore casing screen, disturbed wall rock during drilling and filter pack arrangement possibly restricting flow. All bores suffer well loss to varying degrees based on bore construction technique. The total drawdown in the production bore at the end of 71 hours and 40 minutes was 8.4 m of which a large proportion can be attributed to initial well storage loss.

The rate of drawdown in the bore after 10 minutes into the pumping test is gradual. There is a slight steepening in the drawdown curve after 69 minutes into the test which is interpreted as either the dewatering of a more permeable upper layer within the colluvium or the expanding influence of drawdown meeting a lateral aquifer flow barrier. The pumping test response behaviour indicated leaky aquifer.

There is a cone of drawdown in the colluvium aquifer surrounding the pumping bore which presents a decrease in water level displacement with distance from the pumping bore. Drawdown response data for all monitoring bores is summarised in Table 4 and MB1B-01 and MB1B-02 hydrographs are provided in Figures 8 to 9. A plan view with interpolated drawdown contours at the end of the 3-day pumping test is provided in Figure 10 and a distance drawdown plot provided in Figure 11. There was about 0.3 m of residual drawdown within at least 25 m of the pumping bore at 21 hours after completion of the test which shows minor dewatering of the colluvium aquifer.

Table 4: Drawdown Responses of Bores During the 3-Day Pumping Test

Bore	Distance from PB1B (m)	Drawdown (m)	Residual drawdown after 21 hours recovery time (m)	% Recovery after 21 hours
PB1B	0	8.4	0.27	97
MB1B-01	25.5	0.87	0.27	70
MB1B-02	117.3	0.27	0.14	49

A trend line through the drawdown curve from 69 minutes to 4300 minutes (71 hours and 40 minutes) can be used to extrapolate the extent of drawdown within the bore beyond 3 days and has been applied in Figure 7. The trend line shows (in reference to the sustainability of the bore only) that if bore PB1B is pumped for 2 years at a continuous rate of 3 L/s, the drawdown within the bore would be about 10 m subject to the following assumptions:

- no further “*aquifer flow barriers*” are encountered which may increase the drawdown rate and steepen the drawdown curve;
- no further highly permeable layers in the upper colluvium are dewatered which may increase the drawdown rate and steepen the drawdown curve; and
- no substantial recharge of storage by rainfall.

4.2.2 Estimation of Hydraulic Parameters

Pumping test data of the colluvium aquifer was analysed for hydraulic properties using several methods for a homogeneous, isotropic confined aquifer solution and include:

- Theis (1935);
- Cooper and Jacob (1946); and
- Theis recovery (1935).

All these methods apply to unsteady state flow and assume a fully penetrating well and no well bore storage. The data was analysed by applying curve matching techniques for the methods within the software package AQTESOLVE.

A table summarising results of Transmissivity (T), Storativity (S) and the derived Hydraulic Conductivity (K) of the colluvium aquifer is provided in Table 5. Curve matching solutions for bores are provided in Appendix B. The derived K estimates are bulk values averaged across the thickness of the interpreted aquifer thickness of 21 m.

Aquifer transmissivity estimates at the three bores PB1B, MB1B-01 and MB01-02 were similar ranging from 184 m^2/d at PB1B to 149 m/d at MB01-02. Pseudo storativity (aquifer does not realistically act as a confined system as there is leakage from overlying sediments) estimates were analysed at about 8 x 10^{-3}. Applying an aquifer thickness of 21 m, the average K value was calculated at 8.3 m/d.

4.3 Rising and Falling Head Test Results

Slug testing results have similar values for the four tested bores ranging from 2 m/d at MB1B-02 to 3.4 m/d at PB1C (average of 2.8 m/d). A summary of K solutions for the bores is provided in Table 6 and detailed analytical results are provided in Appendix C. The K estimates derived from these tests are considered to be slightly conservative compared to pumping test results and this maybe reflected by the slightly lower derived K values (average of 2.8 m/d) compared to the pumping test results (average of 8.3 m/d).

Table 5: Hydraulic Parameters Derived From 3-Day Constant Rate Pumping Test (December 2008)

Bore ID	Solution	Curve Fitting		T (m^2/d)	Avg. T (m2/d)	S	Avg. S	Calc. K	Avg. K
		Match	Quality					(m/day)	(m/day)
PB1B	Theis		good	103	184	--	--	4.9	8.8
	Cooper-Jacob	early	fair	388		--		18.4	
	Cooper-Jacob	late	good	100		--		4.8	
	Theis Recovery	late	good	245		--		11.7	
	Theis Recovery	early	good	83		--		4.0	
MB1B-01	Theis		fair	141	188	0.005	0.007	6.7	8.9
	Cooper-Jacob	early	good	337		0.0017		16.1	
	Cooper-Jacob	late	good	110		0.013		5.2	
	Theis Recovery	late	good	210		--		10.0	
	Theis Recovery	early	fair	140		--		6.7	
MB1B-02	Theis		fair	153	149	0.009	0.009	7.0	7.1
	Cooper-Jacob	late	good	146		0.009		6.9	
	Theis Recovery	--	fair	148		0.010		7.4	

T = Transmissivity; S = Storativity; K = Hydraulic Conductivity; Colluvium aquifer thickness = 21 m. K = T / 21m

Table 6: Hydraulic Parameters Derived From Single Borehole Testing

Bore ID	Geology	Rising/Falling Head	Solution	K (m/d) per analytical method	K (m/d) per test	K (m/d) per bore	Curve Match Quality
PB3C	unconsolidated colluvium: silty-clayey gravel	falling	Hvorslev	3.0	2.6	2.5	good
		falling	Bouwer/Rice	2.2			good
		rising	Hvorslev	2.9	2.45		good
		rising	Bouwer/Rice	2.0			good
PB1C	cemented colluvium: silty/sandy clayey gravel	falling	Hvorslev	3.9	3.5	3.4	good
		falling	Bouwer/Rice	3.0			good
		rising	Hvorlsev	3.5	3.2		good
		rising	Bouwer/Rice	2.8			good
MB1B-01	cemented colluvium: silty/sandy clayey gravel	falling	Hvorslev	3.7	3.2	3.2	fair
		falling	Bouwer/Rice	2.7			fair
MB1B-02	unconsolidated colluvium: silty-clayey gravel	falling	Hvorslev	2.5	2.0	2.0	good
		falling	Bouwer/Rice	1.5			good

5.0 GROUNDWATER QUALITY RESULTS

Laboratory and some field water chemistry results are summarised in Tables 7 – 9 and are compared with ANZECC Guidelines for Freshwater Quality (2000) and/or National Drinking Water Guidelines (2004). The SGS Laboratory reports are provided in Appendix D and the field water sampling data sheets and chain of custody forms are provided in Appendix E. The staggered field measurements of pH, EC and temperature monitored during the test show no trend of water mixing from multiple aquifers or deterioration in quality from saltwater intrusion. A graph of the results has been provided in Appendix E-1.

The groundwater is fresh with a very low TDS of about 50 mg/L, slightly acidic and soft. Filtered metal concentrations are below National Drinking Water Guidelines and Freshwater Quality Guidelines with the exception of a zinc concentration of 0.009 mg/L from sample collected on the 21 December which is above the ANZECC Guideline for water quality in fresh water ecosystems. The water sampled was colourless and odourless.

Nutrient concentrations are below ANZECC Guideline for water quality in fresh water ecosystems water guidelines with the exception of nitrate and total nitrogen concentrations of 0.009 mg/L in sample collected on the 21 December which is above the ANZECC.

Table 7: Major Parameter Chemistry - PB01 Groundwater

Parameter	Lab Detection Limits	Sample 14/12/2008	Sample 21/12/2008	National Drinking Water Guidelines (2004)
pH Lab	<0.1	5.6	5.8	**c**
pH Field		5.13	5.15	
EC Lab (µS/cm)	<5	52	51	
EC Field (µS/cm)		48.3	53.5	
HCO3 Alk (mg/L CaCO3)	<5	10	11	
CO3 Alk (mg/L CaCO3)	<5	<5	<5	
Tot Alk (mg/L CaCO3)	<5	10	11	
Acidity to pH8.3 (mg/L CaCO3)	<5	<5	<5	
Hardness (mg/L as CaCO3)	5	na	15	**e**
Turbidity (NTU)	<0.5	11	6.9	**c**
TDS (mg/L)	<10	82	55	**n**
Cl (mg/L)	<2	11	10	**e**
SO_4 (mg/L)	<2	<2	2	500
F (mg/L)	<0.05	<0.05	0.05	1.5
Ca (mg/L)	<0.5	<0.5	<0.5	
Mg (mg/L)	<0.5	3.4	3.7	
Na (mg/L)	<0.5	6.4	20	**e**
K (mg/L)	<0.5	1.4	6.8	
Si (mg/L)	<1	6	6	
Silica, $SiO_{3\ (mg/L)}$	<5	16	16	

Notes: Filtered anions and cation concentrations (laboratory filtered)
c = insufficient data to set guidelines based on health considerations
e = no health-based guideline is considered necessary
n = not necessary

Table 8: Filtered Metal Concentrations - PB01 Groundwater

Parameter	Detection Limits	[1] Sample (filtered) 14/12/2008	[1] Sample (filtered) 21/12/2008	[2] ANZECC Guidelines (99%) for freshwater quality(2000)	3 National Drinking Water Guidelines (2004)
Mn (mg/L)	<0.05	<0.05	<0.05	1.2	0.5
Al (mg/L)	<0.05	0.05	0.59	**c**	**c**
Fe (mg/L)	<0.05	0.15	0.39	**c**	**c**
Pb (mg/L)	<0.001	<0.001	<0.001	0.001	0.01
As (mg/L)	<0.003	<0.003	<0.003	0.001	0.007
Cd (mg/L)	<0.0001	<0.0001	<0.0001	0.00006	0.002
Cu (mg/L)	<0.001	<0.001	<0.001	0.001	2
Zn (mg/L)	<0.005	<0.005	**0.009**	0.0024	**c**
Ba (mg/L)	<0.005	<0.005	<0.005	NA	0.7
Hg (mg/L)	<0.0002	<0.0002	<0.0002	0.00006 inorganic	0.001
Mo (mg/L)	<0.005	<0.005	<0.005	**c**	0.05
Sb (mg/L)	<0.003	0.003	<0.003	**c**	0.003
Se (mg/L)	<0.003	<0.003	<0.003	0.005	0.01
Ag (mg/L)	<0.001	0.003	<0.001	0.00002	0.1
Ni (mg/L)	<0.002	<0.002	<0.002	0.008	0.02
Cr (mg/L)	<0.001	<0.001	<0.001	0.00001(Cr(VI))	0.05 (Cr(VI))

Notes: 1. Metal concentrations are filtered (laboratory filtration);
2. ANZECC Guidelines (2000) freshwater quality trigger values (Table 3.4.1) with an ecosystem protection level of 99%;
3. Drinking water guidelines (2004) is for total metal concentrations;
c = insufficient data to set guidelines based on health considerations; na = not available

Table 9: Nutrients and Coliforms Chemistry - PB01 Groundwater

Parameter	Lab Detection Limits	Sample 14/12/2008	Sample 21/12/2008	[1] ANZECC Guidelines for freshwater quality(2000) (slightly disturbed)	National Drinking Water Guidelines (2004)
NH_3 as N (mg/L)	<0.05	<0.05	<0.05	0.01	**c**
Total Oxidised N (mg/L)	<0.05	0.27	0.25	na	
Total Kjeldahl N (mg/L)	<0.05	1.1	<0.05	na	
Total N (mg/L)	<0.05	**1.4**	0.25	0.35	
Total P (mg/L)	<0.02	<0.02	<0.02	0.01	
NO_2 (mg/L)	<0.005	<0.005	<0.005	na	3
$N0_3$ (mg/L)	<0.05	**0.27**	**0.25**	0.017	50
E. coli (CFU/100mL)	<1	<1	<1		0
Faecal Coliforms (CFU/100 mL)	<1	<1	<1		0

Note: ANZECC Guidelines for freshwater quality (2000) - trigger values provided in Table 3.3.5 for slightly disturbed tropical wetlands and lowland rivers; **c** = insufficient data to set guidelines based on health considerations; na = not available.

In addition the results from sampling the shallow monitoring bores which intersect the sand aquifer are provided as a comparison in Table 10. Like the colluvium groundwater the sand/alluvium aquifer has zinc concentrations slightly above the ANZECC Guidelines for Freshwater Quality (2000).

Table 10: Water Chemistry from Shallow Monitoring Bores AMW1 - AMW6

Parameter	ANZECC 2000 Freshwater Guidelines	AMW1 Nov 2008	AMW2 Nov 2008	AMW3 Nov 2008	AMW4 Nov 2008	AMW5 Nov 2008	AMW6 Nov 2008
Hg (mg/L)	0.00006 inorganic	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Al (mg/L)	c (as pH <6.5)	<0.005	0.018	0.012	0.105	0.014	0.007
As (mg/L)	0.001	<0.0002	<0.0002	<0.0002	0.0002	0.0033	0.0003
Cd (mg/L)	0.00006	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Cr (mg/L)	0.00001(Cr(VI))	0.0004	<0.0002	0.0069	0.0004	<0.0002	0.0004
Cu (mg/L)	0.001	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Pb (mg/L)	0.001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Ni (mg/L)	0.008	<0.0005	0.0006	0.0014	<0.0005	0.0009	0.0006
Zn (mg/L)	0.0024	**0.007**	**0.007**	**0.008**	**0.008**	**0.009**	**0.006**
Fe (mg/L)	**c**	0.016	0.055	<0.002	0.513	2.14	0.08
EC (µS/cm)		43	42	24	13	30	52
pH Field		5.71	5.16	4.85	4.37	5.15	6.09
Turbidity (NTU)		600	600	600	600	600	600
NH_3 as N (mg/L)	0.32	0.023	0.032	<0.005	0.035	0.037	0.031
N (Organic)	na	0.43	0.36	0.19	0.2	0.32	0.15
Oxidised N (mg/L)	na	0.064	0.017	0.1	0.016	0.012	0.39
Total N (mg/L)	0.35	0.51	0.41	0.29	0.25	0.37	0.57
Total P (mg/L)	0.01	0.54	0.14	0.33	0.33	0.33	0.3
Kjeldahl N (mg/L)	na	0.45	0.39	0.19	0.23	0.36	0.18

Note: **c** = insufficient data to set guidelines based on health considerations;
na = not available

6.0 GROUNDWATER MODELLING

6.1 Conceptual Hydrogeological Model

6.1.1 Groundwater Levels and Flow

During the groundwater exploration program, groundwater levels were manually measured in the boreholes using an electronic water level dipper. A summary of the groundwater levels is provided in Table 11. These groundwater levels were used to generate a groundwater contour map as show in Figure 12. The general direction of regional groundwater flow across the site is from southwest to northeast. Groundwater flow is largely controlled by topography with direction of flow from upper to lower elevation (higher to lower hydraulic head).

The hydraulic gradient was calculated from the generated groundwater contours on Figure 12 and ranged from 0.013 in the southwest at the foot of the Seymour Range where contours are more closely spaced to about 0.003 in the east - northeast near the dunal swale where groundwater contours are further apart.

Table 11: Summary of Groundwater Level Measurements

Borehole ID	Water Level (mbgl)	Date
GB3A	7.74	02 Dec. 2008
GB3C (PB3C)	2.01	
GB4A	11.63	
GB4B	5.6	
GB4C	3	
PB1B	5.79	12 Dec. 2008
MB1B-01	4.04	
MB1B-02	1.325	
A-MW2	1.235	
A-MW3	4.58	
A-MW4	2.065	

Groundwater linear flow velocities within the colluvium were estimated to range from about 0.1 m/d to 1 m/d by applying the following equation:

$$Vx = \frac{K}{ne}\left(\frac{dh}{dl}\right)$$

Where Vx = average linear velocity (m/day)

K = hydraulic conductivity (m/day) (apply values from hydraulic testing results)

n_e = effective porosity (assume between 0.2 and 0.3 from text book values)

dh/dl = hydraulic gradient (used values ranging from 0.003 to 0.13

6.1.2 Conceptual Model

Conceptual hydrogeology of the Ella Bay site is represented in the cross section A-A', show on Figure 13. The location of cross section A-A' in plan view is shown in Figure 2 and starts at the base of the Seymour Range in the west and extends to the ocean in the east, spanning a distance of approximately 2 km. The cross-section was constructed from the following resources:

- Groundwater exploration borehole logs;
- Monitoring bore logs;
- Aerial photos of the Ella Bay site;
- Surface elevation maps of the Ella Bay site;
- Regional geology map;
- Groundwater contour figure;
- Interpretation based on coastal-basin facies;
- Interpretation based on aquifer hydraulics;
- Previous Golder reports; and
- 3-day constant rate pumping test results.

The geology of the site can be simplified into the four following hydro-stratigraphic units:

- Sand (K = 8.64 x10^{-1} m/d); shallow aquifer;
- Clay (K = 8.64 x10^{-4} m/d); aquitard;
- Colluvium (K = 8.3 m/d; average K from pumping test results); aquifer; and
- Mixed metamorphic bedrock (generally low permeable basement).

Textbook values for sand and clay K values from Freeze and Cherry (1979)

An aquifer is defined as a saturated permeable geological unit that is permeable enough to yield economic quantities of water from bores. An aquitard is a geological unit of insufficient permeability to yield water for installation of production bores; although the porosity within the unit allows storage of groundwater.

The sand layers at a shallow depth at the site are likely to be beach sand from a previous rise in sea level or possibly deltaic/watercourse channel sands. These units may occur interspersed with finer clay/silty units at depth towards the lower part of the site as a result of marine transgression/regression. These saturated sand units are probably aquifer units of limited extent and depth.

The clay units comprise sandy clay – clayey silt are developed in lower energy environments such as back-swale wetlands or floodplain alluvium. This unit is widespread the site interleaved with the sand lenses and acts as an aquitard below the watertable.

The colluvium can be described as highly variable aquifer with respect to hydraulic properties due to composition and sorting of clay to gravel/cobble grain size. The colluvium in parts of the profile would behave like an aquifer due to relatively higher coarse grain size fraction of sands and gravel – cobbles and moderate sorting into lenses. However, in other parts of the profile the colluvium would behave as an aquitard due to poor grain sorting and relatively higher fraction of fines (clay to silt grain size). The colluvium thickness is envisaged to:

- thin rapidly upslope of the foothills and possibly have the coarsest fraction at the base of the Seymour Range and;
- thin and comprise a proportionally greater fine size fraction towards the dunal swale area. Probably terminate in this area.

Due to the heterogeneity of the colluvium across the site the colluvium aquifer exhibits both leaky and semi-unconfined behaviour.

The basement metamorphic rocks are known to be highly variability in permeability (*pers comm.,* DNRW, Mareeba). Within the bedrock aquifer zones may occur in secondary porosity features such as fracturing, faulting of the rock and the weathered interface with overlying sediments. The primary porosity of the bedrock mass is considered to be of very low permeability.

Infiltration from precipitation is the primary source of recharge to the aquifers on the site. The colluvium unit is recharged from direct infiltration on the slopes of the Seymour Range and seepage through overlying aquitard and sand aquifer unit and potentially fracture flow from the basement rocks. The sand aquifer and clay aquitard recharge from direct surface infiltration and upward seepage from colluvium.

Discharge is via springs at the base of the range, particularly during and after higher intensity rainfall events, within the wetlands, beach sands and interflow at the coastal saltwater interface.

Groundwater flow direction is largely controlled by topography. The general direction of groundwater flow is from southwest to northeast, from the Seymour Range to the ocean, as depicted in Cross-section A-A'.

6.2 Analytical Groundwater Model

6.2.1 Introduction and Model Design

A simple one-layered analytical model was developed in the software package "Winflow version 3.26" to predict groundwater drawdown in the colluvium aquifer from pumping PB1B over extended periods of time at a flow rate of 3 L/s. The colluvium aquifer properties used in the model are based on drilling and test pumping results

An aquifer thickness of 21m was used in the model prior to transient (pumping) simulations and was based on the borelog of PB1B. An initial groundwater level of 7.5m AHD was applied at pumping bore PB1B and a hydraulic gradient of 0.01 was introduced towards the northeast direction (reflects topography and groundwater flow direction as provided in Figure 12). The bores PB1B, MB1B-01, MB1B-02 and two other locations at distances of 1000 and 1500 metres were monitored for drawdown of groundwater levels after specific time periods in the model simulations. Drawdown contours extending around PB1B were predicted for continuous pumping at a rate of 3 L/s for durations of 6 months, 1 year and 2 years.

The model has several limitations and assumptions which reduce the accuracy of drawdown results and these points are provided in Section 6.2.4.

6.2.2 Model Simulation

Four simulations of the model were conducted with the hydraulic parameters K and S varied between expected and upper or lower values. A summary of adopted hydraulic parameters within the model scenarios is presented in Table 12 below.

Table 12: Summary of Model Scenarios and Hydraulic Parameters

Scenarios	Hydraulic Conductivity (m/day)	Storativity	Remarks
1	8.3	0.00795	Most likely - values based on pumping test
2	3.0	0.00795	Less likely - lower K range
3	20.0	0.00795	Less likely - upper K range
4	8.3	0.05	Less likely - upper S range

Scenario 1 is considered the most likely model simulation as K and S are averaged pumping test values.

6.2.3 Results

The drawdown predictions of the colluvium aquifer at bores PB1B, MB1B-01 and MB1B-02 for Scenario 1 is provided as time series plots in Figures 14, 15 and 16 respectively. The modelled result at PB1B does not account for well loss and therefore the drawdown at the bore is substantially less than during the 3-day constant rate pumping test.

A summary of the predicted drawdown amounts at PB1B, MB1B-01, MB1B-02 and two locations 1000 m (approximate distance to southern extremity of Ella Bay Swamp and monitoring bore MW-3 in dunal swale) and 1500 m (monitoring bore MW-4 in duna swale) from the pumping bore after 0.5, 1 and 2 years pumping in all 4 Scenarios are presented in Table 14. Time series plots of predicted drawdown at PB1B, MB1B-01, MB1B-02 from start of pumping until just over 2 years are presented in Figures 14, 15, and 16 respectively. The predicted regional drawdown contours extending out from PB1B after 0.5, 1 and 2 years are provided in Figures 17, 18, and 19 respectively. Note that predictions do not take into account recovery of water levels from rainfall recharge, particularly during the wet season.

With the exception of Scenario 2 (lower K threshold of 3 m/d) the regional drawdown is relatively low after 6 months to one year continuous pumping. Scenarios 3 and 4 which have higher hydraulic conductivity and storativity values typically have lower regional drawdown influence.

Table 13: Summary of Predicted Drawdown for Selected Locations

Scenario	Predicted Drawdown (m) after 6 months				
	PB1B	MB1B-01 (26m*)	MB1B-02 (117m*)	1000m*	1500m*
1	2.55	1.13	0.77	0.27	0.18
2	6.72	2.78	1.79	0.44	0.23
3	1.10	0.51	0.36	0.15	0.11
4	2.33	0.91	0.55	0.08	0.03
Scenario	Predicted Drawdown (m) after 1 Year				
	PB1B	MB1B-01 (26m*)	MB1B-02 (117m*)	1000m*	1500m*
1	2.63	1.21	0.85	0.35	0.25
2	6.95	3.02	2.02	0.64	0.41
3	1.14	0.55	0.40	0.19	0.15
4	2.42	0.99	0.63	0.15	0.08
Scenario	Predicted Drawdown (m) after 2 Year				
	PB1B	MB1B-01 (26m*)	MB1B-02 (117m*)	1000m*	1500m*
1	2.71	1.29	0.93	0.42	0.33
2	7.16	3.23	2.23	0.84	0.59
3	1.17	0.58	0.43	0.22	0.18
4	2.49	1.07	0.71	0.21	0.13

*Note - * Distance from Production bore PB1B.*

It is important to note that the model does not take into account rainfall recharge of the colluvium aquifer or discharge zones. The high rainfall amount in the region (average of 3.5 m/year at Innisfail) would recharge the aquifer and reduce the extent of drawdown. The cone of drawdown around the pumping bore PB1B would contract during the wet season. Therefore, the predicted drawdown from this modelling is likely to be less over a period of time due to rainfall recharge, particularly during the wet season..

6.2.4 Model Limitations

Limitations and assumptions of the analytical model are provided below.

- Recharge is not considered within the analytical model. The colluvium aquifer is subject to recharge from rainfall or stream flow which significantly varies during the year depending on the seasons. Significant rainfall quantities occur during the wet season from December to May (average 3.5m rainfall/year). Expect the cone of depression (drawdown) around the pumping bore to contract during the wet season during and after high rainfall events.
- The model does not apply discharge conditions, i.e. drainage by seepage from the aquifer down hydraulic gradient in the wetland/beach area or vertical movement within the underlying bedrock.
- The model assumes an isotropic homogeneous 1 layered aquifer unit. In reality the colluvium aquifer is highly variable been partially cemented, layered vertically with respect to matrix grain sizes and hydraulic properties and laterally variable in thickness, pinching out with elevation up the Seymour Range.
- Assumed no leakage factor from overlying sediments or underlying bedrock.
- Assumed the colluvium aquifer is of uniform thickness and of infinite extent when in reality the thickness is highly variable with the colluvium aquifer pinching out towards the sea and on the slopes of the Seymour Range.

7.0 GROUNDWATER ABSTRACTION ASSESSMENT

The groundwater abstraction assessment is primarily focused on the effects on the surrounding WHAs from pumping PB1B at a flow rate of 3 L/s. Specifically, investigations to assess potential drawdown impacts on the wetlands near the Northern Conservation Covenant and the dunal swale wetlands connected to the Eastern Conservation Covenant.

Methods for investigating potential impacts from pumping on the surrounding WHAs were as follows:

- The analysis of data collected from electronic water-level measuring devices (In-situ® 300 Level Troll pressure transducer) installed in shallow monitoring bores located near the environmentally sensitive areas; and
- Analytical groundwater modelling to predict aquifer drawdown caused by the pumping of PB1B at 3 L/s.

7.1 Potential Impact on Wetlands Near Northern Conservation Covenant

To determine the impact of pumping from bore PB1B on the wetlands near the Northern Conservation Covenant a point was chosen at the southern extremity of Ella Bay Swamp as a measuring point to represent the wetlands (Ella Bay Swamp). The location of this measuring point is approximately 994 m north-northeast of production bore PB1B and about 200 m from the boundary of the Northern Conservation Covenant. From the aforementioned methods of investigation and the results in this report, Golder presents the following conclusions:

- The bore PB1B can be pumped continuously for at least 35 days at a rate of 3 L/s before potentially producing 0.1 m drawdown in water levels at the southern extremity of Ella Bay Swamp as estimated by groundwater modelling results (refer to time series drawdown plot in Figure 20). The bore may be pumped for 100 days before approximately 0.2 m drawdown of water levels at the same location from model predictions. This is based on the limitations and assumptions of the simple model, particularly no aquifer recharge, and the assumption there is a direct hydraulic connection between the colluvium and the silty clay sediments in the wetlands.
- The radius of pumping influence from PB1B was extrapolated from 250 m (3-day constant rate pumping test) to 994 m on a distance – drawdown plot in Figure 21. The drawdown equivalents at bores MB1B-01 and MB1B-02 was extrapolated to 1.45 m and 0.82 m respectively. These drawdown values may be set as trigger values to indicate that the radius of pumping influence may have reached the southern extremity of the Ella Bay Swamp. If the trigger levels are reached then the pump in PB1B should be shut off until the static water level at the bore has recovered 80%.
- Groundwater level data was collected from A-MW2 (located between PB1B and the Ella Bay Swamp) prior and during the 3-day constant rate pumping test. The drawdown of bore A-MW2 is graphically shown in Figure 22, with the duration of the pumping test labelled. The data shows an overall decline in water level prior and during the pumping test which is a natural recession, probably due to lack of rainfall recharge. The tidal oscillations in A-MW2 are compared with the tidal record from Flying Fish Point in Figure 22. The tidal oscillations in water level data from A-MW2 do not match the Flying Fish Point tidal record from 12 December to 19 December. After 19 December the tidal oscillations in the water level data from A-MW2 match the Flying Fish Point tidal record. Reasons why the tidal oscillations do not match the Flying Fish Point tidal record throughout the data collection are unknown but may be attributed to lag time caused by the inland location of the monitoring bore. There is no underlying evidence that the 3-day CRPT impacted water levels in monitoring bore A-MW2.

7.2 Potential Impact on Wetland Swales Near Eastern Conservation Covenant

To determine potential impact of the production bore PB1B on the dunal swale wetland near the Eastern Conservation Covenant, the shallow monitoring bores A-MW3 (located between PB1B and the dunal swale) and A-MW4 (located on the western edge of the dunal swale wetland located 1538 meters from PB1B), were selected as a measuring points to represent the wetland swales. The location of A-MW3 and A-MW4 are east and down gradient from the pumping bore (refer to Figure 2 for locations). The regional geology map and borehole logs for bores A-MW3 and A-MW4 show the geology of the near the wetland swales to be composed of sand to clayey sand. From the aforementioned methods of investigation and the analyses in this report, Golder presents the following conclusions:

- The groundwater modelling results (Figure 17 and 18) indicate bore PB1B may be pumped continuously for 35 days at flow rate of 3 L/s before potentially producing 0.1 m drawdown at bore A-MW3 and for 80 days before potentially producing 0.1 m drawdown at bore A-MW4. This is based on the limitations and assumptions of the simple model, particularly no recharge and the assumption there is a direct hydraulic connection between the colluvium and the sandy sediments in the wetlands,
- The groundwater level monitoring data was collected from bores A-MW3 and A-MW4 prior and during the 3-day constant rate pumping test. The drawdown in bores A-MW3 and A-MW4 is graphically shown in Figure 22, with the duration of the pumping test labelled. Oscillations in the data represent tidal propagation. Overall the slope of the trend in the drawdown plots can be described as flat, and there is no evidence that the 3-day constant rate pumping test impacted water levels in bores A-MW3 and A-MW4. The water level data prior and during the pumping test does not show an overall recession compare to data at bore A-MW2 (Figure 23). The reason maybe due to the location of monitoring bore A-MW2 is closer to the Seymour Range which means it is more sensitive to water level fluctuations due to rainfall recharge characteristics of the topography. Additionally, alike A-MW2, the observation data from A-MW3 and A-MW4 exhibit oscillations that can be attributed to tidal propagations. In Figure 22, the tidal oscillations from A-MW3 and A-MW4 are compared with the tidal record from Flying Fish Point. and do not match from 12 December to 19 December, however after 19 December they are similar. Reasons why the tidal oscillations do not match the Flying Fish Point tidal record throughout the data collection are unknown but may be attributed to lag time caused by the inland location of the monitoring bore
- The colluvium aquifer may not span the distance between the foot of the ranges and the dunal swale wetland system behind the beach or is buried 10's of metres deep beneath marine and alluvium interfingered clayey sediments. It may be possible that there is no direct hydraulic connection between the dunal swale wetland and the colluvium aquifer.

8.0 RECOMMENDATIONS

Operational Management of Production Bores and Monitoring

To promote groundwater supply sustainability and to minimise potential environmental impacts, Golder recommends the following operational management measures for the production and monitoring bores:

- The discharge line from bore PB1B be fitted with a flow meter;
- Groundwater levels in production bore PB1B and affiliated monitoring bores MB1B-01 and MB1B-02 need to be monitored either manually with a water lever dipper or with electronic measuring equipment (i.e. Campbell Scientific pressure transducers and data loggers) prior to pumping and on a weekly basis throughout the duration of the pumping. Measurements from fixed point on casing and converted to metres Australian Height Datum (AHD) and also metres above ground level. Results to be entered in a log book.
- The installation of a weather station and data logger on site to record localised rainfall to assist groundwater recharge estimations.

- The production bore PB1B may be pumped at a maximum flow rate of 3 L/s for long periods of time up to 35 days and possibly up to flow rates of 4 to 6 L/s for shorter timeframes (a higher pumping rate or longer duration would need to be reviewed and approved by a senior level hydrogeologist);
- Allow for 80% recovery of the static water level between pumping durations; and
- Monitor groundwater levels in monitoring bores A-MW2, A-MW3 and AMW4 at weekly intervals during pumping. Suggest measurements obtained with a groundwater level dipper. Measurements from fixed point on casing and converted to metres Australian Height Datum and also metres above ground level. Results to be entered in a log book.
- The flow abstraction volumes from bore PB1B should be recorded in a log book at least on a monthly basis to quantify yields from the aquifer over time; and
- The stopping and starting times of the pump and flow meter readings at this point be recorded in a log book.
- The bore PB3C may be used as a backup emergency water supply for short periods of time. The bore is likely to silt up and choke the pump or dewater if used for an extended period of time of several days use. The pump should not be positioned at or near the bottom of the bore for this reason. The depth of the bore should be frequently dipped during operations to assess rate of siltation. This will require the removal of the pump prior to dipping the bottom depth of the bore.
- The water quality of production bore PB1B during pumping operations is monitored at least 3 monthly intervals for pH and electrical conductivity to evaluate trends indicating potential deterioration in water quality. If water is used for drinking purposes then possibly undertake a comprehensive potability analysis on an annual basis.
- The mode of operations for pumping bore PB1B is modified according to the groundwater response recorded in monitoring bores, for example, the drawdown influences in the vicinity of the wetlands near bore A-MW2 may take much longer than calculated from analytical modelling due to a poor hydraulic connection between colluvium and wetland sediments. This can only be confirmed by routine monitoring of water levels during pumping operations.
- The monitoring bores MB1B-01 and MB1B-02 should be monitored during the pumping of bore PB1B so they do not exceed the proposed, aforementioned trigger levels; shut off the pumping bore if proposed trigger levels are exceeded and allow for 80% recovery before pumping resumes.

9.0 IMPORTANT INFORMATION

Your attention is drawn to the document – “Limitations of This Report” which is included in Appendix F of this report.

Report Signature Page

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FIGURES

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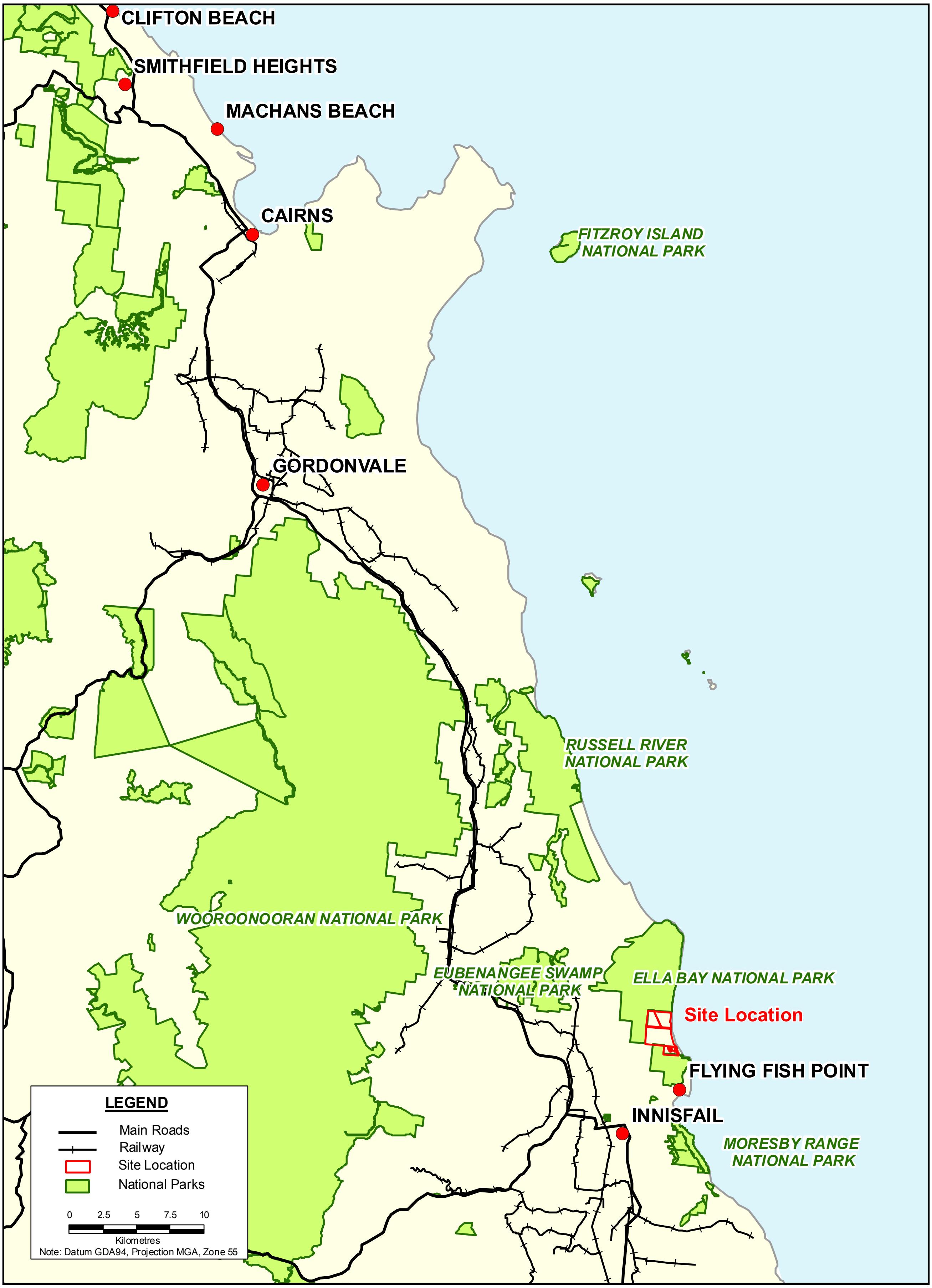

CLIENT Satori Resorts Ella Bay Pty Ltd

PROJECT ELLA BAY RESOURCE EVALUATION

DRAWN DK

DATE 16/02/09

CHECKED RWD

DATE 06/03/09

TITLE

REGIONAL LOCATION PLAN

SCALE 1:400,000

PROJECT No 087673031

FIGURE No 1

REV No 0

A4

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Golder Associates

CLIENT Satori Resorts Ella Bay Pty Ltd

PROJECT Ella Bay GW Resource Evaluation

DRAWN GPG DATE 06/03/09

CHECKED *RWD DATE 06/03/09

SCALE 1:10,000

TITLE ELLA BAY SITE PLAN AND BOREHOLE LOCATIONS

PROJECT No 087673031 FIGURE No 2 REV No A A3

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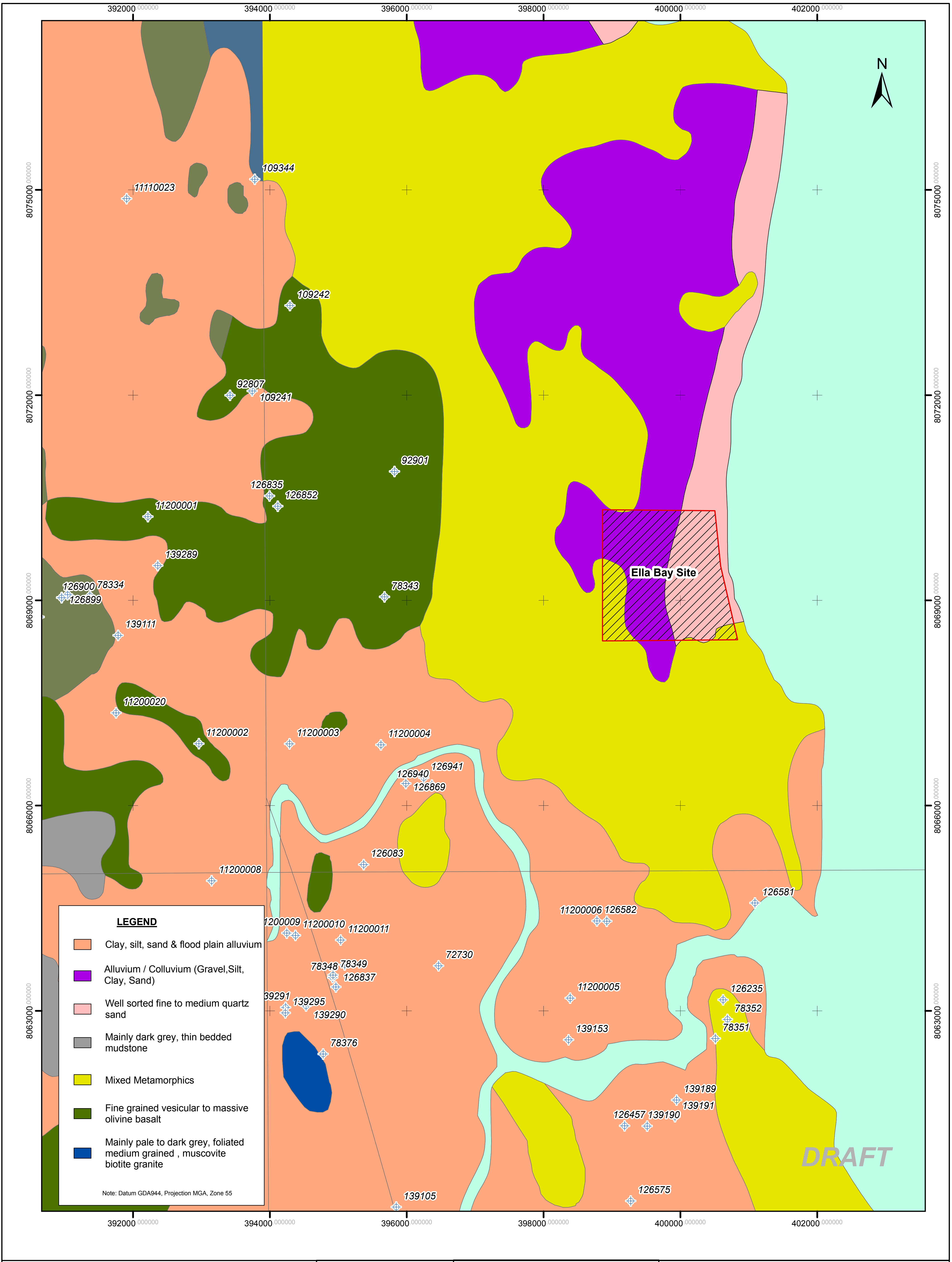

⌖ DNR Registered Groundwater Bores

Golder Associates

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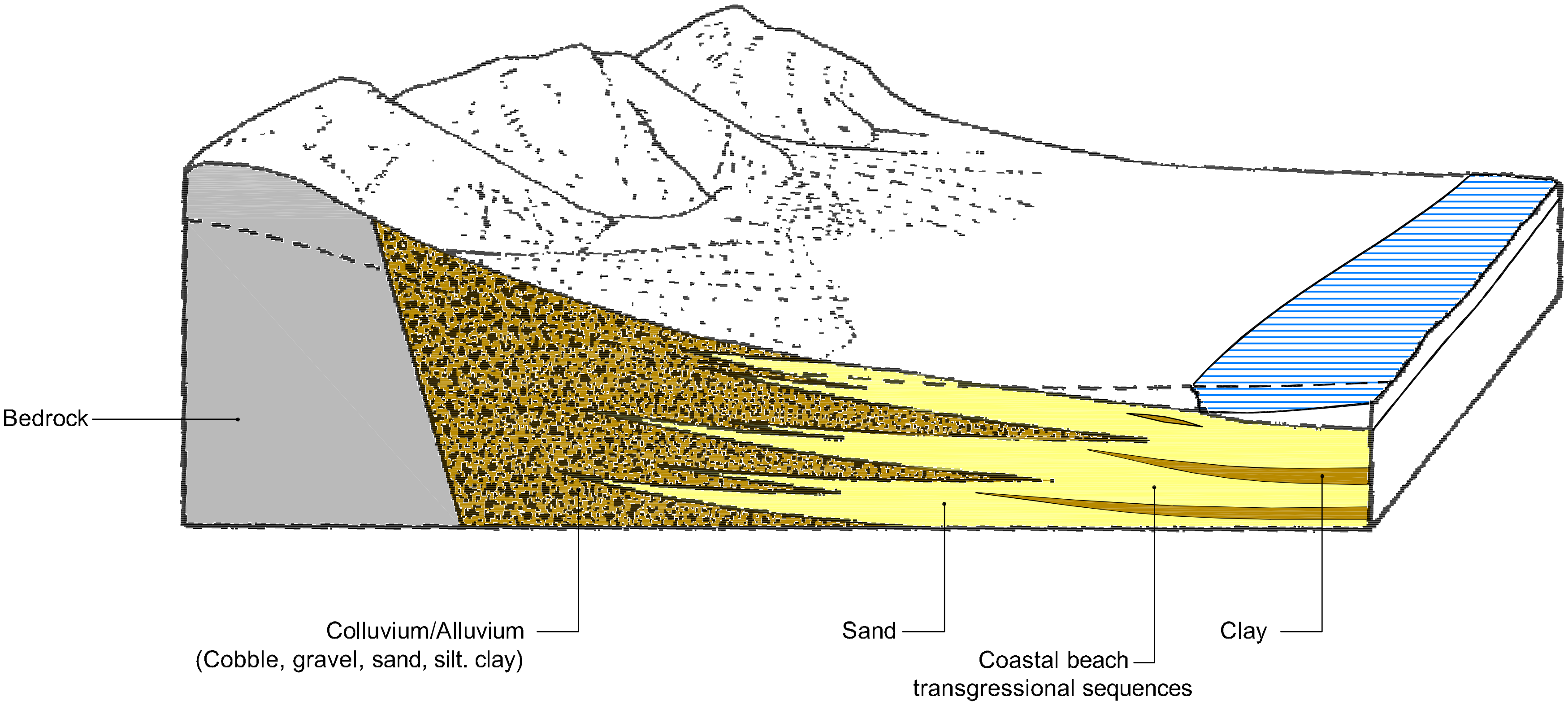

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NOTE
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Golder Associates

CLIENT	Satori Resorts Ella Bay Pty Ltd		
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SCALE	1:10,000		

PROJECT
Ella Bay GW Resource Evaluation

TITLE
GROUNDWATER EXPLORATION AREAS

PROJECT No	FIGURE No	REV No	
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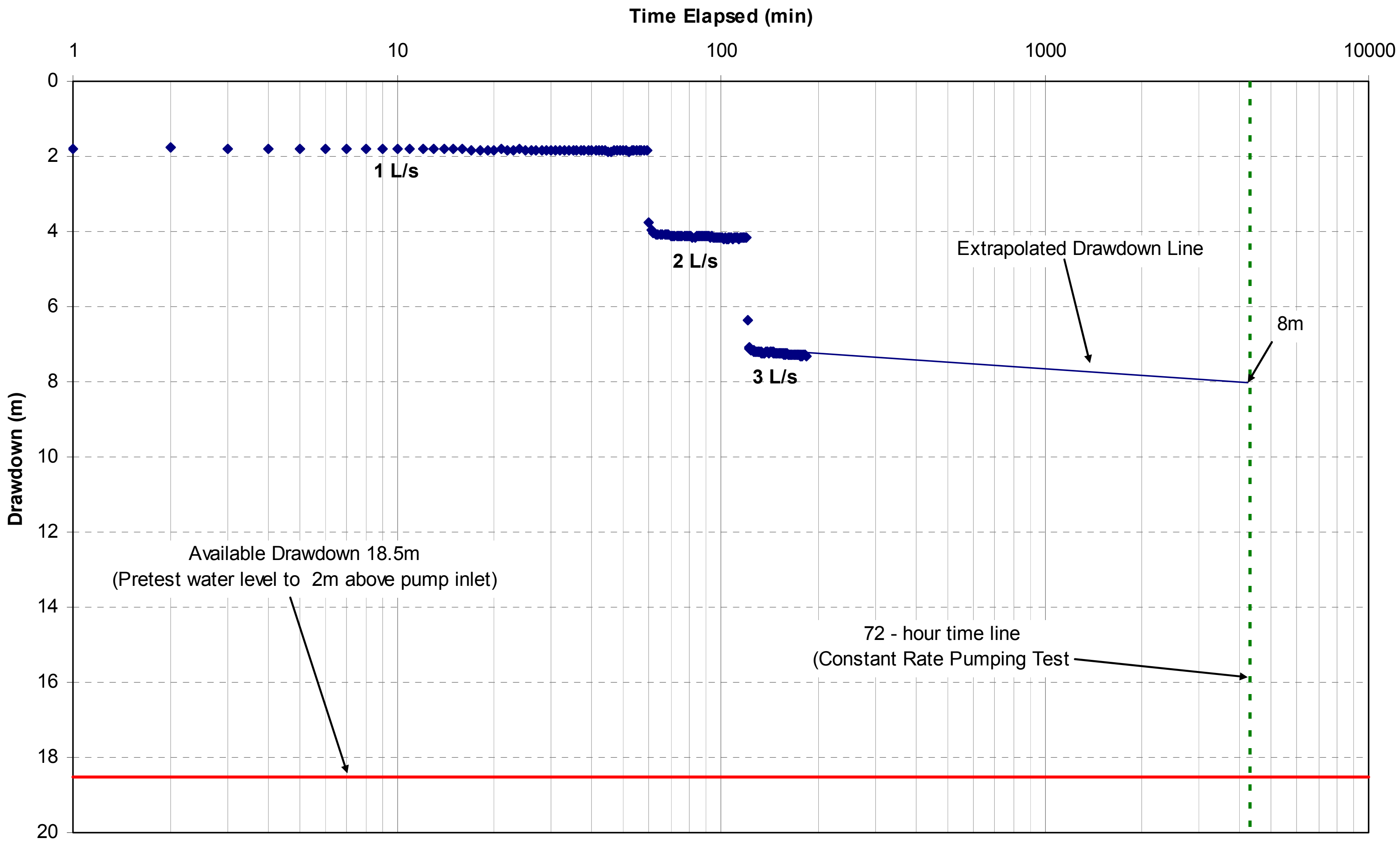

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Satori Resorts Ella Bay Pty Ltd

PROJECT
Ella Bay Groundwater Resource Evaluation

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DATE Mar 2009

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TITLE
Results of 3-hour Step Rate Pumping Test at PB1B

PROJECT No 087673031
FIGURE No 6
REV No T
A4

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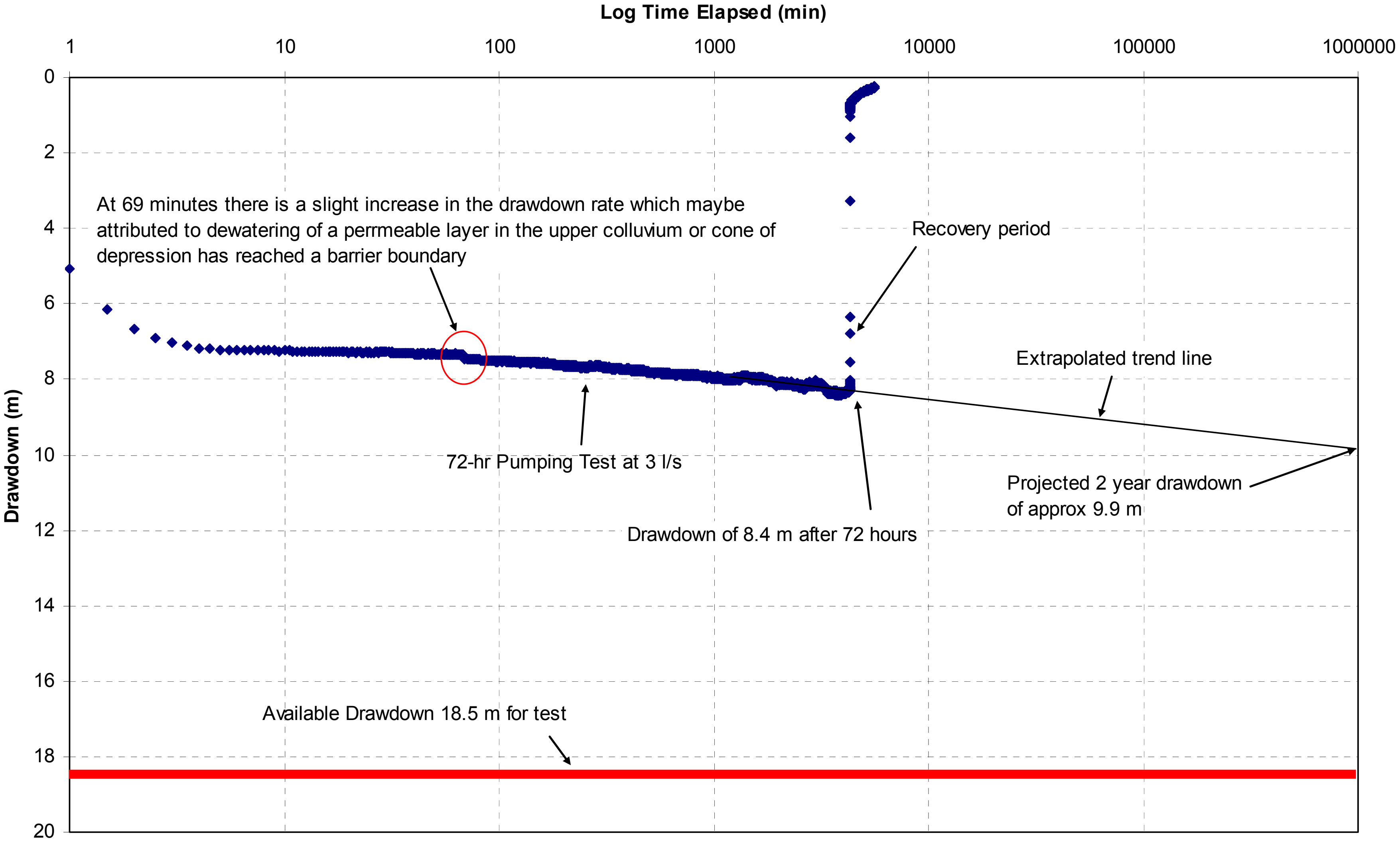

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CLIENT Satori Resorts Ella Bay Pty Ltd		PROJECT Ella Bay Groundwater Resource Evaluation	
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SCALE Not to scale		PROJECT No 087673031	FIGURE No 7	REV No T	A4

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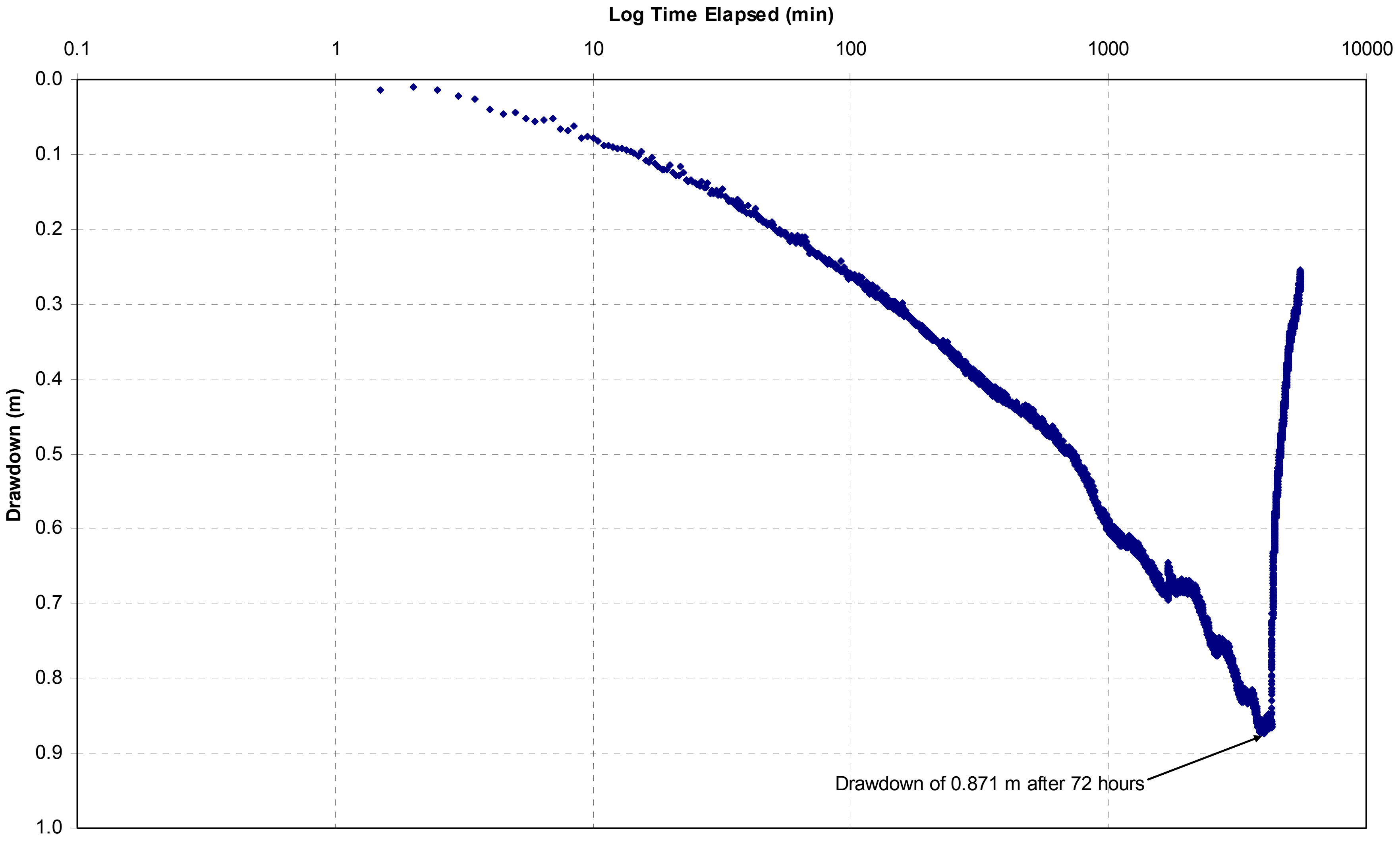
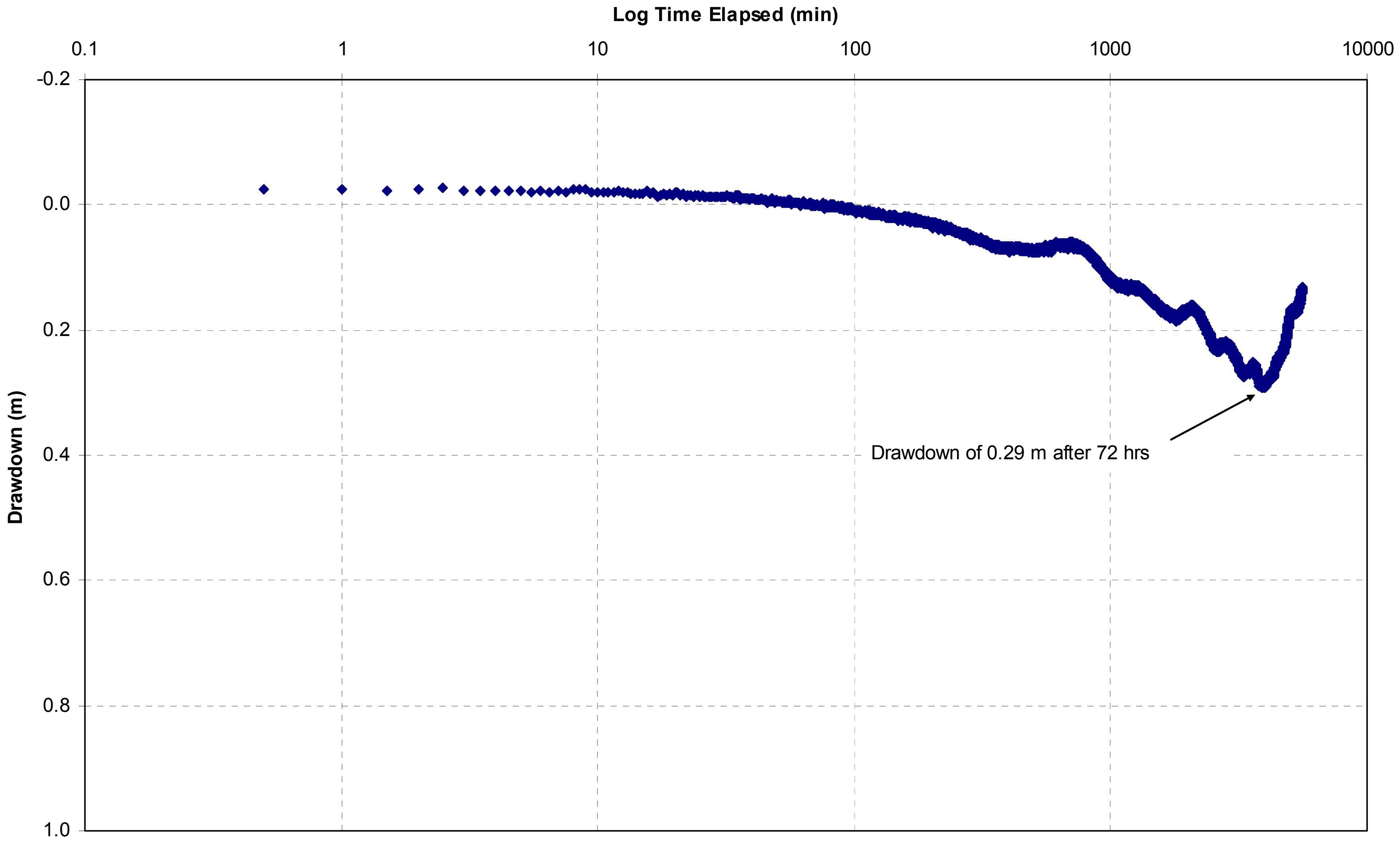


Monitoring Bore MB1B-01 is located 25.5m from Production Bore PB1B

Golder Associates

CLIENT Satori Resorts Ella Bay Pty Ltd		PROJECT Ella Bay Groundwater Resource Evaluation	
DRAWN SK	DATE Feb 2009	TITLE **Drawdown in MB1B-01 from 3-Day Pumping Test at PB1B**	
CHECKED RWD	DATE Mar 2009		
SCALE Not to scale		PROJECT No 087673031	FIGURE No 8
		REV No T	A4



Monitoring Bore MB1B-02 is located 117.25 m from Production Bore PB1B

CLIENT Satori Resorts Ella Bay Pty Ltd		PROJECT Ella Bay Groundwater Resource Evaluation	
DRAWN SK	DATE Feb 2009	TITLE **Drawdown in MB1B-02 from 3-Day Pumping Test at PB1B**	
CHECKED RWD	DATE Mar 2009		
SCALE Not to scale		PROJECT No 087673031	FIGURE No **9** REV No **T** **A4**

1:10000

0 200 400 600 800 1000 m

200 100

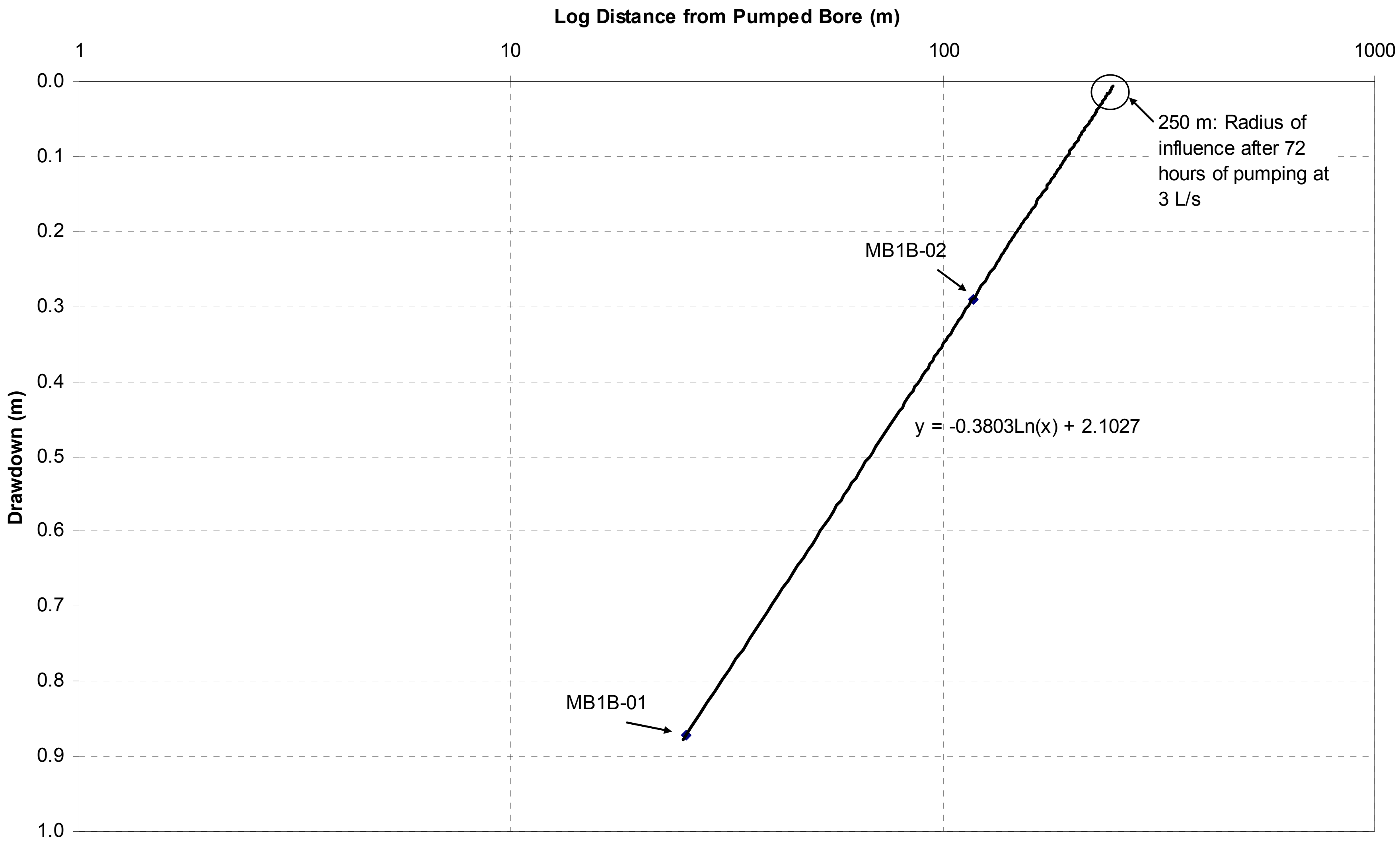
NOTE
BASE PLAN DERIVED FROM "SCHLENCKER MAPPING P/L", DRAWING No. ELLABAY_CONTOURS.DXF, DATE 08/07/08

Golder Associates

CLIENT	Satori Resorts Ella Bay Pty Ltd	PROJECT	Ella Bay GW Resource Evaluation
DRAWN	GPG	DATE	06/03/09
CHECKED	*RWD	DATE	06/03/09
TITLE	RADIUS OF INFLUENCE & DRAWDOWN CONTOURS FROM 72 HOUR PUMPING TEST AT 3L/S		
SCALE	1:10,000	PROJECT No	087673031
FIGURE No	10	REV No	2
	A3		

NOTE: THE * BESIDE THE TYPED INITIALS DENOTES THE ORIGINAL DRAWING ISSUE WAS SIGNED OR INITIALLED BY THAT RESPECTIVE PERSON.

K:\CAIRNS\08\87673031\Figures\087673031-001-R-FIG10_rev2.dwg Mar 09, 2009 - 3:18pm



CLIENT Satori Resorts Ella Bay Pty Ltd		PROJECT Ella Bay Groundwater Resource Evaluation		
DRAWN SK	DATE Feb 2009	TITLE **Distance Drawdown Plot of 3-Day Pumping Test at 3 L/s**		
CHECKED RWD	DATE Mar 2009			
SCALE Not to scale		PROJECT No 087673031	FIGURE No 11	REV No T

A4

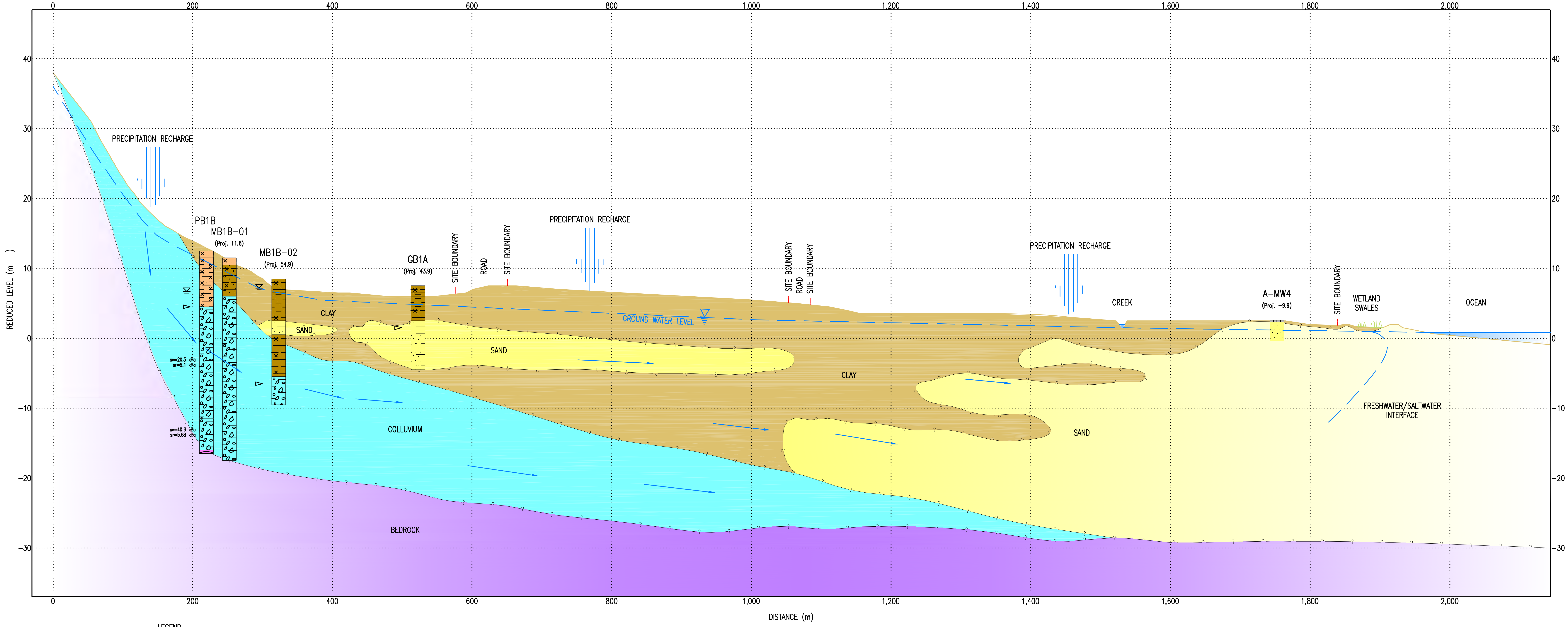
NOTE
BASE PLAN DERIVED FROM "SCHLENCKER MAPPING P/L", DRAWING No. ELLABAY_CONTOURS.DXF, DATE 08/07/08

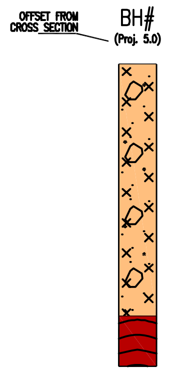
Golder Associates

CLIENT Satori Resorts Ella Bay Pty Ltd
PROJECT Ella Bay GW Resource Evaluation
DRAWN GPG
DATE 06/03/09
CHECKED *RWD
DATE 06/03/09
TITLE GROUND WATER COUNTOR LEVELS
SCALE 1:10,000
PROJECT No 087673031
FIGURE No 12
REV No 2
A3

NOTE: THE * BESIDE THE TYPED INITIALS DENOTES THE ORIGINAL DRAWING ISSUE WAS SIGNED OR INITIALLED BY THAT RESPECTIVE PERSON.

K:\CAIRNS\08\87673031\Figures\087673031-001-R-FIG12_rev2.dwg Mar 09, 2009 - 3:19pm





LEGEND

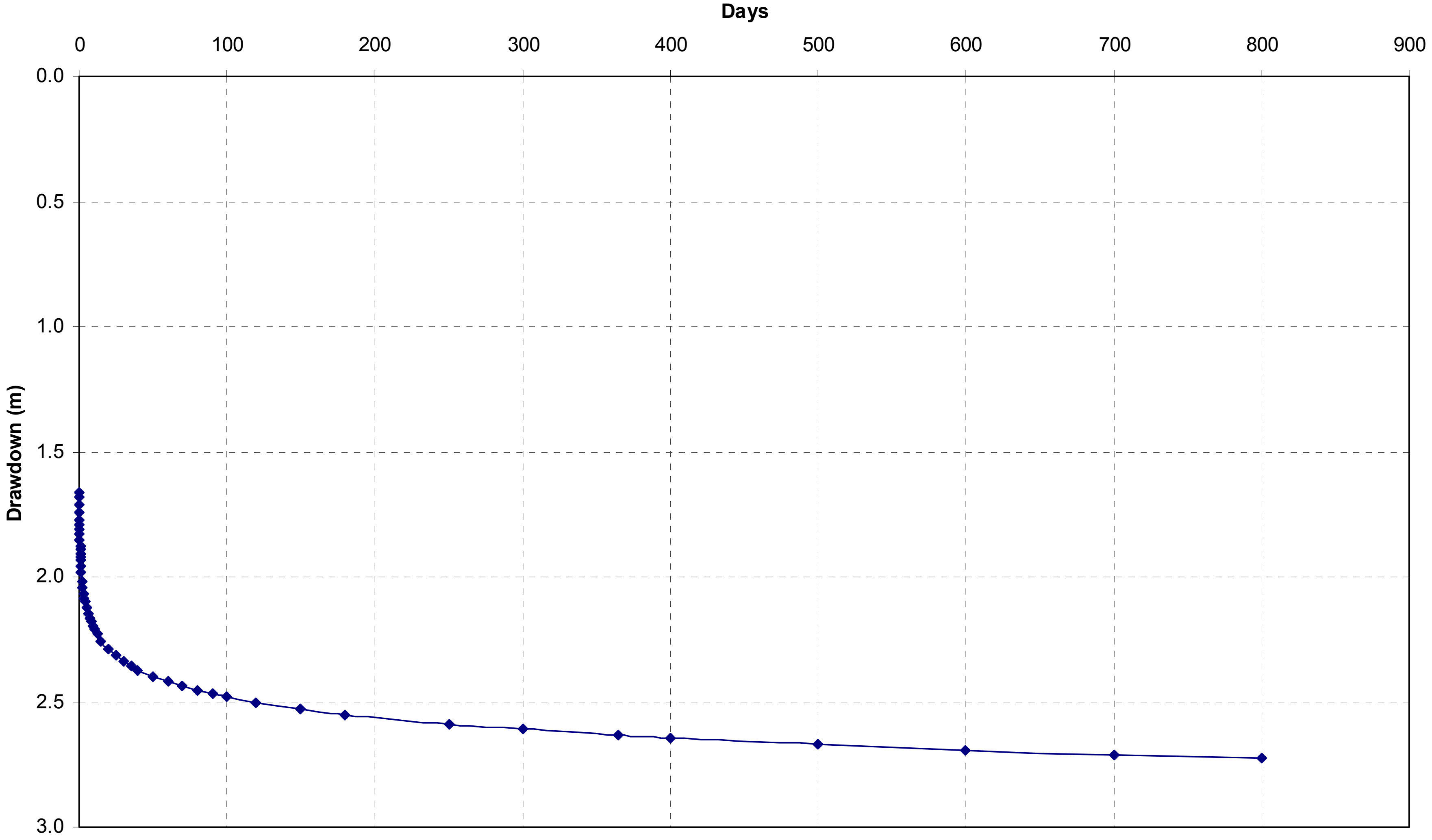
- ▥ TOPSOIL
- ▨ Clayey SILT
- ▨ Sandy SILT
- ▨ CLAY
- ▨ Silty CLAY
- ▨ Sandy Silty CLAY
- ▨ SAND
- ▨ Clayey SAND
- ▨ Clayey GRAVEL (COLLUVIUM)
- ▨ MIXED METAMORPHICS (BEDROCK)
- → GROUNDWATER FLOW DIRECTION
- ▽ GROUNDWATER LEVEL

Golder Associates

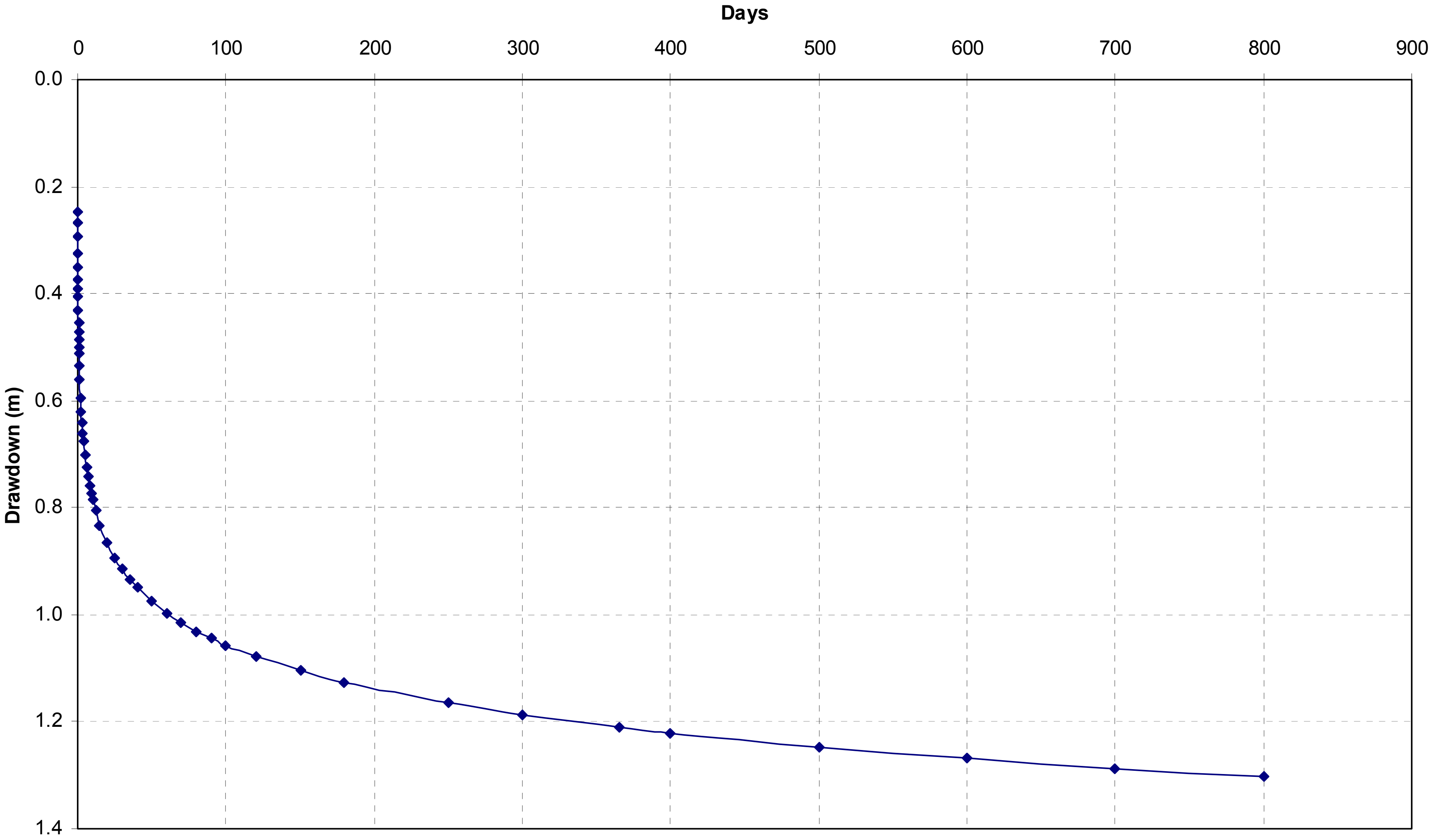
CLIENT	Satori Resorts Ella Bay Pty Ltd		
DRAWN	GPG	DATE	06/03/09
CHECKED	*RWD	DATE	06/03/09
SCALE	H 1:4000 V 1:200		

PROJECT	Ella Bay GW Resource Evaluation		
TITLE	HYDROGEOLOGICAL CONCEPTUAL MODELOF CROSS SECTION A-A'		
PROJECT No 087673031	FIGURE No 13	REV No 2	A3+

NOTE: THE * BESIDE THE TYPED INITIALS DENOTES THE ORIGINAL DRAWING ISSUE WAS SIGNED OR INITIALLED BY THAT RESPECTIVE PERSON.



CLIENT Satori Resorts Ella Bay Pty Ltd		PROJECT Ella Bay Groundwater Resource Evaluation
DRAWN SK	DATE Feb 2009	TITLE **Predicted Drawdown at Production Bore PB1B**
CHECKED RWD	DATE Mar 2009	
SCALE Not to scale		PROJECT No 087673031 · FIGURE No 14 · REV No T · A4



Monitoring Bore MB1B-01 is located 25.5m from Production Bore PB1B

Golder Associates

CLIENT Satori Resorts Ella Bay Pty Ltd

PROJECT Ella Bay Groundwater Resource Evaluation

DRAWN SK

DATE Feb 2009

CHECKED RWD

DATE Mar 2009

TITLE **Predicted Drawdown at Monitoring Bore MB1B-01**

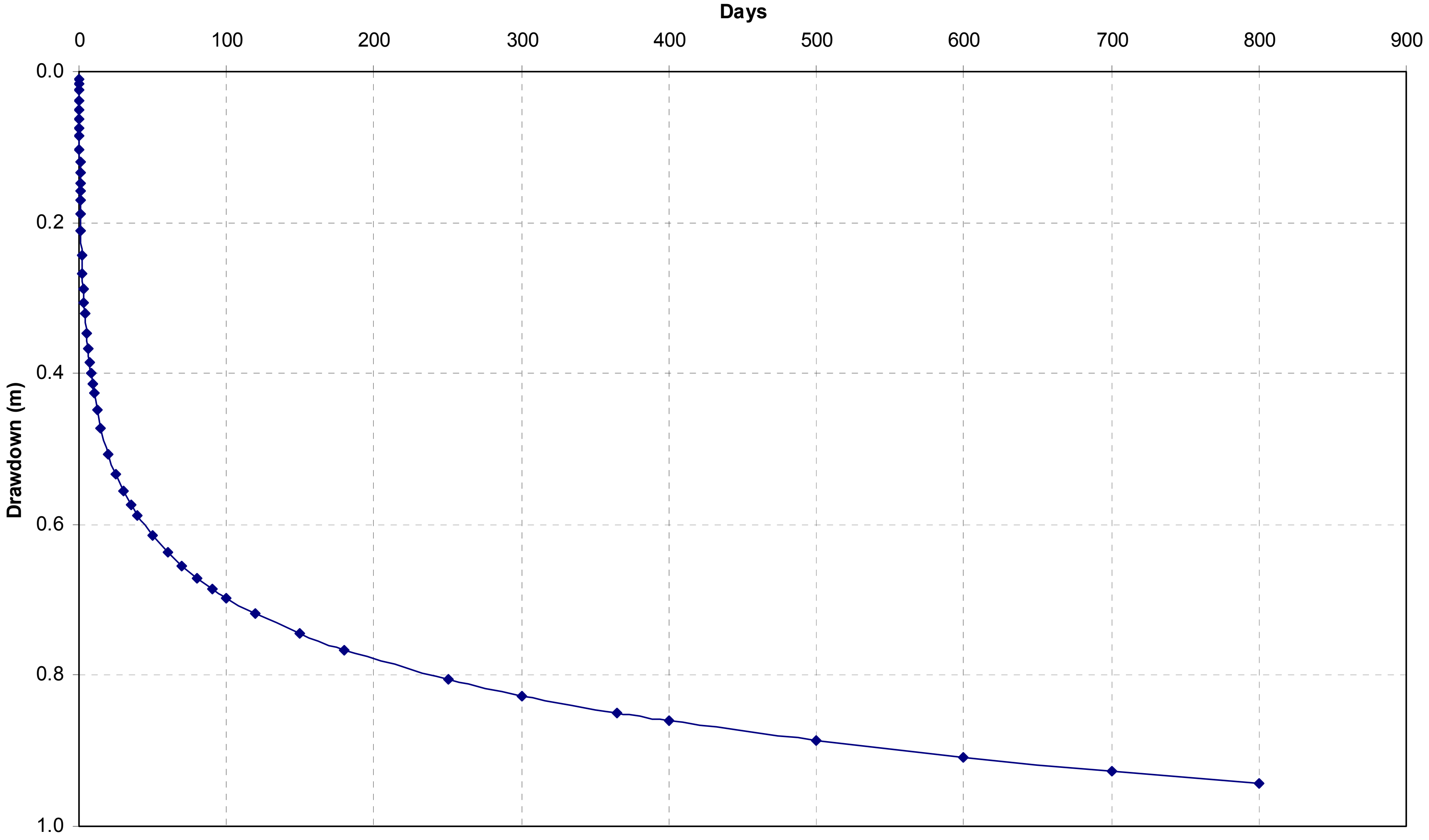
SCALE Not to scale

PROJECT No 087673031

FIGURE No **15**

REV No **T**

A4



Monitoring Bore MB1B-02 is located117.25m from Production Bore PB1B

Golder Associates

CLIENT
Satori Resorts Ella Bay Pty Ltd

PROJECT
Ella Bay Groundwater Resource Evaluation

DRAWN SK
DATE Feb 2009

CHECKED RWD
DATE Mar 2009

TITLE
Predicted Drawdown at Monitoring Bore MB1B-02

SCALE Not to scale

PROJECT No 087673031

FIGURE No **16**

REV No **T**

A4

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NOTE
BASE PLAN DERIVED FROM "SCHLENCKER MAPPING P/L", DRAWING No. ELLABAY_CONTOURS.DXF, DATE 08/07/08

Golder Associates

CLIENT: Satori Resorts Ella Bay Pty Ltd
PROJECT: Ella Bay GW Resource Evaluation
DRAWN: GPG DATE: 06/03/09
CHECKED: *RWD DATE: 06/03/09
TITLE: PREDICTED DRAW DOWN CONTOURS AFTER 6 MONTHS OF CONTINUOUS PUMPING PB1B AT 3 L/S
SCALE: 1:10,000
PROJECT No: 087673031
FIGURE No: 17
REV No: 2
A3

NOTE: THE * BESIDE THE TYPED INITIALS DENOTES THE ORIGINAL DRAWING ISSUE WAS SIGNED OR INITIALLED BY THAT RESPECTIVE PERSON.

K:\CAIRNS\08\87673031\Figures\087673031-001-R-FIG17_rev2.dwg Mar 09, 2009 - 3:32pm

NOTE
BASE PLAN DERIVED FROM "SCHLENCKER MAPPING P/L", DRAWING No. ELLABAY_CONTOURS.DXF, DATE 08/07/08

CLIENT	Satori Resorts Ella Bay Pty Ltd		
DRAWN	GPG	DATE	06/03/09
CHECKED	*RWD	DATE	06/03/09
SCALE	1:10,000		

PROJECT	Ella Bay GW Resource Evaluation		
TITLE	PREDICTED DRAWDOWN CONTOURS AFTER 1 YEAR OF CONTINUOUS PUMPING PB1B AT 3 L/S		
PROJECT No	087673031	FIGURE No	18
REV No	2		A3

NOTE: THE * BESIDE THE TYPED INITIALS DENOTES THE ORIGINAL DRAWING ISSUE WAS SIGNED OR INITIALLED BY THAT RESPECTIVE PERSON.

K:\CAIRNS\08\87673031\Figures\087673031-001-R-FIG18_rev2.dwg Mar 09, 2009 - 3:31pm

1:10000

200 100 0 200 400 600 800 1000 m

NOTE
BASE PLAN DERIVED FROM "SCHLENCKER MAPPING P/L", DRAWING No. ELLABAY_CONTOURS.DXF, DATE 08/07/08

Golder Associates

CLIENT: Satori Resorts Ella Bay Pty Ltd

PROJECT: Ella Bay GW Resource Evaluation

DRAWN: GPG DATE: 06/03/09

CHECKED: *RWD DATE: 06/03/09

TITLE: PREDICTED DRAWDOWN CONTOURS AFTER 2 YEARS OF CONTINUOUS PUMPING PB1B AT 3 L/S

SCALE: 1:10,000

PROJECT No: 087673031

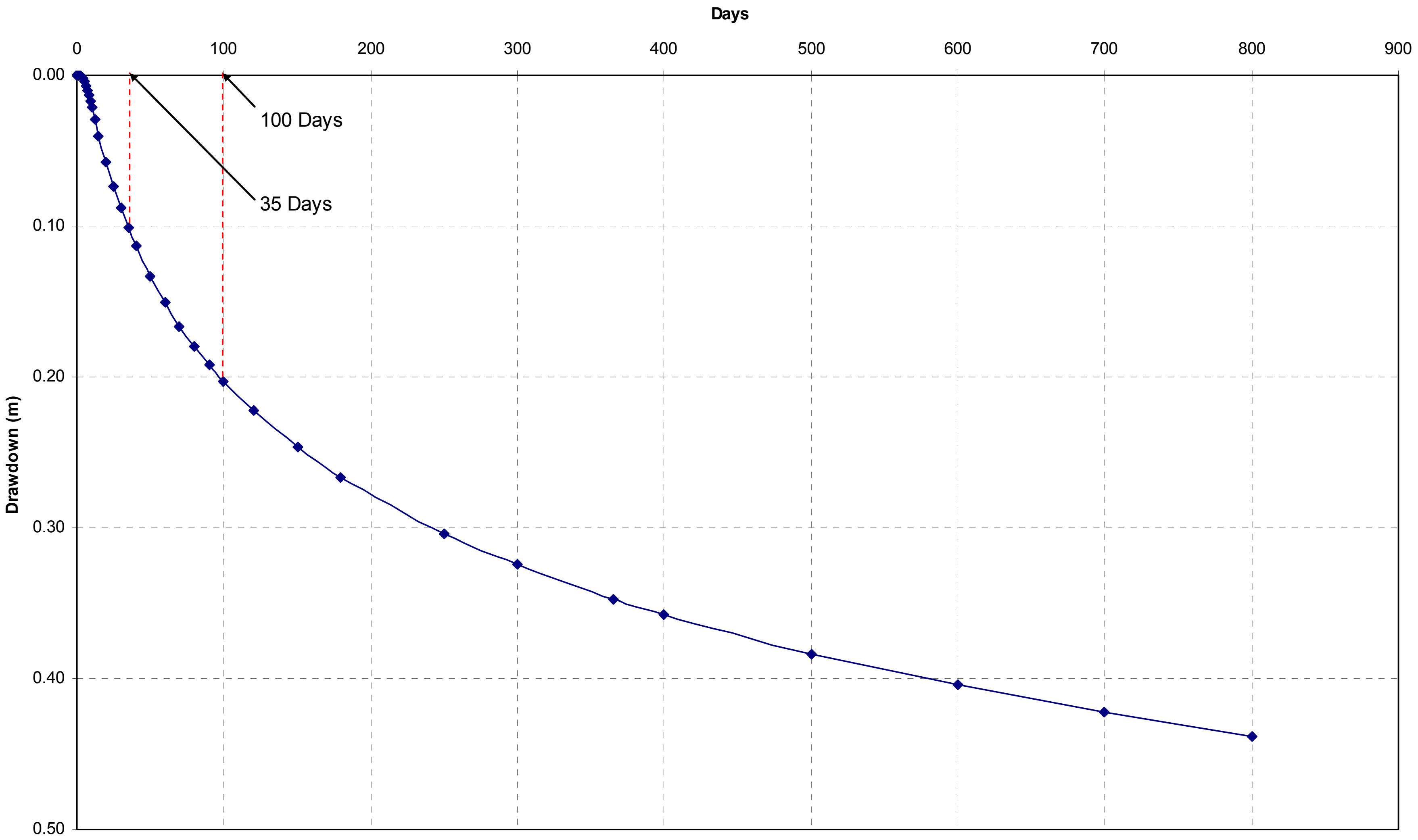
FIGURE No: 19

REV No: 2

A3

NOTE: THE * BESIDE THE TYPED INITIALS DENOTES THE ORIGINAL DRAWING ISSUE WAS SIGNED OR INITIALLED BY THAT RESPECTIVE PERSON.

K:\CAIRNS\08\87673031\Figures\087673031-001-R-FIG19_rev2.dwg Mar 09, 2009 - 3:21pm



The southern extremity of Ella Bay Swamp is located 994 m from production bore PB1B

CLIENT Satori Resorts Ella Bay Pty Ltd		PROJECT Ella Bay Groundwater Resource Evaluation	
DRAWN SK	DATE Feb 2009	TITLE **Predicted Drawdown Over Time at Southern Extremity of Ella Bay Swamp**	
CHECKED RWD	DATE Mar 2009		
SCALE Not to scale		PROJECT No 087673031	FIGURE No **20** REV No **T** **A4**

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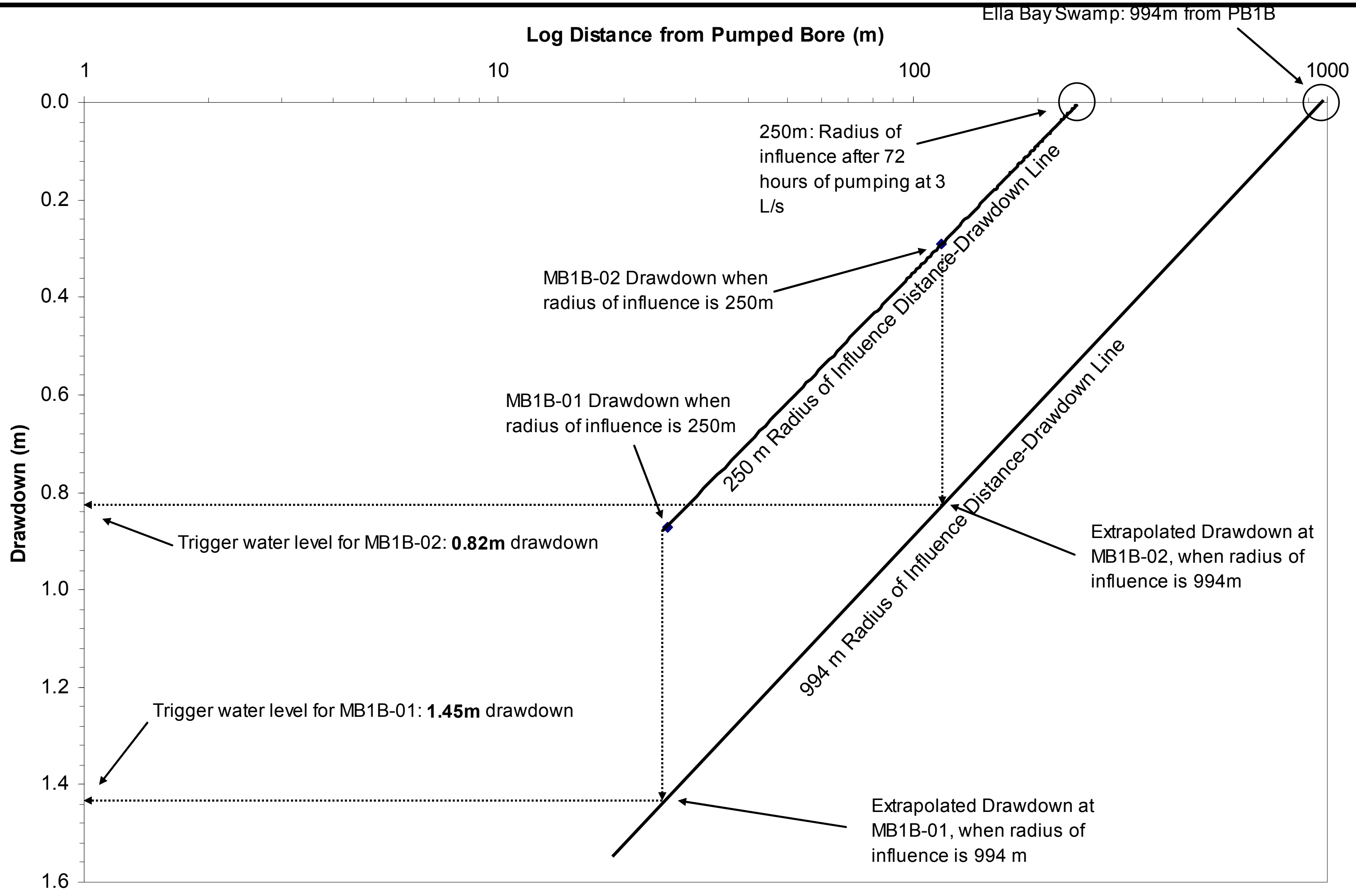

Golder Associates

CLIENT
Satori Resorts Ella Bay Pty Ltd

PROJECT
Ella Bay Groundwater Resource Evaluation

DRAWN SK
DATE Feb 2009

CHECKED RWD
DATE Mar 2009

TITLE
Projected Drawdown at Monitoring Bores MB1B-01 and MB1B-02 for Pumping Influence of PB1B Extending to Southern Extremity of Ella Bay Swamp

SCALE Not to scale

PROJECT No 087673031

FIGURE No 21

REV No T

A4

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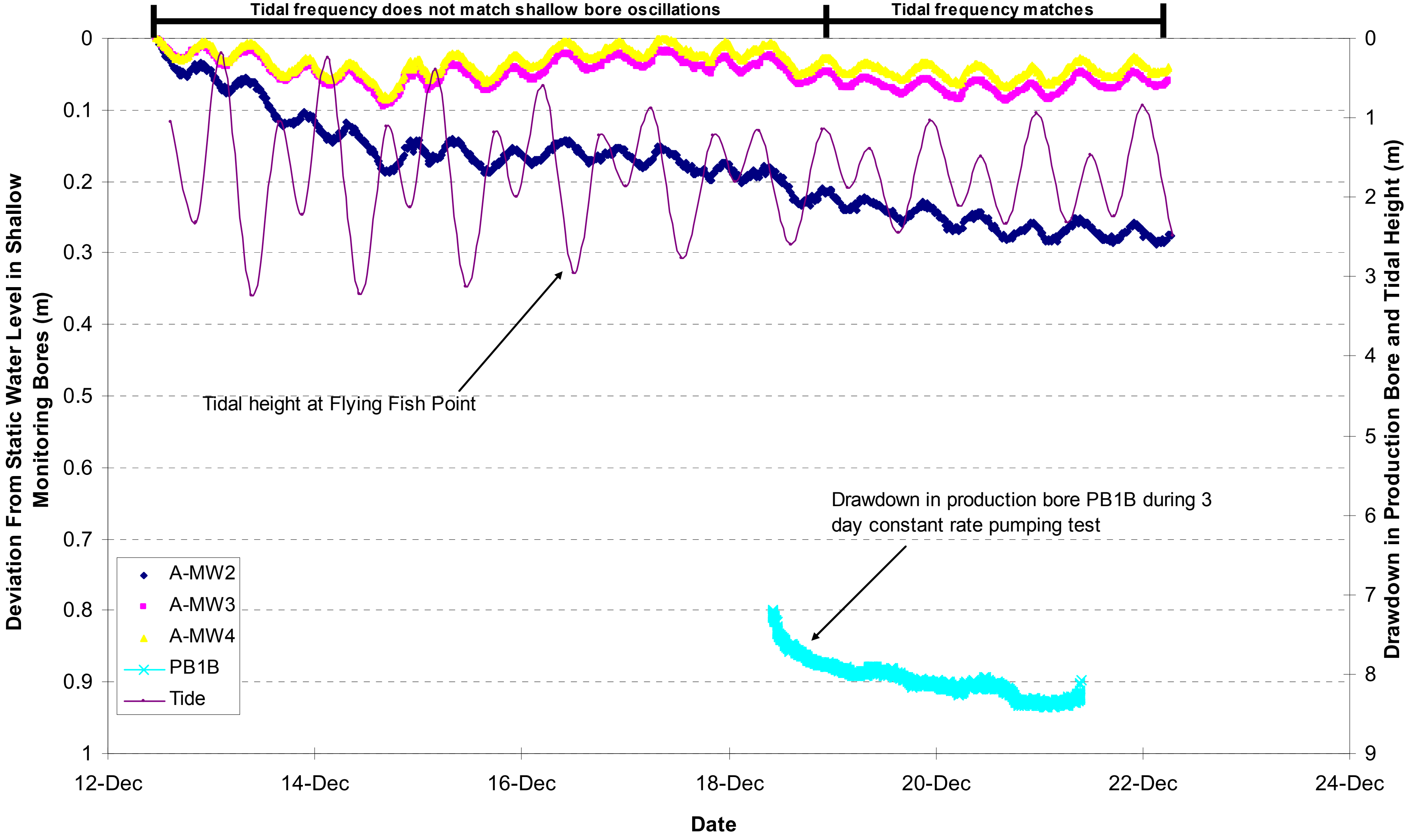

CLIENT	Satori Resorts Ella Bay Pty Ltd	PROJECT	Ella Bay Groundwater Resource Evaluation
DRAWN SK	DATE Feb 2009	TITLE	**Hydrograph Showing Tidal and PB1B Pumping Effects on Shallow Monitoring Bores**
CHECKED RWD	DATE Mar 2009		
SCALE	Not to scale	PROJECT No 087673031	FIGURE No **22** REV No **T** **A4**

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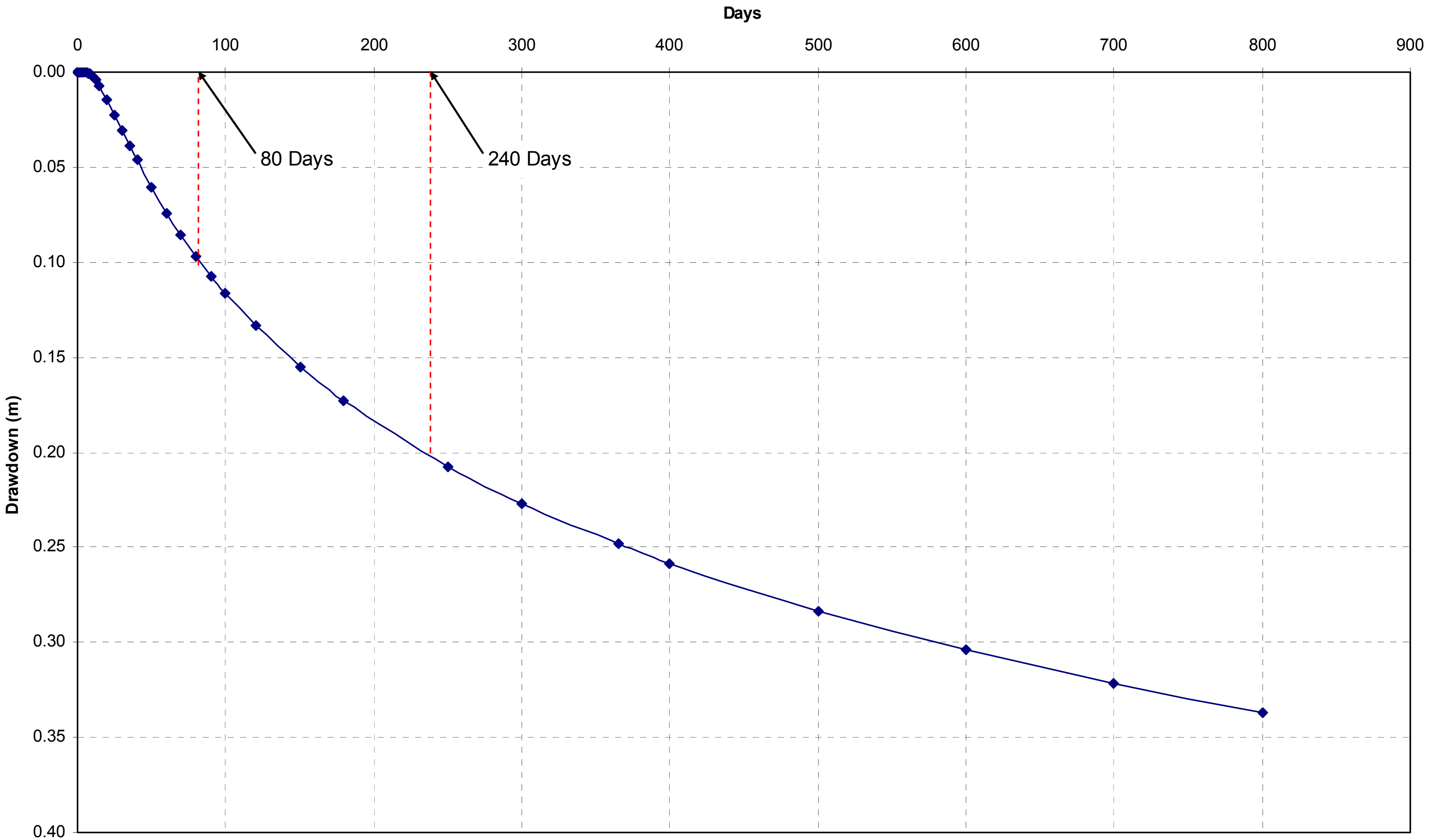


The southern extremity of Ella Bay Swamp is located 994 m from production bore PB1B

CLIENT	Satori Resorts Ella Bay Pty Ltd	PROJECT	Ella Bay Groundwater Resource Evaluation
DRAWN	SK	DATE	Feb 2009
CHECKED	RWD	DATE	Mar 2009
TITLE	**Predicted Drawdown Over Time at Monitoring Bore A-MW4 (Dunal Swale)**		
SCALE	Not to scale	PROJECT No	087673031
FIGURE No	23	REV No	T
A4			

APPENDIX A

BORELOGS

BOREHOLE REPORTS

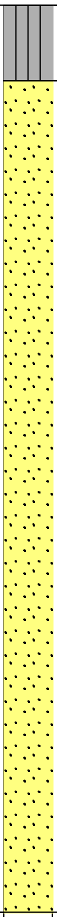
Checked by: ....

Date: ....9/3/09....................................

Golder Associates

REPORT OF BOREHOLE: A-MW4

SHEET: 1 OF 1
CLIENT: Satori Resorts
DRILL RIG: Eziprobe
PROJECT: ELLA BAY GW EXPLORATION
SURFACE RL: 2.6 m DATUM:
DRILLER: Golder Associates
LOCATION: Ella Bay, NE Queensland
INCLINATION: -90°
LOGGED:
DATE: 13/11/06
JOB NO: 087673031
HOLE DIA: mm HOLE DEPTH: 3.00 m
CHECKED:
DATE:

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			0.0	2.60								
				0.25 2.35								
			0.5									
			1.0									
			1.5									
			2.0									
			2.5									
			3.0	3.00 -0.40					END OF BOREHOLE @ 3.00 m			
			3.5									
			4.0									
			4.5									
			5.0									

This report of borehole must be read in conjunction with accompanying notes and abbreviations.

GAP6_0-1BETA_BRISCOLOUR.GLB FULL PAGE J:\CAIRNS.08\087673031_ELLA_BAY\GINT\ELLABAY.GPJ GAP5_1.GDT 09/03/2009 12:54:20 PM

GAP gINT FN. F01a
RL2

REPORT OF BOREHOLE: GB1A

Golder Associates

SHEET: 1 OF 1
CLIENT: Satori Resorts
DRILL RIG: BoartLongyear DB520
PROJECT: ELLA BAY GW EXPLORATION
SURFACE RL: 7.5 m DATUM:
DRILLER: NUMAC Drilling
LOCATION: Ella Bay, NE Queensland
INCLINATION: -90°
LOGGED: RWD DATE: 6/12/08
JOB NO: 087673031
HOLE DIA: 131 mm HOLE DEPTH: 12.00 m
CHECKED: DMW DATE: 3/2/09

METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	MONITORING WELL DETAILS
Air rotary, direct circulation, with 125 mm diameter blade bit.		6 m bgl, cut water	0	7.50			CL/ ML	Silty CLAY Brown; low plasticity; dry.			–
				1.00 *1.50* 6.00			CI CH	CLAY Brown; medium plasticity; moist.			
								CLAY Dark grey to black; high plasticity; fat clay; trace fine sand; moist; (lacustrine clay).			
				3.00 4.50			CL/ ML	Silty CLAY Brown; low plasticity; some fine sand; dry.			
			5	*5.00* 2.50			SC	Clayey SAND Grey; fine to medium sand; dry.			
				6.00 1.50	Encountered water at 6 m bgl, not enough flow for testing (shallow sand aquifer).		SC	Clayey SAND Grey; fine to medium sand; wet.			
			10	*12.00* -4.50				END OF BOREHOLE @ 12.00m Refusal due to unconsolicated, wet sand.			

15

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This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for hydrogeological purposes only, without attempt to assess geotechnical properties or possible contamination. Any reference to geotechnical properties or potential contamination are for information only and do not necessarily indicate the presence or absence of the properties stated.

REPORT OF BOREHOLE: GB3A

CLIENT: Satori Resorts
PROJECT: ELLA BAY GW EXPLORATION
LOCATION: Ella Bay, NE Queensland
JOB NO: 087673031

SURFACE RL: 20 m DATUM:
INCLINATION: -90°
HOLE DIA: 206 mm HOLE DEPTH: 60.50 m

SHEET: 1 OF 2
DRILL RIG: BoartLongyear DB520
DRILLER: NUMAC Drilling
LOGGED: RWD DATE: 25/11/08
CHECKED: DMW DATE: 3/2/09

METHOD: Air rotary, direct circulation, with 200 mm diameter downhole hammer.

WATER:
7.74 m bgl [illegible] water in sand lense
19 m bgl, cut water

DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	MONITORING WELL DETAILS
0	20.00			ML/ SM	Sandy SILT Brown; 80% fines; 20% fine sand; trace gravel; trace organics; dry.			–
	6.00 14.00			CL/ ML	Silty CLAY Reddish-brown; medium placticity; trace fine sand; dry.			
	8.00 12.00			CL/ ML	Silty CLAY Reddish-brown; with brown fine sand lenses; medium placticity; moist.			
10	10.00 10.00			CL/ ML	Silty Sandy CLAY Reddish-brown; 70% fines; 30% fine sand; medium plasticity; wet.			
	12.00 8.00			CL/ ML	Silty Sandy CLAY Reddish-brown with yellow (mottled); 70% fines; 30% fine to medium sand; medium plasticity; dry to moist.			
	19.00 1.00			GM	Silty GRAVEL Reddish-brown; fine to coarse, angular to sub-angular gravel; quartz schist, low strength; fine to coarse sand; (cemented colluvium); wet.			
	33.00 -13.00			GM	33 to 42 m bgl - some small cobbles; quartz with iron staining; possible fracture zone.			
40								

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for hydrogeological purposes only, without attempt to assess geotechnical properties or possible contamination. Any reference to geotechnical properties or potential contamination are for information only and do not necessarily indicate the presence or absence of the properties stated.

REPORT OF BOREHOLE: GB3A

SHEET: 2 OF 2

CLIENT: Satori Resorts
PROJECT: ELLA BAY GW EXPLORATION
LOCATION: Ella Bay, NE Queensland
JOB NO: 087673031

SURFACE RL: 20 m DATUM:
INCLINATION: -90°
HOLE DIA: 206 mm HOLE DEPTH: 60.50 m

DRILL RIG: BoartLongyear DB520
DRILLER: NUMAC Drilling
LOGGED: RWD DATE: 25/11/08
CHECKED: DMW DATE: 3/2/09

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	MONITORING WELL DETAILS
Air rotary, direct circulation, with 200 mm diameter downhole hammer.			40					GM	Silty GRAVEL Reddish-brown; fine to coarse, angular to sub-angular gravel; quartz schist, low strength; fine to coarse sand; (cemented colluvium); wet.			
				42.00 -22.00				GM				
			45									
				49.00 -29.00				GM	49 to 52 m bgl - small cobbles; quartz with iron staining.			
			50									
				52.00 -32.00				GW	Sandy GRAVEL Brown, black, white, red; fine to medium gravel; flat fragments (schist); some fines; (bedrock); wet.			
			55									
			60									
				60.50 -40.50					END OF BOREHOLE @ 60.50m			
			65									
			70									
			75									
			80									

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for hydrogeological purposes only, without attempt to assess geotechnical properties or possible contamination. Any reference to geotechnical properties or potential contamination are for information only and do not necessarily indicate the presence or absence of the properties stated.

Golder Associates

REPORT OF BOREHOLE: GB3B

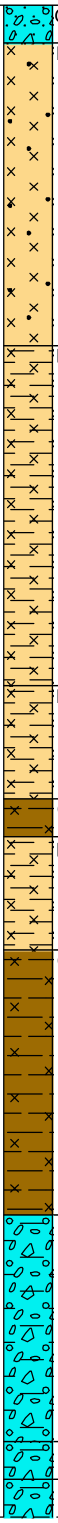
SHEET: 1 OF 2

CLIENT: Satori Resorts
PROJECT: ELLA BAY GW EXPLORATION
LOCATION: Ella Bay, NE Queensland
JOB NO: 087673031

SURFACE RL: 26 m DATUM:
INCLINATION: -90°
HOLE DIA: 206 mm HOLE DEPTH: 60.50 m

DRILL RIG: BoartLongyear DB520
DRILLER: NUMAC Drilling
LOGGED: RWD DATE: 28/11/08
CHECKED: DMW DATE: 3/2/09

METHOD: Air rotary, direct circulation, with 200 mm diameter downhole hammer.



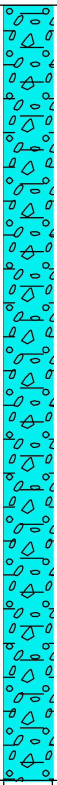
Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	MONITORING WELL DETAILS
Air rotary, direct circulation, with 200 mm diameter downhole hammer.			0	26.00				GW	Sandy GRAVEL Brown; fine to coarse gravel; fine to coarse sand; trace organics; dry; (top soil).			–
				1.00 25.00				ML/ SM	Sandy SILT Brown; low plasticity; 60% fines; 30% fine to coarse sand; 10% fine to medium, sub-angular to sub-rounded gravel; dry.			
				9.00 17.00				ML/ CL	Clayey SILT Brown to reddish-brown; low plasticity; 90% fines; 10% fine sand; dry.			
				18.00 8.00				ML/ CL	SAA - wet, not enough water for yield.			
				21.00 5.00				CL/ ML	Silty CLAY Dark brown; low to medium plasticity; moist.			
				22.00 4.00				ML/ CL	Clayey SILT Brown; low plasticity; 90% fines; 10% fine sand; dry.			
				25.00 1.00				CL/ ML	Silty CLAY Brown; low plasticity; dry to moist.			
				32.00 -6.00				GC	Clayey GRAVEL Brown, black, gray, white; fine, sub-angular gravel (schist, quartz); some medium to coarse sand; moist; (colluvium).			
				38.00 -12.00				GC	Clayey GRAVEL with Cobbles Brown, black, gray, white; fine to coarse, angular to sub-angular gravel (schist, quartz); some medium to			
				39.00 -13.00				GC				
			40									

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for hydrogeological purposes only, without attempt to assess geotechnical properties or possible contamination. Any reference to geotechnical properties or potential contamination are for information only and do not necessarily indicate the presence or absence of the properties stated.

REPORT OF BOREHOLE: GB3B

SHEET: 2 OF 2

CLIENT:	Satori Resorts			DRILL RIG:	BoartLongyear DB520
PROJECT:	ELLA BAY GW EXPLORATION	SURFACE RL: 26 m	DATUM:	DRILLER:	NUMAC Drilling
LOCATION:	Ella Bay, NE Queensland	INCLINATION: -90°		LOGGED: RWD	DATE: 28/11/08
JOB NO:	087673031	HOLE DIA: 206 mm	HOLE DEPTH: 60.50 m	CHECKED: DMW	DATE: 3/2/09



Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	MONITORING WELL DETAILS
Air rotary, direct circulation, with 200 mm diameter downhole hammer.			40					GC	coarse sand; moist.			
									Clayey GRAVEL Brown, black, gray, white; fine to coarse, angular to sub-angular gravel; flat fragments; moist; (bedrock).			
			45									
			50									
			55									
			60	*60.50* -34.50					END OF BOREHOLE @ 60.50m Dry borehole.			
			65									
			70									
			75									
			80									

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REPORT OF BOREHOLE: GB3C-01

				SHEET:	1 OF 1
CLIENT:	Satori Resorts			DRILL RIG:	BoartLongyear DB520
PROJECT:	ELLA BAY GW EXPLORATION	SURFACE RL: 10 m	DATUM:	DRILLER:	NUMAC Drilling
LOCATION:	Ella Bay, NE Queensland	INCLINATION: -90°		LOGGED: RWD	DATE: 4/12/08
JOB NO:	087673031	HOLE DIA: 206 mm	HOLE DEPTH: 12.00 m	CHECKED: DMW	DATE: 3/2/09

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	– MONITORING WELL DETAILS
Air rotary, direct circulation, with 200 mm diameter downhole hammer		5 m bgl, cut water (perched water table?)	0	10.00				ML/ SM	Sandy SILT Dark brown; 60% fines; 40% fine to medium sand; trace gravel; dry.			
			5	*5.00* 5.00				SW	SAND Light-brown; fine to coarse sand; wet.			
			10									
				12.00 -2.00					END OF BOREHOLE @ 12.00m Could not advance borehole past 12 m bgl. Refusal due to unconsolidated wet sand.			
			15									
			20									
			25									
			30									
			35									
			40									

GAP6_0-1BETA_BRISCOLOUR.GLB FULL PAGE J:\CAIRNS.08\087673031_ELLA_BAY\GINT\ELLABAY.GPJ GAP5_1.GDT 09/03/2009 12:54:39 PM

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for hydrogeological purposes only, without attempt to assess geotechnical properties or possible contamination. Any reference to geotechnical properties or potential contamination are for information only and do not necessarily indicate the presence or absence of the properties stated.

REPORT OF BOREHOLE: GB3C-02

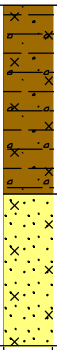
Golder Associates

CLIENT: Satori Resorts
PROJECT: ELLA BAY GW EXPLORATION
LOCATION: Ella Bay, NE Queensland
JOB NO: 087673031

SURFACE RL: 10 m DATUM:
INCLINATION: -90°
HOLE DIA: 206 mm HOLE DEPTH: 9.00 m

SHEET: 1 OF 1
DRILL RIG: BoartLongyear DB520
DRILLER: NUMAC Drilling
LOGGED: RWD DATE: 4/12/08
CHECKED: DMW DATE: 3/2/09

Drilling					Sampling	Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	MONITORING WELL DETAILS
Air rotary, direct circulation, with 200 mm diameter downhole hammer		▽ 9 m bgl, cut water (perched water table?)	0	10.00				CL/ SM	Sandy Silty CLAY Light-brown; low plasticity; 60% fines; 30% fine sand; 10% fine gravel; dry.			–
			5	5.00 5.00				SM	Silty SAND Light-brown; 90% fine to coarse sand; 10% fines; wet.			
				9.00 1.00	EC = 90.7 uS/cm pH = 4.7				END OF BOREHOLE @ 9.00m Refusal due to unconsolicated wet sand.			
			10									
			15									
			20									
			25									
			30									
			35									
			40									



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REPORT OF BOREHOLE: GB3C-03

SHEET: 1 OF 1
CLIENT: Satori Resorts
PROJECT: ELLA BAY GW EXPLORATION
LOCATION: Ella Bay, NE Queensland
JOB NO: 087673031
SURFACE RL: 10 m DATUM:
INCLINATION: -90°
HOLE DIA: 206 mm HOLE DEPTH: 12.00 m
DRILL RIG: BoartLongyear DB520
DRILLER: NUMAC Drilling
LOGGED: RWD DATE: 4/12/08
CHECKED: DMW DATE: 3/2/09

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	MONITORING WELL DETAILS
Air rotary, direct circulation, with 200 mm diameter downhole hammer		5 m bgl, cut water (perched water table?)	0	10.00				ML/ SM	Sandy SILT Dark brown; 60% fines; 40% fine to medium sand; trace gravel; dry to moist.			
			5	5.00 5.00				SW	SAND Light-brown; fine to coarse sand; some fines; wet.			
			10	12.00 -2.00					END OF BOREHOLE @ 12.00m Could not advance borehole past 12 m bgl. Refusal due to unconsolidated wet sand.			
			15									
			20									
			25									
			30									
			35									
			40									

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Golder Associates

REPORT OF BOREHOLE: GB4A

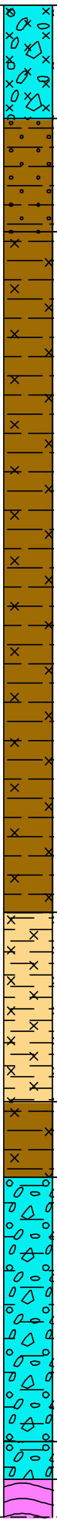
SHEET: 1 OF 2

CLIENT:	Satori Resorts		DRILL RIG: BoartLongyear DB520
PROJECT:	ELLA BAY GW EXPLORATION	SURFACE RL: 26 m DATUM:	DRILLER: NUMAC Drilling
LOCATION:	Ella Bay, NE Queensland	INCLINATION: -90°	LOGGED: RWD DATE: 30/11/08
JOB NO:	087673031	HOLE DIA: 206 mm HOLE DEPTH: 55.00 m	CHECKED: DMW DATE: 3/2/09

METHOD: Air rotary, direct circulation, with 200 mm diameter downhole hammer.

WATER: 11.63 m bgl (2/12/08)

WATER: 31 m bgl, cut water



DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION
0	26.00		GM	Silty GRAVEL Reddish-brown; 60% fine to medium gravel (hardened clay peds); 30% fines; 10% fine to coarse sand; dry; (residual soil?).
3.00	23.00		CL/SC	Sandy CLAY Reddish-brown; low plasticity; 70% fines; 25% fine to coarse sand; 5% fine gravel; dry; (residual soil?).
6.00	20.00		CL/SC	Silty CLAY Reddish-brown to dark brown; 90% fines; 10% fine sand; dry to moist.
24.00	2.00		ML/CL	Clayey SILT Brown; 90% fines; 10% fine sand; dry to moist.
29.00	-3.00		CL/SC	Silty CLAY Brown with red; 80% fines; 15% fine sand; 5% fine gravel; moist.
31.00	-5.00		GC	Clayey GRAVEL Brown, black, white, grey; fine to medium gravel (quartz and feldspar?); wet; (colluvium).
38.00	-12.00	EC = 45.2 uS/cm	GC	Clayey GRAVEL Brown, black, white, grey; fine to medium gravel; trace pitted sub-angular fragments; (possible fracture zone).
39.00	-13.00	pH = 5.4		

MOISTURE | CONSISTENCY DENSITY | MONITORING WELL DETAILS

Golder Associates

REPORT OF BOREHOLE: GB4A

SHEET: 2 OF 2
CLIENT: Satori Resorts
PROJECT: ELLA BAY GW EXPLORATION
LOCATION: Ella Bay, NE Queensland
JOB NO: 087673031
SURFACE RL: 26 m DATUM:
INCLINATION: -90°
HOLE DIA: 206 mm HOLE DEPTH: 55.00 m
DRILL RIG: BoartLongyear DB520
DRILLER: NUMAC Drilling
LOGGED: RWD DATE: 30/11/08
CHECKED: DMW DATE: 3/2/09

Drilling					Sampling	Field Material Description						
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	*DEPTH* RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	MONITORING WELL DETAILS
Air rotary, direct circulation, with 200 mm diameter downhole hammer.			40						SCHIST BEDROCK Black; fine oblate chips; wet.			
			45									
			50									
			55	*55.00* -29.00					END OF BOREHOLE @ 55.00m			
			60									
			65									
			70									
			75									
			80									

Golder Associates

REPORT OF BOREHOLE: GB4B

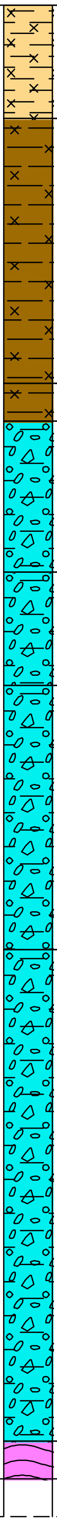
CLIENT: Satori Resorts
PROJECT: ELLA BAY GW EXPLORATION
LOCATION: Ella Bay, NE Queensland
JOB NO: 087673031

SURFACE RL: 18 m DATUM:
INCLINATION: -90°
HOLE DIA: 206 mm HOLE DEPTH: 39.00 m

SHEET: 1 OF 2
DRILL RIG: BoartLongyear DB520
DRILLER: NUMAC Drilling
LOGGED: RWD DATE: 1/12/08
CHECKED: DMW DATE: 3/2/09

METHOD: Air rotary, direct circulation, with 200 mm diameter downhole hammer.

WATER: 5.6 m bgl (2/12/08); 15 m bgl, cut water



DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION
0	18.00		ML/ CL	Clayey SILT Reddish-brown; very low plasticity; 90% fines; 10% fine sand; dry.
3.00	15.00		CL/ ML	Silty CLAY Brown; very low plasticity; 90% fines; 10% sand; dry.
10.00	8.00		CL/ ML	SAA - moist (residual soil?).
11.00	7.00		GC	Clayey GRAVEL Fine to medium, sub-rounded to sub-angular gravel; fine to coarse sand; moist; (colluvium).
15.00	3.00	Encountered water at 15 m bgl, not enough flow for testing.	GC	SAA - wet.
18.00	0.00		GC	Clayey GRAVEL Fine to medium gravel; fine to coarse sand; trace small, sub-angular cobbles (schist); (colluvium); (possible fracture zone).
25.00	-7.00	EC = 40.6 uS/cm pH = 5.36	GC	Clayey GRAVEL Fine to medium, sub-rounded to sub-angular gravel; fine to coarse sand; wet; (colluvium).
38.00	-20.00			SCHIST BEDROCK Fine oblate chips; wet.
39.00	-21.00			END OF BOREHOLE @ 39.00m Not able to advance bore past 39 m bgl due ot fines

MOISTURE | CONSISTENCY DENSITY | MONITORING WELL DETAILS

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REPORT OF BOREHOLE: GB4B

CLIENT: Satori Resorts		SHEET: 2 OF 2	
		DRILL RIG: BoartLongyear DB520	
PROJECT: ELLA BAY GW EXPLORATION	SURFACE RL: 18 m DATUM:	DRILLER: NUMAC Drilling	
LOCATION: Ella Bay, NE Queensland	INCLINATION: -90°	LOGGED: RWD	DATE: 1/12/08
JOB NO: 087673031	HOLE DIA: 206 mm HOLE DEPTH: 39.00 m	CHECKED: DMW	DATE: 3/2/09

Drilling					Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY	MONITORING WELL DETAILS
			40						clogging hammer and borehole collapse. Produced water is extemely silty.			
			45									
			50									
			55									
			60									
			65									
			70									
			75									
			80									

REPORT OF BOREHOLE: GB4C

SHEET: 1 OF 1

CLIENT: Satori Resorts
PROJECT: ELLA BAY GW EXPLORATION
LOCATION: Ella Bay, NE Queensland
JOB NO: 087673031

SURFACE RL: 11.5 m DATUM:
INCLINATION: -90°
HOLE DIA: 206 mm HOLE DEPTH: 24.00 m

DRILL RIG: BoartLongyear DB520
DRILLER: NUMAC Drilling
LOGGED: RWD DATE: 2/12/08
CHECKED: DMW DATE: 3/2/09

Drilling				Sampling		Field Material Description					
METHOD	PENETRATION RESISTANCE	WATER	DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY
Air rotary, direct circulation, with 200 mm diameter downhole hammer.			0	11.50				CL	CLAY Brown; moderate plasticity; some silt; trace fine sand; trace organics; dry to moist.		
				1.00 10.50				CL	CLAY Light brown; medium plasticity; some silt; dry to moist.		
				2.50				GC	Clayey GRAVEL Dark grey; 60% fine to coarse gravel; 30% fines; trace cobble; trace fine to coarse sand; wet; (alluvium).		
		3 m bgl, cut water (shallow alluvial aquifer) 3 m bgl (on 2/12/08)		3.00 8.50	EC = 40.4 uS/cm pH = 5.39			GW	Silty Sandy GRAVEL Brown; 50% medium to coarse, sub-angular to sub-rounded gravel; 40% fines; 10% fine to coarse sand; trace organics; slight ammonia odour; (alluvium).		
			5								
			10								
		15 m bgl, cut water	15	15.00 -3.50				GC/ GM	Clayey Silty GRAVEL Brown with black and white; 50% fine to medium, sub-rounded to sub-angular gravel; 40% fines; 10% fine to coarse sand; wet.		
			20		EC = 42.7 uS/cm pH = 5.37						
				24.00 -12.50					END OF BOREHOLE @ 24.00m Refusal due to borehole collapse.		
			25								
			30								
			35								
			40								

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MONITORING WELL DETAILS

Golder Associates

REPORT OF BOREHOLE: MB1B-01

SHEET: 1 OF 1

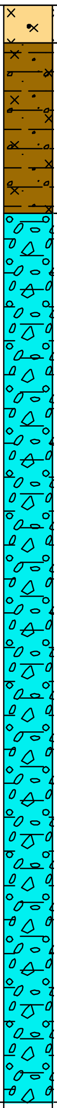
CLIENT:	Satori Resorts			DRILL RIG:	BoartLongyear DB520
PROJECT:	ELLA BAY GW EXPLORATION	SURFACE RL: 11.5 m	DATUM:	DRILLER:	NUMAC Drilling
LOCATION:	Ella Bay, NE Queensland	INCLINATION: -90°		LOGGED: RWD	DATE: 7/12/08
JOB NO:	087673031	HOLE DIA: 206 mm	HOLE DEPTH: 29.00 m	CHECKED: DMW	DATE: 3/2/09

Drilling | **Sampling** | **Field Material Description**

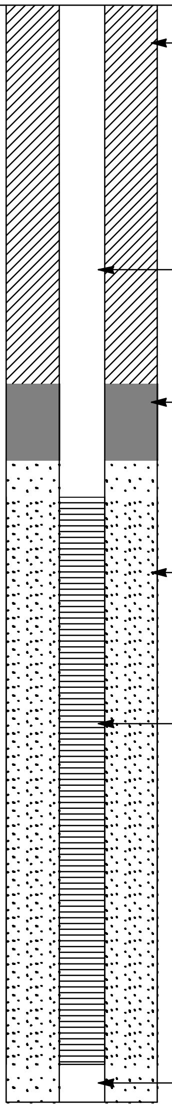
METHOD: Air rotary, direct circulation, with 200 mm diameter downhole hammer.

WATER: 4.04 m bgl (12/12/08); [illegible] m bgl, cut water

DEPTH (metres)	DEPTH RL	SAMPLE OR FIELD TEST	RECOVERED	GRAPHIC LOG	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION	MOISTURE	CONSISTENCY DENSITY
0	11.50				ML/SM	Sandy SILT Brown; 70% fines; 30% fine sand; trace gravel; dry; (topsoil).		
1.00	10.50				CL/SM	Sandy Silty CLAY Reddish-brown; very low plasticity; dry.		
5.50	6.00				GC	Clayey GRAVEL Fine, sub-angular to sub-rounded gravel; some fine to coarse sand; some fines; wet; (cemented colluvium).		
10.00	1.50					10 to 12 m bgl - some white clay lenses		
29.00	-17.50					END OF BOREHOLE @ 29.00m		



MONITORING WELL DETAILS



Ground surface to 10 m bgl. Cement grout seal.

+ 1m agl to 13 m bgl 125 mm PVC (CL12) casing blank.

10 to 12 m bgl Bentonite seal.

12 to 29 m bgl Filter-pack , 5/2 grade sand.

13 to 28 m bgl 50 mm PVC (CL18) screen 1 mm slot aperture at 10 mm spacing.

28 to 29 m bgl 50 mm PVC bottom sump.

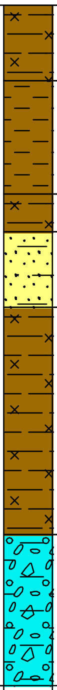
REPORT OF BOREHOLE: MB1B-02

SHEET: 1 OF 1
CLIENT: Satori Resorts
PROJECT: ELLA BAY GW EXPLORATION
LOCATION: Ella Bay, NE Queensland
JOB NO: 087673031
SURFACE RL: 8.5 m DATUM:
INCLINATION: -90°
HOLE DIA: 206 mm HOLE DEPTH: 18.00 m
DRILL RIG: BoartLongyear DB520
DRILLER: NUMAC Drilling
LOGGED: RWD DATE: 7/12/08
CHECKED: DMW DATE: 3/2/09

Drilling | **Sampling** | **Field Material Description**

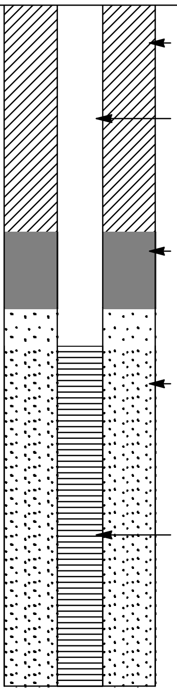
METHOD: Air rotary, direct circulation, with 200 mm diameter downhole hammer.

WATER: 1.33 m bgl (12/12/08) ◁; 15 m bgl, cut water ▽



DEPTH (metres)	DEPTH RL	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION
0	8.50	CL/ML	Silty CLAY Light brown; low plasticity; some fine sand; dry.
2.00	6.50	CH	CLAY Grey; high plasticity; fat clay; some silt; moist; (lacustrine clay)
5.00	3.50	CL/ML	Silty CLAY Light brown; medium plasticity; moist.
6.00	2.50	SC	Clayey SAND Grey; 70% fine sand; 30% fines; moist.
8.00	0.50	CL/ML	Silty CLAY Brown; medium plasticity; trace coarse sand; moist.
14.00	-5.50	GC	Clayey GRAVEL Reddish-brown; fine to medium, sub-angular to subrounded gravel; trace fine to medium sand; wet; (unconsolidated colluvium).
18.00	-9.50		END OF BOREHOLE @ 18.00m Refusal due to fines and sand clogging hammer.

MONITORING WELL DETAILS



Ground surface to 6 m bgl. Cement grout seal.
+ 1m agl to 9 m bgl 50 mm PVC (CL12) casing blank.
6 to 8 m bgl Bentonite seal.
8 to 18 m bgl Filter-pack , 5/2 grade sand.
9 to 18 m bgl 50 mm PVC (CL12) screen 1 mm slot aperture at 10 mm spacing.

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REPORT OF BOREHOLE: NW Production Bore (PB1B)

SHEET: 1 OF 1

CLIENT: Satori Resorts		DRILL RIG: BoartLongyear DB520	
PROJECT: ELLA BAY GW EXPLORATION	SURFACE RL: 12.5 m DATUM:	DRILLER: NUMAC Drilling	
LOCATION: Ella Bay, NE Queensland	INCLINATION: -90°	LOGGED: RWD	DATE: 6/12/08
JOB NO: 087673031	HOLE DIA: 206 mm HOLE DEPTH: 29.00 m	CHECKED: DMW	DATE: 3/2/09

Drilling | **Sampling** | **Field Material Description**

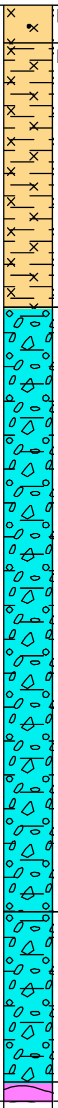
METHOD: Air rotary, direct circulation, with 200 mm diameter downhole hammer.

WATER: 5.79 m bgl (8/12/08) water

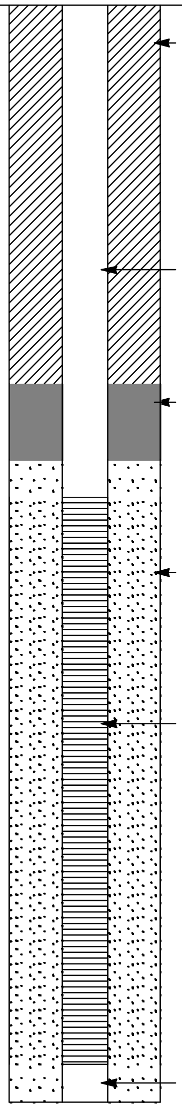
DEPTH (metres)	DEPTH / RL	SAMPLE OR FIELD TEST	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION
0	12.50		ML/SM	Sandy SILT Brown; 80% fines; 20% fine to medium sand; dry.
	1.00 11.50		ML/CL	Clayey SILT Reddish-brown; very low plasticity; some fine to medium gravel (rounded, weathered, weak, schist); dry.
	8.00 4.50	EC = 20.5 uS/cm pH = 5.1	GC	Clayey GRAVEL Reddish-brown; fine to medium, sub-angular to subrounded gravel; some fine to medium sand; wet; (cemented colluvium).
	24.00 -11.50	EC = 40.6 uS/cm pH = 5.68	GC	Clayey GRAVEL with Cobbles Reddish-brown; fine to medium sub-angular gravel (trace pitting); some angular cobbles; wet; (cemented colluvium); possible fracture zone.
	28.50			SCHIST BEDROCK Black; fine oblate chips.
	29.00 -16.50			END OF BOREHOLE @ 29.00m

DEPTH scale: 0, 5, 10, 15, 20, 25, 30, 35, 40

GRAPHIC LOG



MONITORING WELL DETAILS



Ground surface to 10 m bgl. Cement grout seal.

+ 0.7 m agl to 13 m bgl 125 mm PVC (CL12) casing blank.

10 to 12 m bgl Bentonite seal.

12 to 29 m bgl Filter-pack , 5/2 grade sand.

13 to 28 m bgl 125 mm PVC (CL 12) screen 1 mm slot aperture at 10 mm spacing.

28 to 29 m bgl 125 mm PVC bottom sump.

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REPORT OF BOREHOLE: West Production Bore (PB3C)

SHEET: 1 OF 1

CLIENT: Satori Resorts
PROJECT: ELLA BAY GW EXPLORATION
LOCATION: Ella Bay, NE Queensland
JOB NO: 087673031

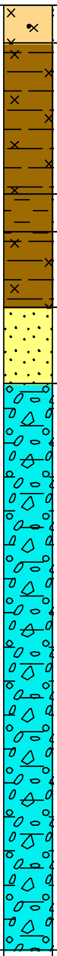
SURFACE RL: 10 m DATUM:
INCLINATION: -90°
HOLE DIA: 206 mm HOLE DEPTH: 25.00 m

DRILL RIG: BoartLongyear DB520
DRILLER: NUMAC Drilling
LOGGED: RWD DATE: 29/11/08
CHECKED: DMW DATE: 3/2/09

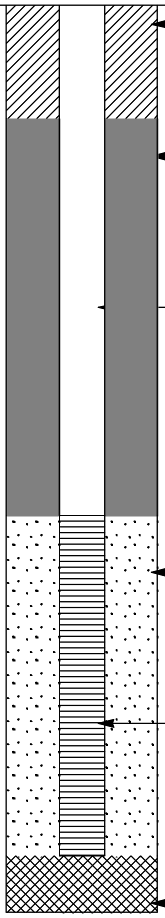
METHOD: Air rotary, direct circulation, with 200 mm diameter downhole hammer.

WATER: 10 m bgl, cut water; 2.01 m bgl (2/12/08)

DEPTH (metres)	RL	SAMPLE OR FIELD TEST	USC Symbol	SOIL / ROCK MATERIAL DESCRIPTION
0	10.00		ML/SM	Sandy SILT Dark brown; 60% fines; 40% fine to medium sand; trace gravel; dry; (top soil).
1.00	9.00		CL/ML	Silty CLAY Orangish-brown and gray (mottled); low plasticity; 80% fines; 20% fine sand; trace gravel; dry.
5.00	5.00		CL	CLAY Light brown; very low plasticity; 60% fines; 40% fine sand; dry.
6.00	4.00		CL/ML	Silty CLAY Reddish-brown; low to medium plasticity; 10% fine sand; dry.
8.00	2.00		SP	SAND Light brown; fine grained; cemented; medium density; dry.
10.00	0.00		GC	Clayey GRAVEL Brown, black, white, gray; fine to medium, sub-angular to sub-rounded gravel (schist, quartz); fine to coarse sand; wet; (unconsolidated colluvium).
19.00	-9.00			19 m bgl, extremely silty water.
25.00	-15.00	EC = 75.5 uS/cm pH = 4.75 EC = 40.5 uS/cm pH = 4.64		END OF BOREHOLE @ 25.00m End of advancement, hammer jammed with sediment.



MONITORING WELL DETAILS



- Ground surface to 3 m bgl. Cement grout seal.
- Ground surface to 2.5 m bgl 250 mm conductive casing.
- 3 to 13.5 m bgl Bentonite seal.
- + 1m agl to 13.5 m bgl 125 mm PVC (CL12) casing blank.
- 13.5 to 22.5 m bgl Natural filter-pack , bore wall allowed to collapse around screen.
- 13.5 to 22.5 m bgl 50 mm PVC (CL 12) screen 1 mm slot aperture at 10 mm spacing.
- 22.5 to 25 m bgl Fall-in.

GAP6_0-1BETA_BRISCOLOUR.GLB FULL PAGE J:\CAIRNS.08\087673031_ELLA_BAY\GINT\ELLABAY.GPJ GAP5_1.GDT 09/03/2009 12:55:21 PM

This report of borehole must be read in conjunction with accompanying notes and abbreviations. It has been prepared for hydrogeological purposes only, without attempt to assess geotechnical properties or possible contamination. Any reference to geotechnical properties or potential contamination are for information only and do not necessarily indicate the presence or absence of the properties stated.

GAP gINT FN. F01d
RL2

EXPLANATION OF NOTES, ABBREVIATIONS & TERMS USED ON BOREHOLE AND TEST PIT REPORTS

DRILLING/EXCAVATION METHOD

AS*	Auger Screwing	RD	Rotary blade or drag bit	HQ	Diamond Core - 63 mm
AD*	Auger Drilling	RT	Rotary Tricone bit	NMLC	Diamond Core - 52 mm
*V	V-Bit	RAB	Rotary Air Blast	NQ	Diamond Core - 47 mm
*T	TC-Bit, e.g. ADT	RC	Reverse Circulation	BH	Tractor Mounted Backhoe
HA	Hand Auger	PT	Push Tube	EX	Tracked Hydraulic Excavator
ADH	Hollow Auger	CT	Cable Tool Rig	EE	Existing Excavation
DTC	Diatube Coring	JET	Jetting	HAND	Excavated by Hand Methods
WB	Washbore or Bailer	NDD	Non-destructive drilling		

PENETRATION/EXCAVATION RESISTANCE

L **Low resistance.** Rapid penetration possible with little effort from the equipment used.

M **Medium resistance.** Excavation/possible at an acceptable rate with moderate effort from the equipment used.

H **High resistance** to penetration/excavation. Further penetration is possible at a slow rate and requires significant effort from the equipment.

R **Refusal or Practical Refusal.** No further progress possible without the risk of damage or unacceptable wear to the digging implement or machine.

These assessments are subjective and are dependent on many factors including the equipment power, weight, condition of excavation or drilling tools, and the experience of the operator.

WATER

▽	Water level at date shown	◁	Partial water loss
▷	Water inflow	◀	Complete water loss

GROUNDWATER NOT OBSERVED	The observation of groundwater, whether present or not, was not possible due to drilling water, surface seepage or cave in of the borehole/test pit.
GROUNDWATER NOT ENCOUNTERED	The borehole/test pit was dry soon after excavation. However, groundwater could be present in less permeable strata. Inflow may have been observed had the borehole/test pit been left open for a longer period.

SAMPLING AND TESTING

SPT	Standard Penetration Test to AS1289.6.3.1-1993
4,7,11 N=18	4,7,11 = Blows per 150mm. N = Blows per 300mm penetration following 150mm seating
30/80mm	Where practical refusal occurs, the blows and penetration for that interval are reported
RW	Penetration occurred under the rod weight only
HW	Penetration occurred under the hammer and rod weight only
HB	Hammer double bouncing on anvil
DS	Disturbed sample
BDS	Bulk disturbed sample
G	Gas Sample
W	Water Sample
FP	Field permeability test over section noted
FV	Field vane shear test expressed as uncorrected shear strength (s_v = peak value, s_r = residual value)
PID	Photoionisation Detector reading in ppm
PM	Pressuremeter test over section noted
PP	Pocket penetrometer test expressed as instrument reading in kPa
U63	Thin walled tube sample - number indicates nominal sample diameter in millimetres
WPT	Water pressure tests

Ranking of Visually Observable Contamination and Odour (for specific soil contamination assessment projects)

R = 0	No visible evidence of contamination	R = A	No non-natural odours identified
R = 1	Slight evidence of visible contamination	R = B	Slight non-natural odours identified
R = 2	Visible contamination	R = C	Moderate non-natural odours identified
R = 3	Significant visible contamination	R = D	Strong non-natural odours identified

ROCK CORE RECOVERY

TCR = Total Core Recovery (%)

$$= \frac{Length\ of\ core\ recovered}{Length\ of\ core\ run} \times 100$$

SCR = Solid Core Recovery (%)

$$= \frac{\sum Length\ of\ cylindrical\ core\ recovered}{Length\ of\ core\ run} \times 100$$

RQD = Rock Quality Designation (%)

$$= \frac{\sum Axial\ lengths\ of\ core > 100\ mm}{Length\ of\ core\ run} \times 100$$

METHOD OF SOIL DESCRIPTION
USED ON BOREHOLE AND TEST PIT REPORTS

▨	FILL	▨	CLAY (CL, CI or CH)
▨	GRAVEL (GP or GW)	▨	ORGANIC SOILS (OL or OH or Pt)
▨	SAND (SP or SW)	▨	COBBLES or BOULDERS
▨	SILT (ML or MH)		

Combinations of these basic symbols may be used to indicate mixed materials such as sandy clay.

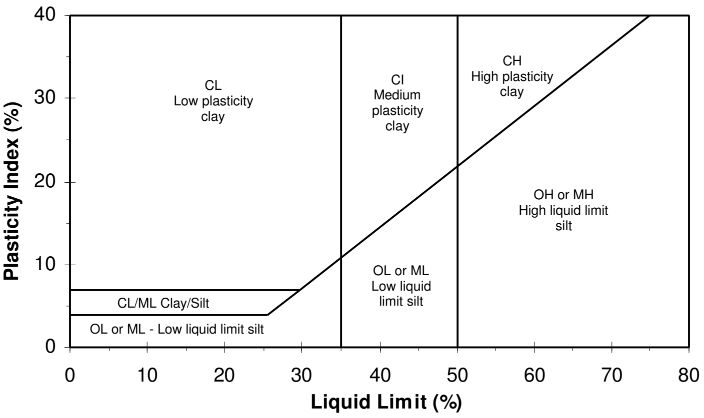
CLASSIFICATION AND INFERRED STRATIGRAPHY

Soil and Rock is classified and described in Reports of Boreholes and Test Pits using the preferred method given in AS1726 – 1993, Appendix A. The material properties are assessed in the field by visual/tactile methods.

Particle Size

Major Division	Sub Division	Particle Size
BOULDERS		> 200 mm
COBBLES		63 to 200 mm
GRAVEL	Coarse	20 to 63 mm
	Medium	6.0 to 20 mm
	Fine	2.0 to 6.0 mm
SAND	Coarse	0.6 to 2.0 mm
	Medium	0.2 to 0.6 mm
	Fine	0.075 to 0.2 mm
SILT		0.002 to 0.075 mm
CLAY		< 0.002 mm

Plasticity Properties



MOISTURE CONDITION

AS1726 - 1993

Symbol	Term	Description
D	Dry	Sands and gravels are free flowing. Clays & Silts may be brittle or friable and powdery.
M	Moist	Soils are darker than in the dry condition & may feel cool. Sands and gravels tend to cohere.
W	Wet	Soils exude free water. Sands and gravels tend to cohere.

CONSISTENCY AND DENSITY

AS1726 - 1993

Symbol	Term	Undrained Shear Strength
VS	Very Soft	0 to 12 kPa
S	Soft	12 to 25 kPa
F	Firm	25 to 50 kPa
St	Stiff	50 to 100 kPa
VSt	Very Stiff	100 to 200 kPa
H	Hard	Above 200 kPa

Symbol	Term	Density Index %	SPT "N" #
VL	Very Loose	Less than 15	0 to 4
L	Loose	15 to 35	4 to 10
MD	Medium Dense	35 to 65	10 to 30
D	Dense	65 to 85	30 to 50
VD	Very Dense	Above 85	Above 50

In the absence of test results, consistency and density may be assessed from correlations with the observed behaviour of the material.

SPT correlations are not stated in AS1726 – 1993, and may be subject to corrections for overburden pressure and equipment type.

TERMS FOR ROCK MATERIAL STRENGTH & WEATHERING AND ABBREVIATIONS FOR DEFECT DESCRIPTIONS

STRENGTH

Symbol	Term	Point Load Index, $Is_{(50)}$ (MPa)	Field Guide
EL	Extremely Low	< 0.03	Easily remoulded by hand to a material with soil properties.
VL	Very Low	0.03 to 0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with knife; too hard to cut a triaxial sample by hand. Pieces up to 30 mm can be broken by finger pressure.
L	Low	0.1 to 0.3	Easily scored with a knife; indentations 1 mm to 3 mm show in the specimen with firm blows of pick point; has dull sound under hammer. A piece of core 150 mm long by 50 mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
M	Medium	0.3 to 1	Readily scored with a knife; a piece of core 150 mm long by 50 mm diameter can be broken by hand with difficulty.
H	High	1 to 3	A piece of core 150 mm long by 50 mm diameter cannot be broken by hand but can be broken with pick with a single firm blow; rock rings under hammer.
VH	Very High	3 to 10	Hand specimen breaks with pick after more than one blow; rock rings under hammer.
EH	Extremely High	>10	Specimen requires many blows with geological pick to break through intact material; rock rings under hammer.

ROCK STRENGTH TEST RESULTS

▼	Point Load Strength Index, $I_s(50)$, Axial test (MPa)
◀	Point Load Strength Index, $I_s(50)$, Diametral test (MPa)

Relationship between $I_s(50)$ and UCS (unconfined compressive strength) will vary with rock type and strength, and should be determined on a site-specific basis. UCS is typically 10 to 30 x $I_s(50)$, but can be as low as 5.

ROCK MATERIAL WEATHERING

Symbol		Term	Field Guide
RS		Residual Soil	Soil developed on extremely weathered rock; the mass structure and substance fabric are no longer evident; there is a large change in volume but the soil has not been significantly transported.
EW		Extremely Weathered	Rock is weathered to such an extent that it has soil properties - i.e. it either disintegrates or can be remoulded, in water.
DW	HW	Distinctly Weathered	Rock strength usually changed by weathering. The rock may be highly discoloured, usually by iron staining. Porosity may be increased by leaching, or may be decreased due to deposition of weathering products in pores. In some environments it is convenient to subdivide into Highly Weathered and Moderately Weathered, with the degree of alteration typically less for MW.
	MW		
SW		Slightly Weathered	Rock is slightly discoloured but shows little or no change of strength relative to fresh rock.
FR		Fresh	Rock shows no sign of decomposition or staining.

ABBREVIATIONS FOR DEFECT TYPES AND DESCRIPTIONS

Defect Type

B	Bedding parting
X	Foliation
C	Contact
L	Cleavage
J	Joint
SS/SZ	Sheared seam/zone (Fault)
CS/CZ	Crushed seam/zone (Fault)
DS/DZ	Decomposed seam/zone
IS/IZ	Infilled seam/zone
S	Schistocity
V	Vein

Coating or Infilling

Cn	Clean
Sn	Stain
Vr	Veneer
Ct	Coating or Infill

Planarity

Pl	Planar
Un	Undulating
St	Stepped

Roughness

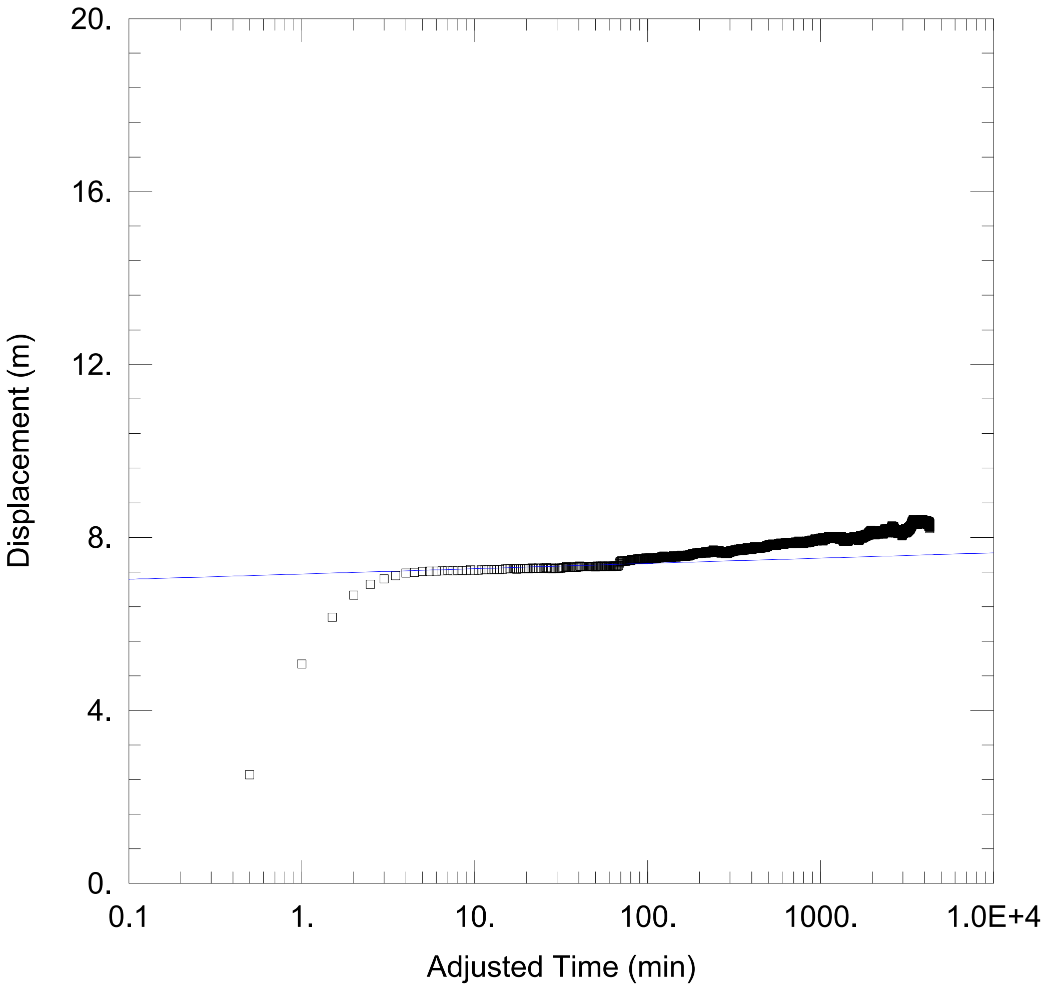
Sl	Slickensided
Sm	Smooth
Ro	Rough

Vertical Boreholes – The dip (inclination from horizontal) of the defect is given.

Inclined Boreholes – The inclination is measured as the acute angle to the core axis.

APPENDIX B

PUMPING TEST AQTESOLV ANALYSES



72 HOUR CONSTANT RATE PUMPING TEST (3 L/S) PRODUCTION BORE PB1B RESPONSE

PROJECT INFORMATION

Company: Golder Associates Pty Ltd
Client: Satori Resorts
Project: 087673031
Location: Ella Bay
Test Well: EB08-PB1B
Obs. Well: EB08-PB1B
Test Date: 18/12/2008

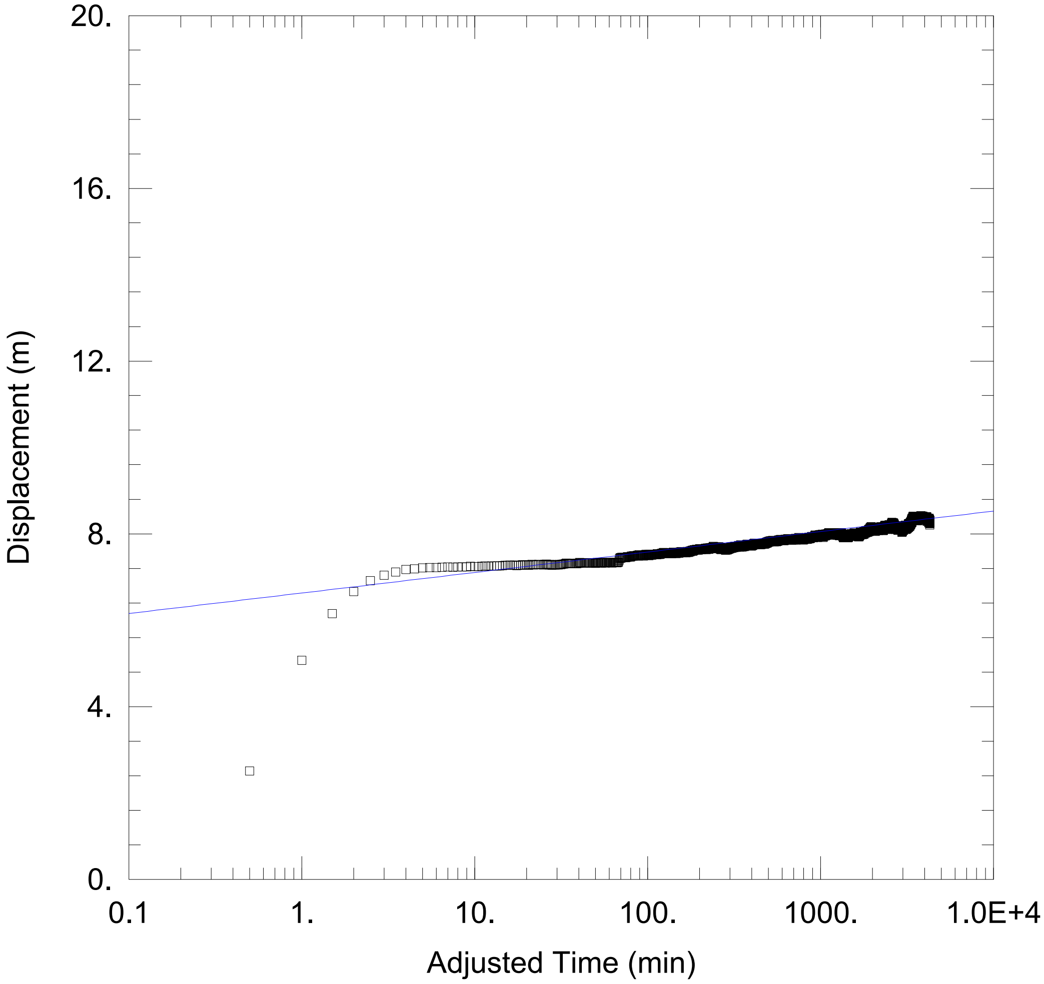
AQUIFER DATA

Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Jacob

T = 387.9 m^2/day
S = 1.602E-57



72 HOUR CONSTANT RATE PUMPING TEST (3 L/S) PRODUCTION BORE PB1B RESPONSE

PROJECT INFORMATION

Company: Golder Associates Pty Ltd
Client: Satori Resorts
Project: 087673031
Location: Ella Bay
Test Well: EB08-PB1B
Obs. Well: EB08-PB1B
Test Date: 18/12/2008

AQUIFER DATA

Saturated Thickness: 21. m

Anisotropy Ratio (Kz/Kr): 1.

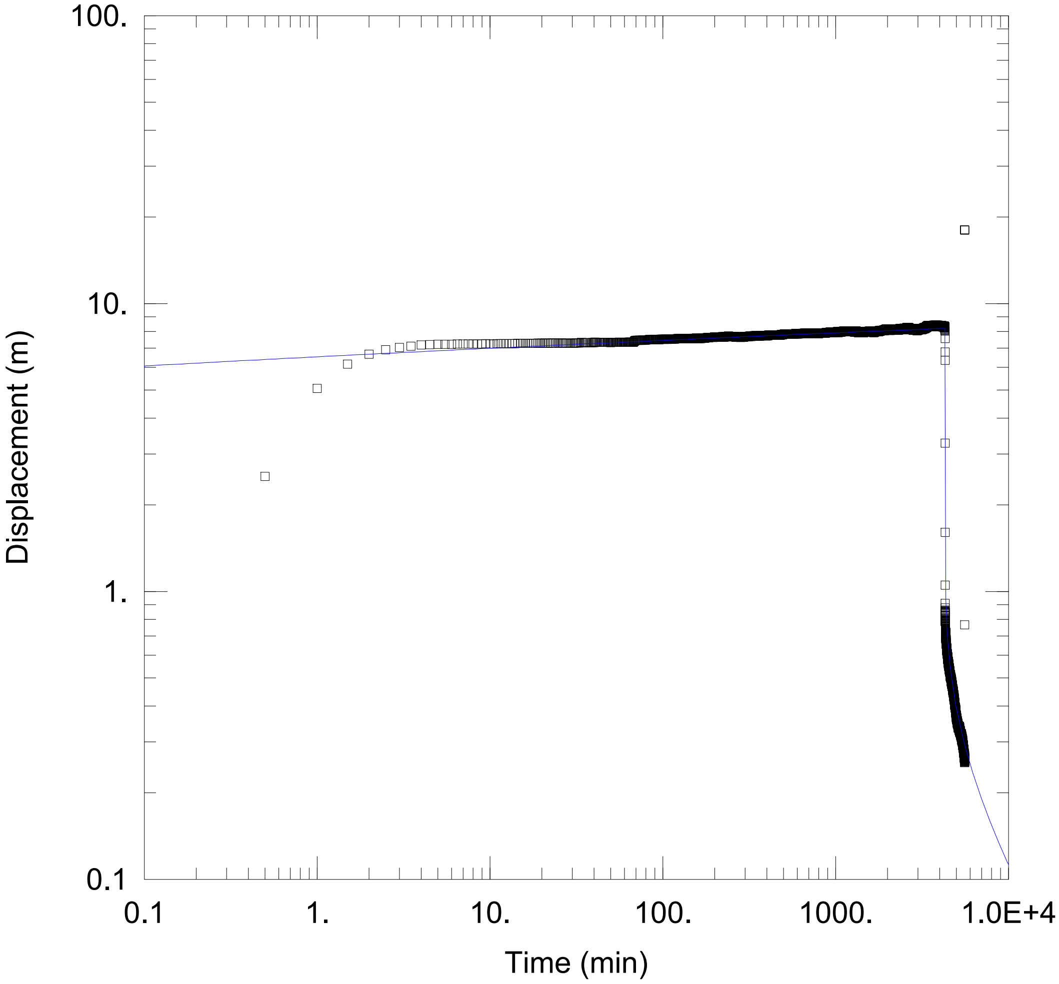
SOLUTION

Aquifer Model: Confined

Solution Method: Cooper-Jacob

T = 100.2 m^2/day

S = 1.134E-13



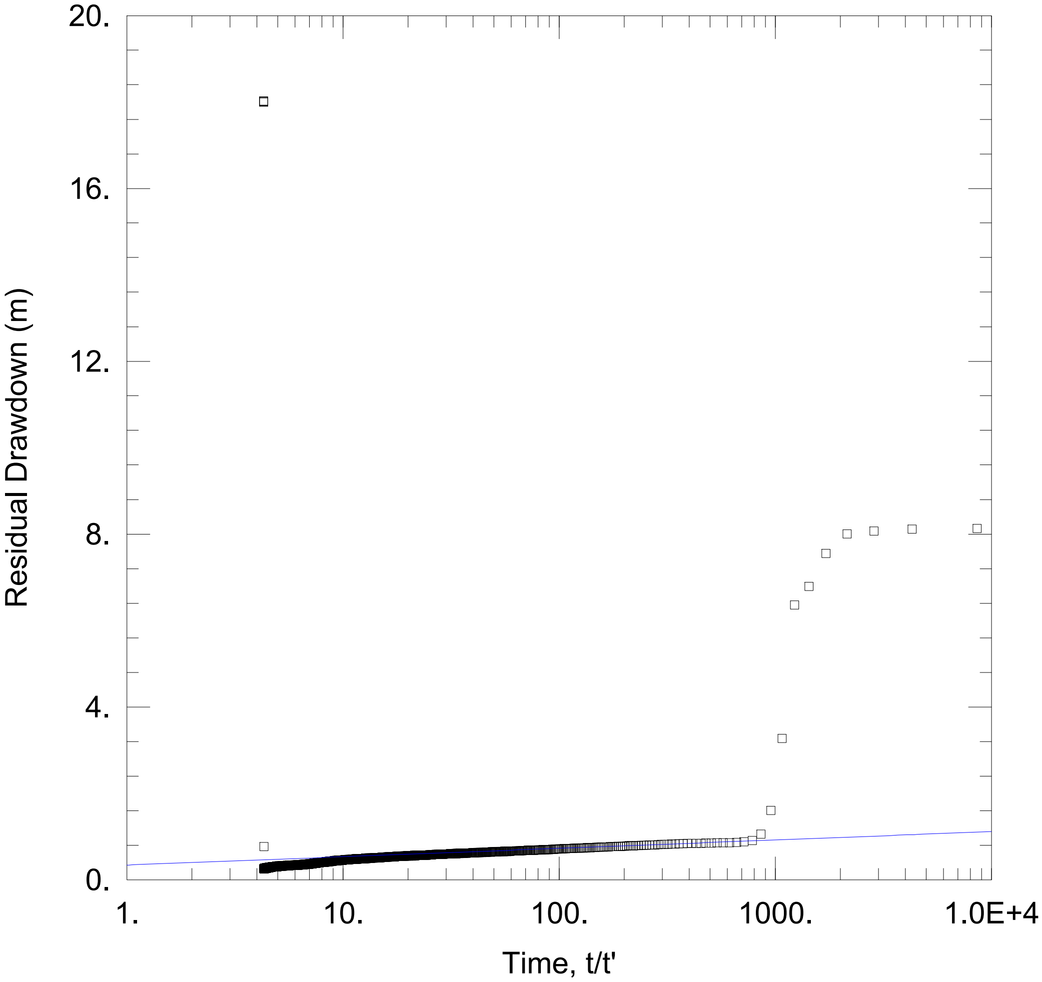
72 HOUR CONSTANT RATE PUMPING TEST (3 L/S) - PRODUCTION BORE PB1B RESPONSE

PROJECT INFORMATION

Company: Golder Associates Pty Ltd
Client: Satori Resorts
Project: 087673031
Location: Ella Bay
Test Well: EB08-PB1B
Obs. Well: EB08-PB1B
Test Date: 18/12/2008

SOLUTION

Aquifer Model: Confined	Solution Method: Theis
T = 103. m^2/day	S = 7.844E-14
Kz/Kr = 1.	b = 21. m



72 HOUR CONSTANT RATE PUMPING TEST (3 L/S) - PRODUCTION BORE PB1B RESPONSE

PROJECT INFORMATION

Company: Golder Associates Pty Ltd
Client: Satori Resorts
Project: 087673031
Location: Ella Bay
Test Well: EB08-PB1B
Obs. Well: EB08-PB1B
Test Date: 18/12/2008

AQUIFER DATA

Saturated Thickness: 21. m

Anisotropy Ratio (Kz/Kr): 1.

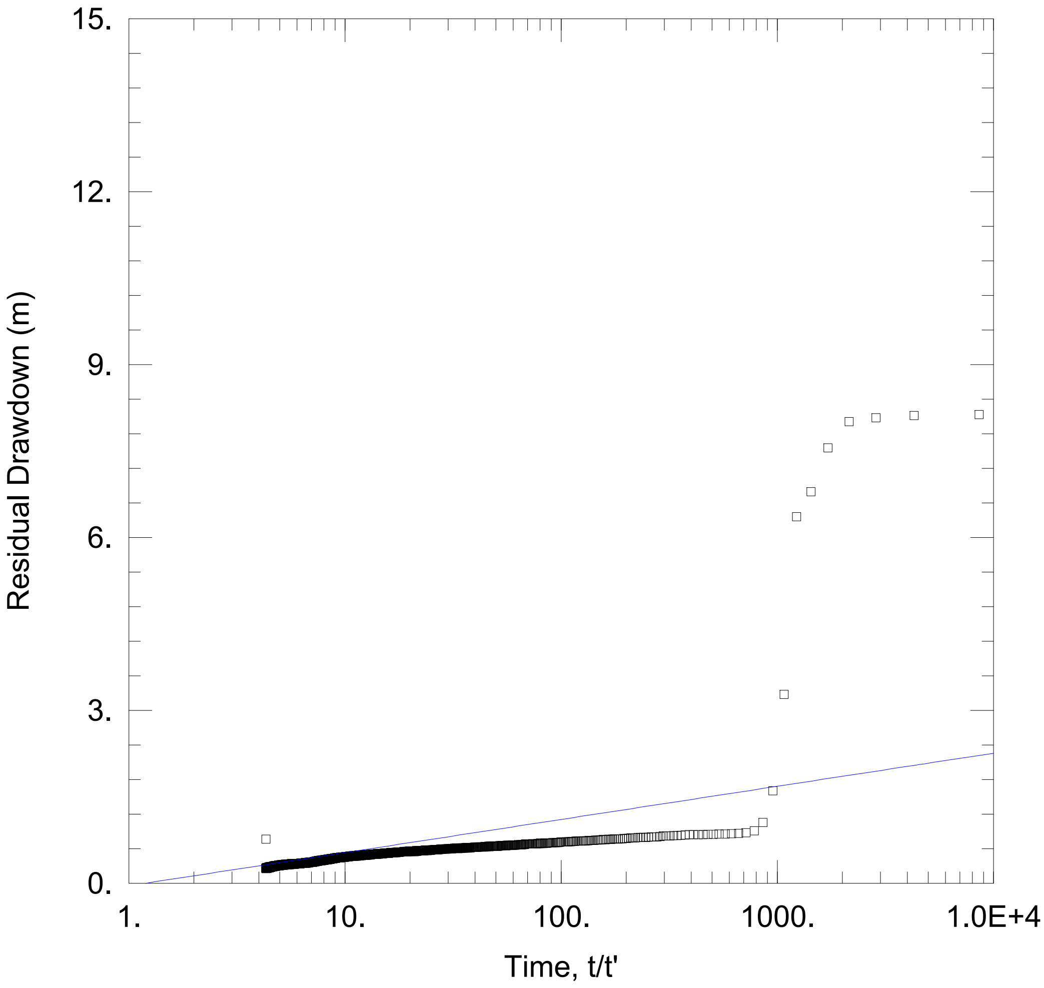
SOLUTION

Aquifer Model: Confined

Solution Method: Theis (Recovery)

T = 245.3 m^2/day

S/S' = 0.01781



72 HOUR CONSTANT RATE PUMPING TEST (3 L/S) - PRODUCTION BORE PB1B RESPONSE

PROJECT INFORMATION

Company: Golder Associates Pty Ltd
Client: Satori Resorts
Project: 087673031
Location: Ella Bay
Test Well: EB08-PB1B
Obs. Well: EB08-PB1B
Test Date: 18/12/2008

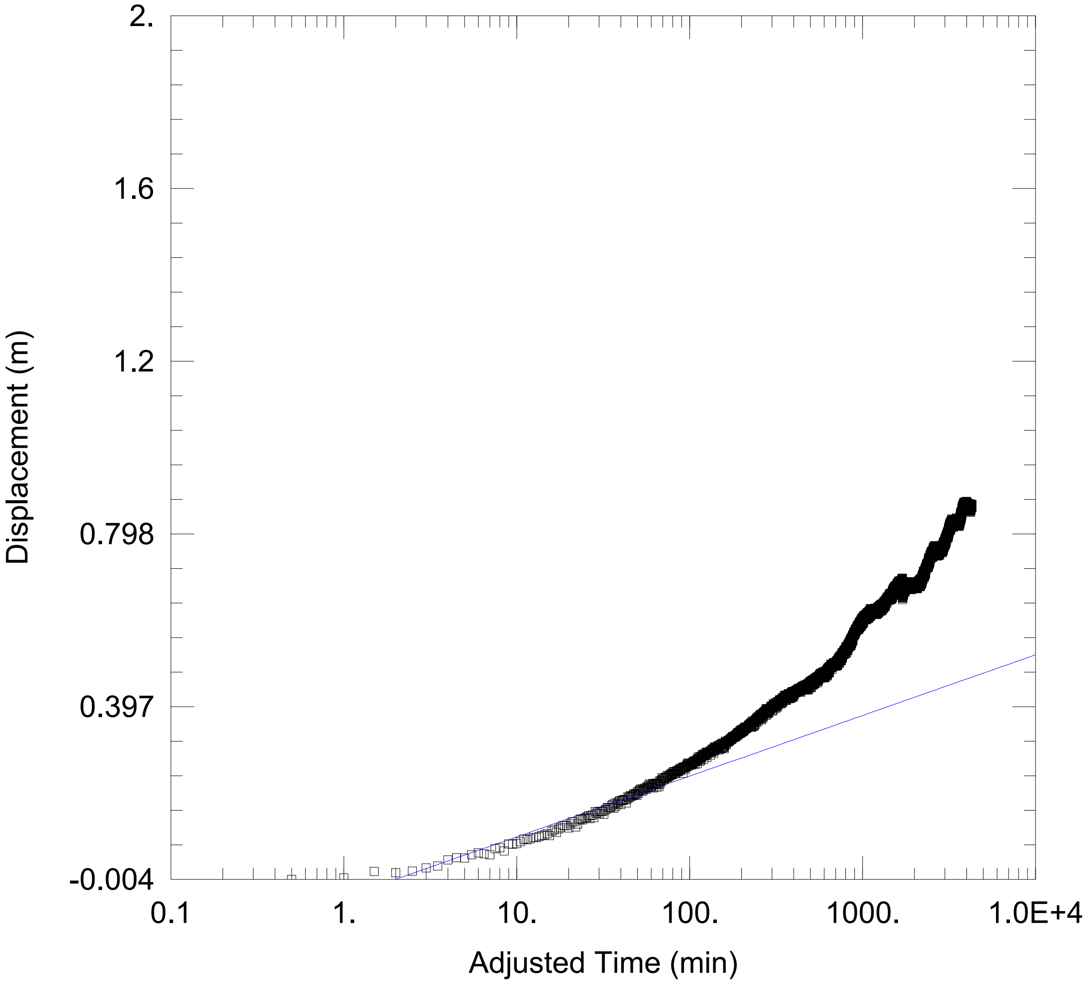
AQUIFER DATA

Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

SOLUTION

Aquifer Model: Confined
Solution Method: Theis (Recovery)

T = 82.58 m^2/day
S/S' = 1.201



72 HOUR CONSTANT RATE PUMPING TEST (3 L/S) - BORE MB1B-01 RESPONSE

Data Set: J:\...\EB08-MB1B-01_Cooper-Jacob_Early match.aqt
Date: 02/17/09 Time: 11:30:21

PROJECT INFORMATION

Company: Golder Associates Pty Ltd
Client: Satori Resorts
Project: 087673031
Location: Ella Bay
Test Well: EB08-PB1B
Test Date: 18/12/2008

AQUIFER DATA

Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
EB08-PB1B	0	0

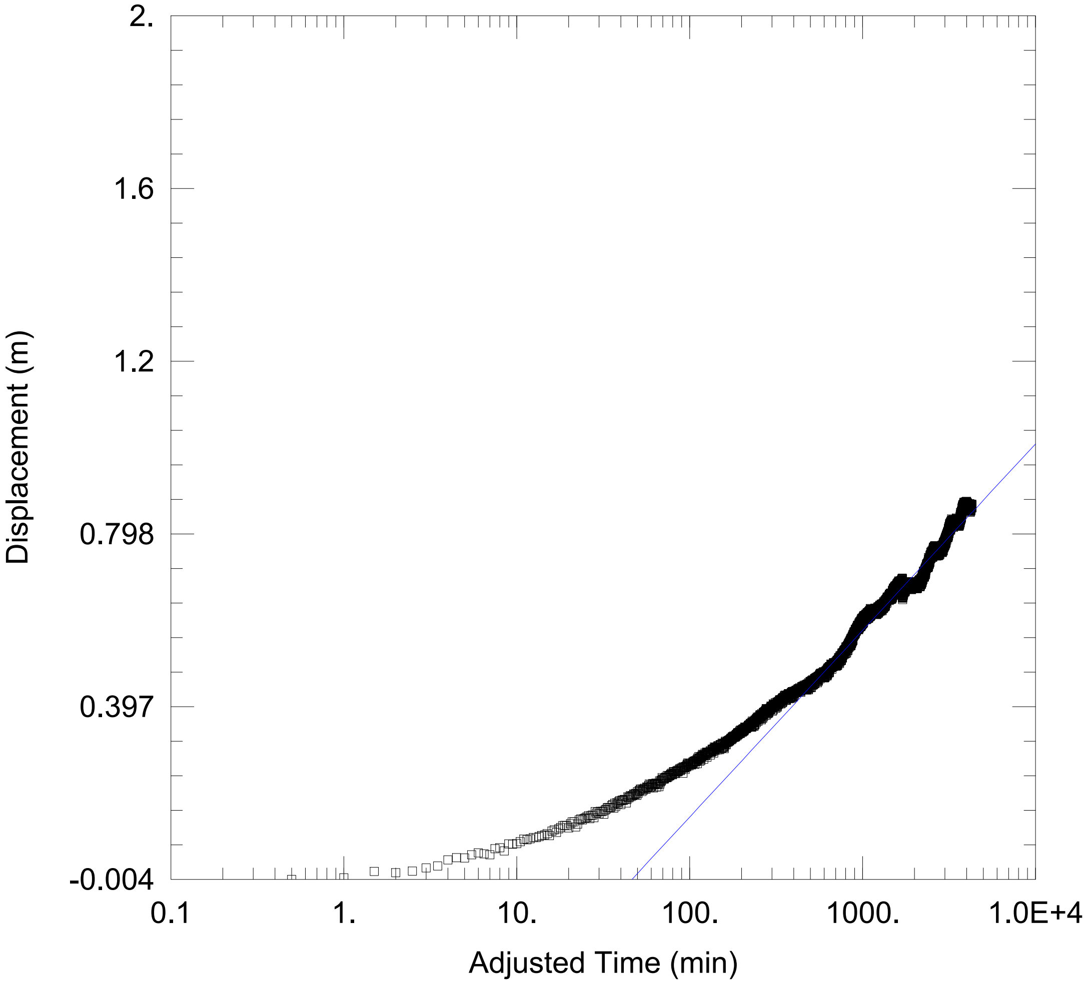
Observation Wells

Well Name	X (m)	Y (m)
□ EB08-MB1B-01	25.5	0

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Jacob

T = 337.4 m^2/day
S = 0.001733



72 HOUR CONSTANT RATE PUMPING TEST (3 L/S) - BORE MB1B-01 RESPONSE

PROJECT INFORMATION

Company: Golder Associates Pty Ltd
Client: Satori Resorts
Project: 087673031
Location: Ella Bay
Test Well: EB08-PB1B
Test Date: 18/12/2008

AQUIFER DATA

Saturated Thickness: 21. m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
EB08-PB1B	0	0

Observation Wells

Well Name	X (m)	Y (m)
□ EB08-MB1B-01	25.5	0

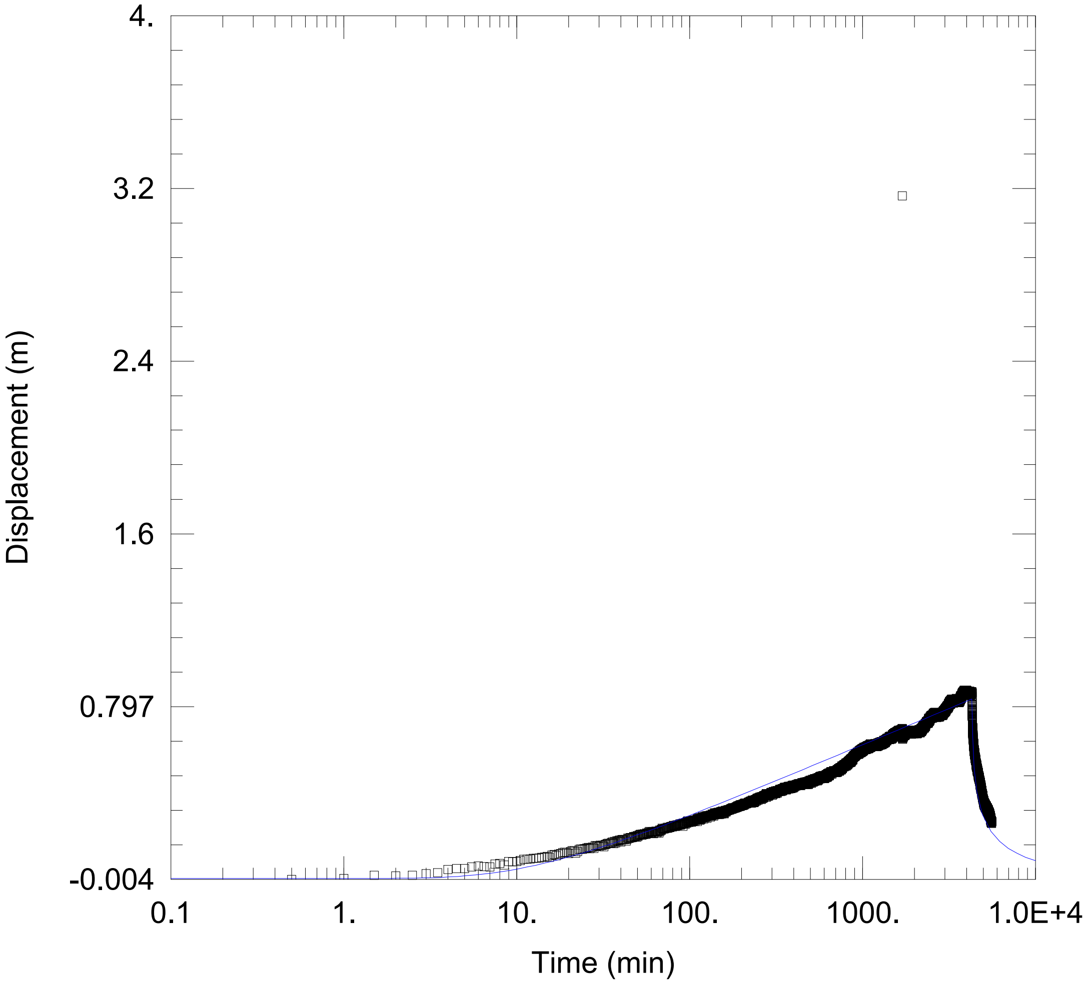
SOLUTION

Aquifer Model: Confined

Solution Method: Cooper-Jacob

T = 109.7 m^2/day

S = 0.01252



72 HOUR CONSTANT RATE PUMPING TEST (3 L/S) - BORE MB1B-01 RESPONSE

Data Set: J:\...\EB08-MB1B-01_Theis.aqt
Date: 02/17/09 Time: 11:32:10

PROJECT INFORMATION

Company: Golder Associates Pty Ltd
Client: Satori Resorts
Project: 087673031
Location: Ella Bay
Test Well: EB08-PB1B
Test Date: 18/12/2008

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
EB08-PB1B	0	0

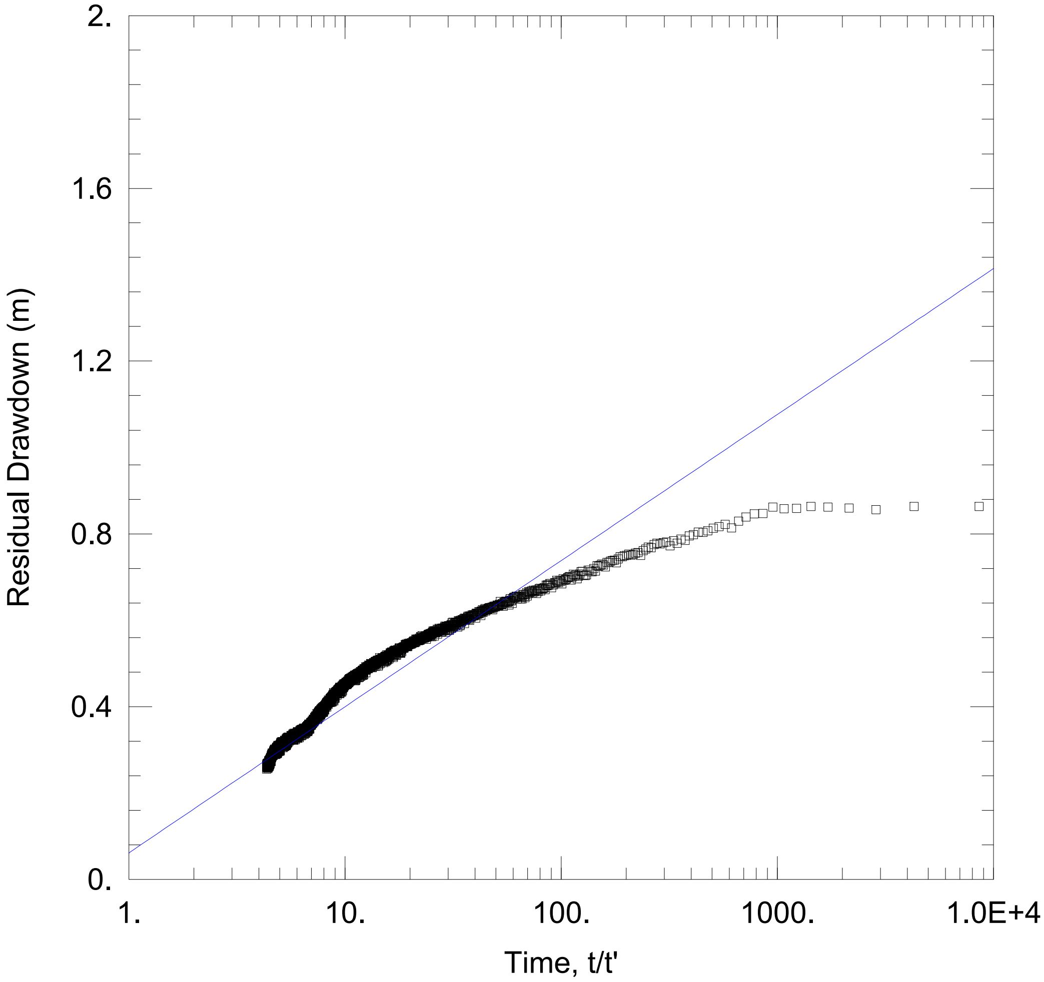
Observation Wells

Well Name	X (m)	Y (m)
□ EB08-MB1B-01	25.5	0

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 140.6 m^2/day
S = 0.004998
Kz/Kr = 1.
b = 21. m



72 HOUR CONSTANT RATE PUMPING TEST (3 L/S) - BORE MB1B-01

PROJECT INFORMATION

Company: Golder Associates Pty Ltd
Client: Satori Resorts
Project: 087673031
Location: Ella Bay
Test Well: EB08-PB1B
Test Date: 18/12/2008

AQUIFER DATA

Saturated Thickness: 21. m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
EB08-PB1B	0	0

Observation Wells

Well Name	X (m)	Y (m)
□ EB08-MB1B-01	25.5	0

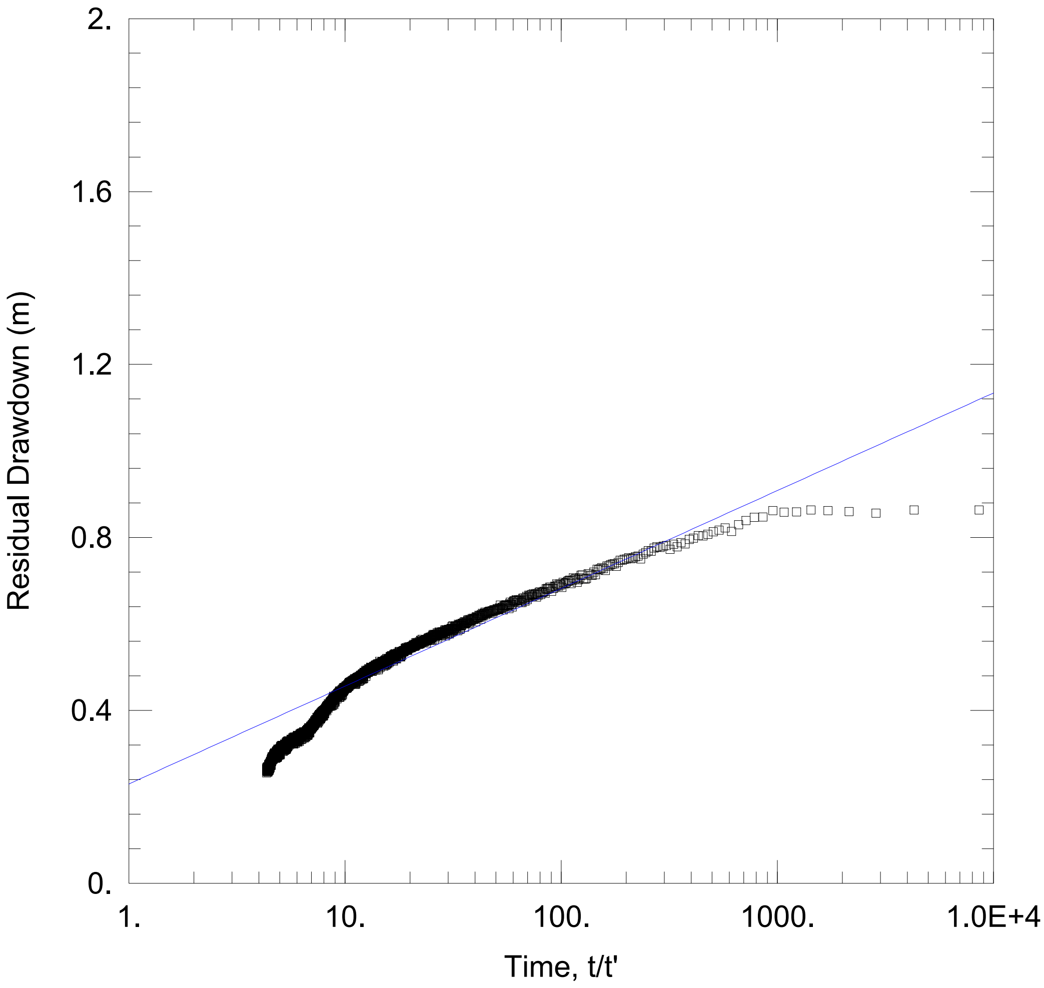
SOLUTION

Aquifer Model: Confined

Solution Method: Theis (Recovery)

T = 140.4 m^2/day

S/S' = 0.6615



72 HOUR CONSTANT RATE PUMPING TEST (3 L/S) - BORE MB1B-01 RESPONSE

PROJECT INFORMATION

Company: Golder Associates Pty Ltd
Client: Satori Resorts
Project: 087673031
Location: Ella Bay
Test Well: EB08-PB1B
Test Date: 18/12/2008

AQUIFER DATA

Saturated Thickness: 21. m

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
EB08-PB1B	0	0

Observation Wells

Well Name	X (m)	Y (m)
□ EB08-MB1B-01	25.5	0

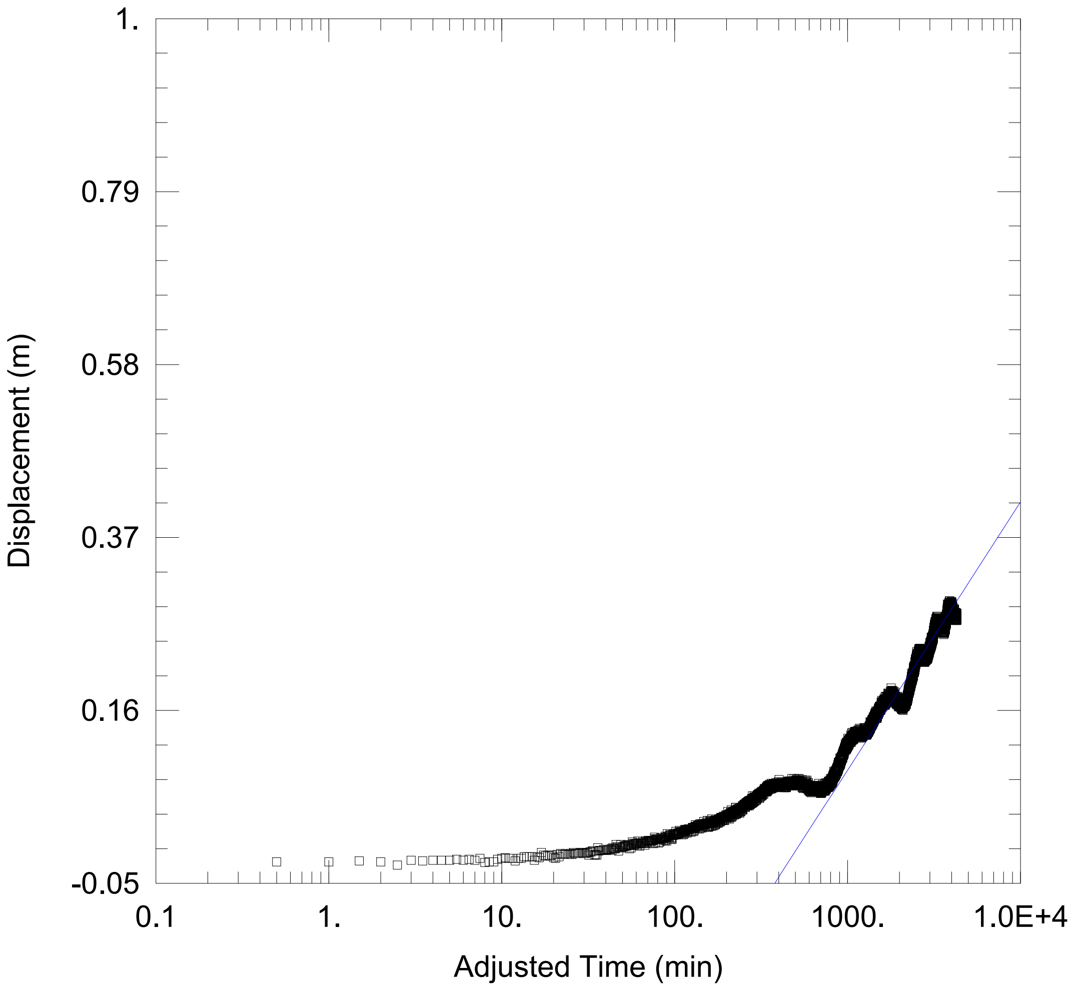
SOLUTION

Aquifer Model: Confined

Solution Method: Theis (Recovery)

T = 210. m^2/day

S/S' = 0.09688



72 HOUR CONSTANT RATE PUMPING TEST (3 L/S) - BORE MB1B-02 RESPONSE

Data Set: J:\...\EB08-MB1B-02_Cooper-Jacob_Late match.aqt
Date: 02/17/09 Time: 11:33:53

PROJECT INFORMATION

Company: Golder Associates Pty Ltd
Client: Satori Resorts
Project: 087673031
Location: Ella Bay
Test Well: EB08-PB1B
Test Date: 18/12/2008

AQUIFER DATA

Saturated Thickness: 21. m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
EB08-PB1B	0	0

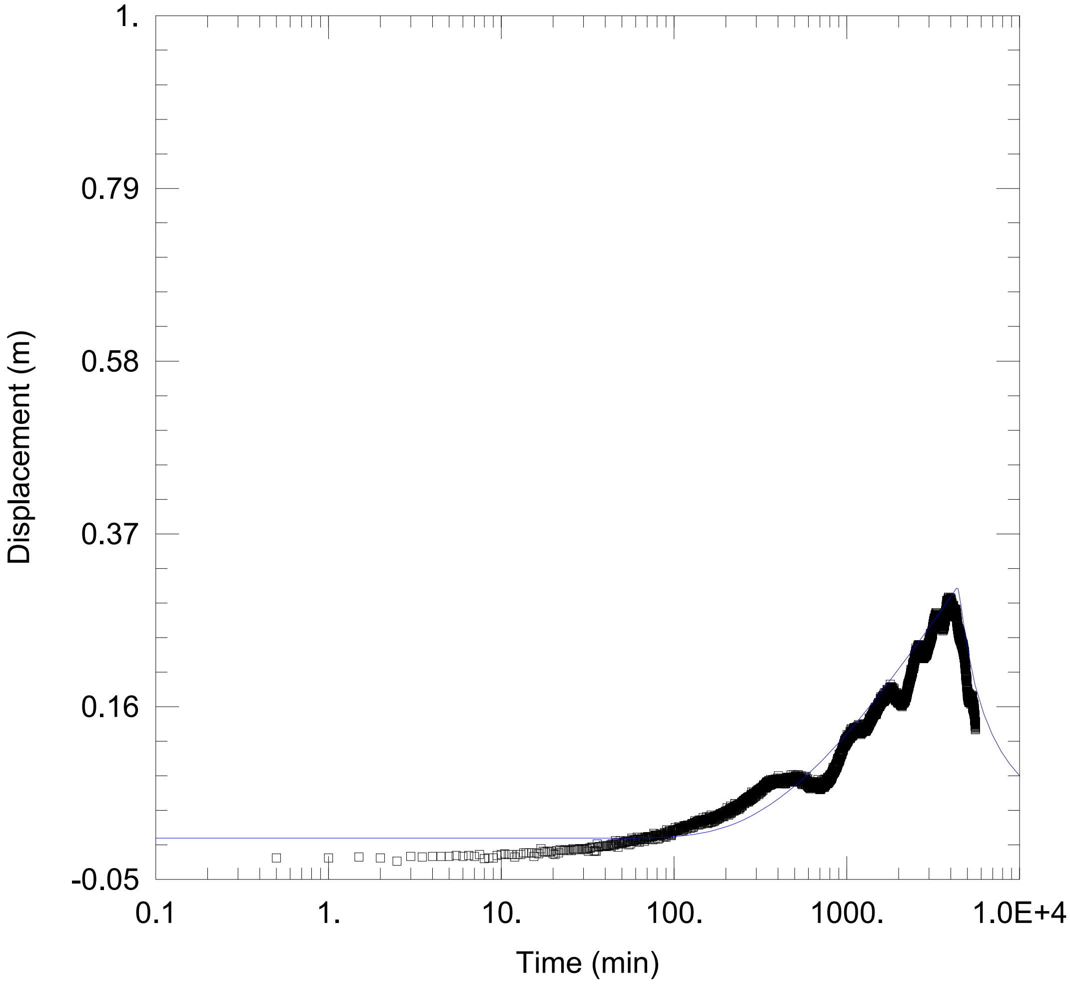
Observation Wells

Well Name	X (m)	Y (m)
□ EB08-MB1B-02	117.25	0

SOLUTION

Aquifer Model: Confined Solution Method: Cooper-Jacob

T = 145.8 m^2/day S = 0.008963



72 HOUR CONSTANT RATE PUMPING TEST (3 L/S) - BORE MB1B-01 RESPONSE

Data Set: J:\...\EB08-MB1B-02_Theis.aqt
Date: 02/17/09 Time: 11:34:34

PROJECT INFORMATION

Company: Golder Associates Pty Ltd
Client: Satori Resorts
Project: 087673031
Location: Ella Bay
Test Well: EB08-PB1B
Test Date: 18/12/2008

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
EB08-PB1B	0	0

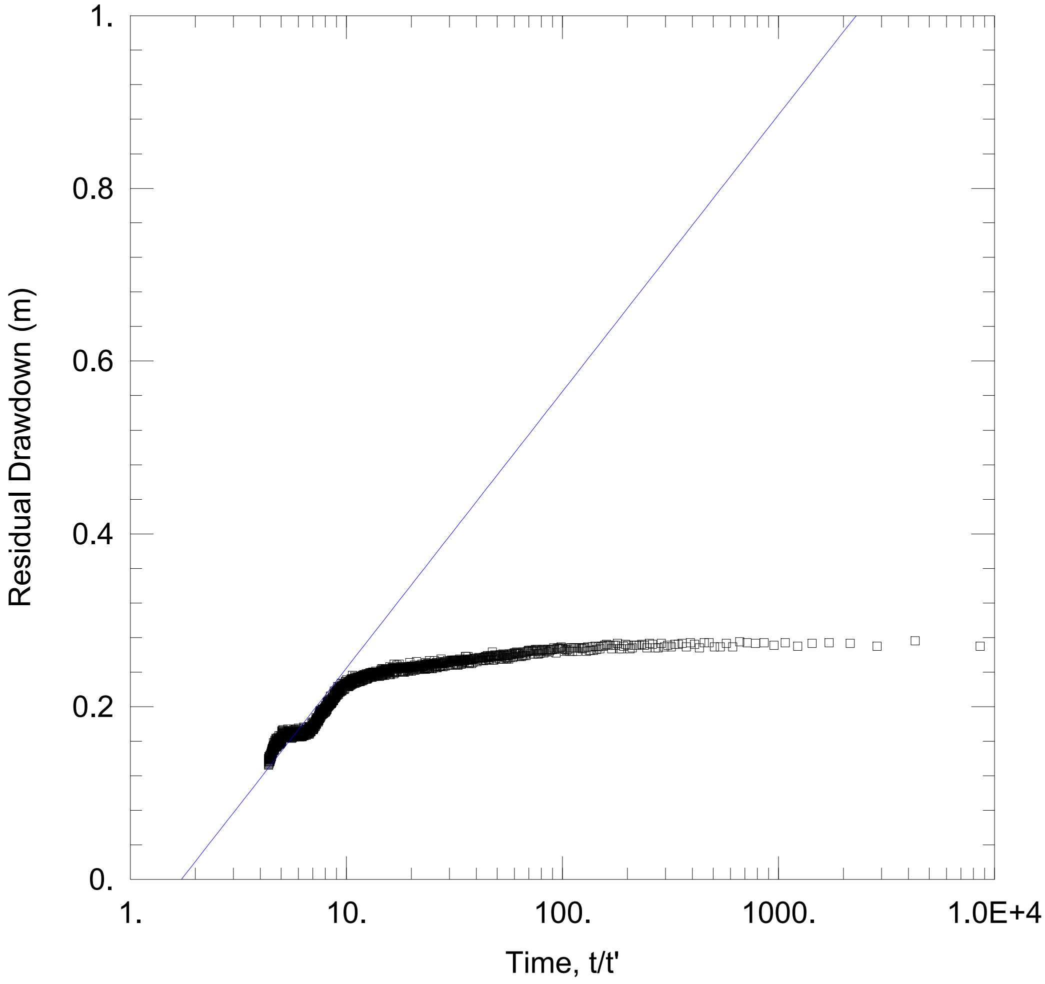
Observation Wells

Well Name	X (m)	Y (m)
□ EB08-MB1B-02	117.25	0

SOLUTION

Aquifer Model: Confined
Solution Method: Theis

T = 145.8 m^2/day
S = 0.008963
Kz/Kr = 1.
b = 21. m



72 HOUR CONSTANT RATE PUMPING TEST (3 L/S) - BORE MB1B-01 RESPONSE

Data Set: J:\...\EB08-MB1B-02_Theis_Recovery_Late match.aqt
Date: 02/17/09 Time: 11:35:08

PROJECT INFORMATION

Company: Golder Associates Pty Ltd
Client: Satori Resorts
Project: 087673031
Location: Ella Bay
Test Well: EB08-PB1B
Test Date: 18/12/2008

AQUIFER DATA

Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (m)	Y (m)
EB08-PB1B	0	0

Observation Wells

Well Name	X (m)	Y (m)
□ EB08-MB1B-02	117.25	0

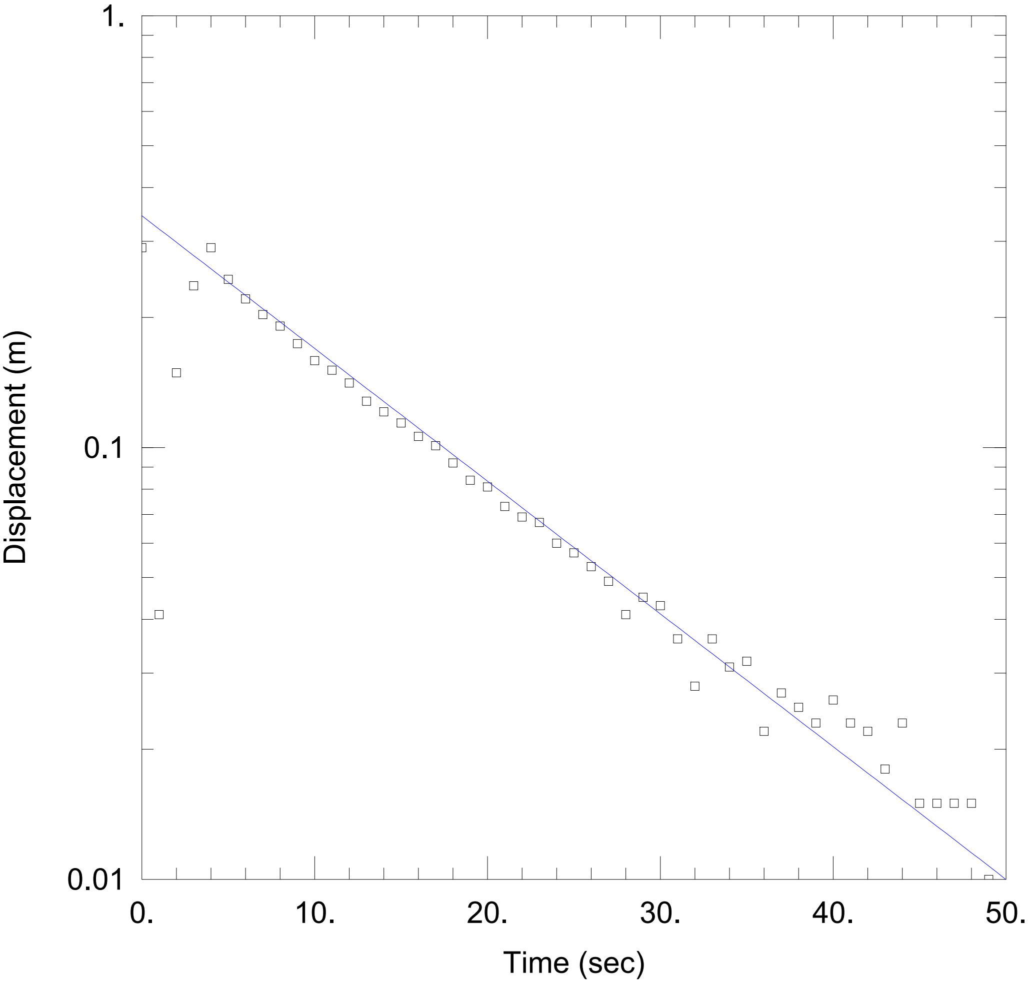
SOLUTION

Aquifer Model: Confined
Solution Method: Theis (Recovery)

T = 148.3 m^2/day
S/S' = 1.731

APPENDIX C

SLUG TEST AQTESOLV ANALYSES



SLUG TEST EB08-PB1B (SLUG IN)

Data Set: J:\...\EB08-PB1B_Slug In_BouwerRice.aqt
Date: 02/17/09 Time: 11:19:17

PROJECT INFORMATION

Company: Golder Associates Pty Ltd
Client: Satori Resorts
Project: 087673031
Location: Ella Bay
Test Well: EB08-PB1B
Test Date: 12/12/2008

AQUIFER DATA

Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

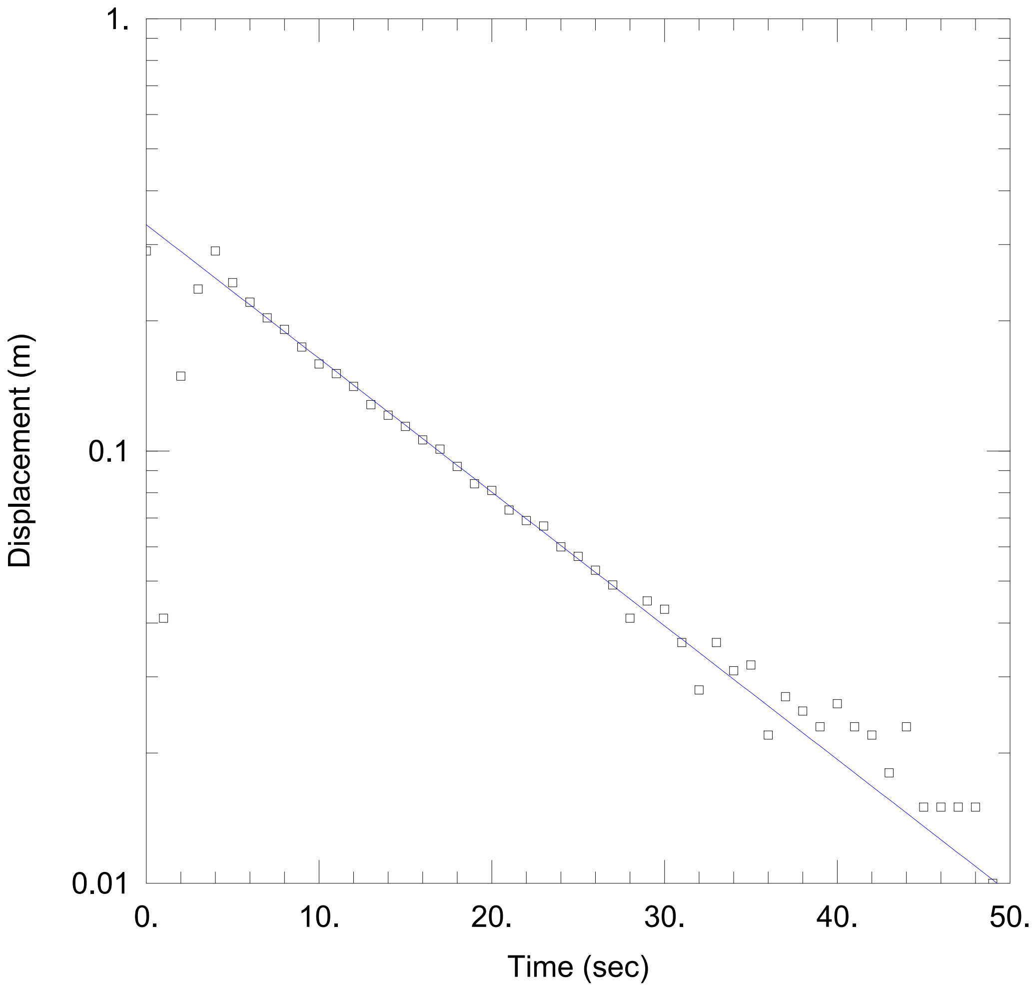
WELL DATA (EB08-PB1B)

Initial Displacement: 0.29 m
Total Well Penetration Depth: 20. m
Casing Radius: 0.0625 m
Static Water Column Height: 1. m
Screen Length: 15. m
Well Radius: 0.12 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 2.963 m/day
y0 = 0.344 m



SLUG TEST EB08-PB1B (SLUG IN)

Data Set: J:\...\EB08-PB1B_Slug In_Hvorslev.aqt
Date: 02/17/09 Time: 11:19:45

PROJECT INFORMATION

Company: Golder Associates Pty Ltd
Client: Satori Resorts
Project: 087673031
Location: Ella Bay
Test Well: EB08-PB1B
Test Date: 12/12/2008

AQUIFER DATA

Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

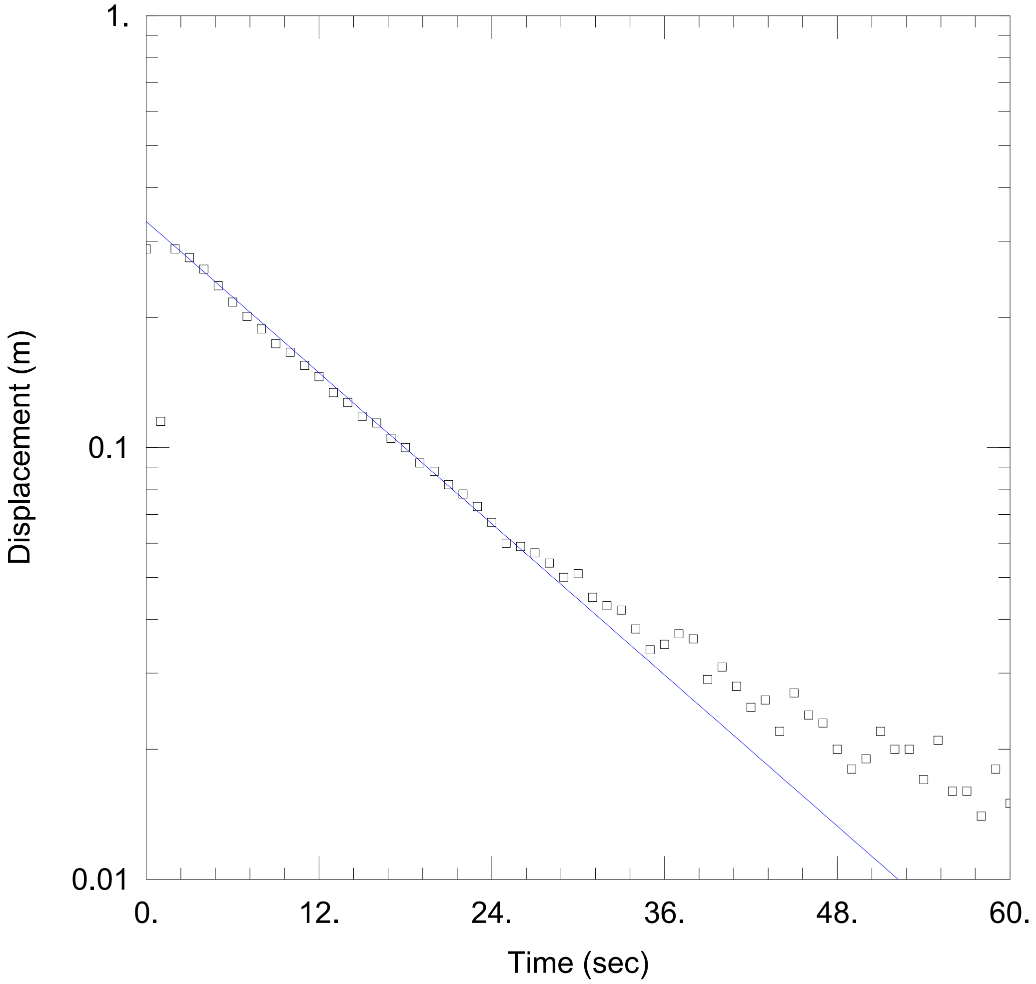
WELL DATA (EB08-PB1B)

Initial Displacement: 0.29 m
Total Well Penetration Depth: 20. m
Casing Radius: 0.0625 m
Static Water Column Height: 1. m
Screen Length: 15. m
Well Radius: 0.12 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 3.869 m/day
y0 = 0.3337 m



SLUG TEST EB08-PB1B (SLUG OUT)

Data Set: J:\...\EB08-PB1B_Slug Out_BouwerRice.aqt
Date: 02/17/09 Time: 11:20:21

PROJECT INFORMATION

Company: Golder Associates Pty Ltd
Client: Satori Resorts
Project: 087673031
Location: Ella Bay
Test Well: EB08-PB1B
Test Date: 12/12/2008

AQUIFER DATA

Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

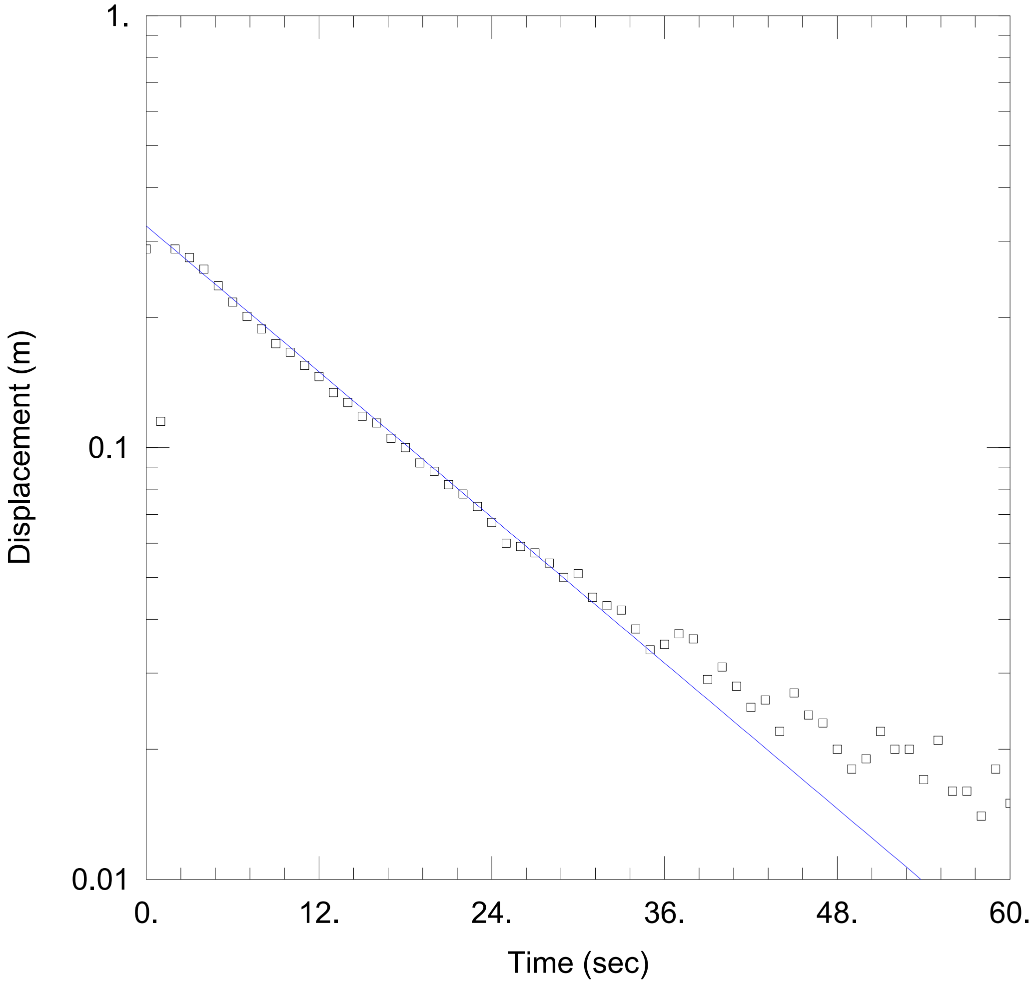
WELL DATA (EB08-PB1B)

Initial Displacement: 0.288 m
Static Water Column Height: 1. m
Total Well Penetration Depth: 20. m
Screen Length: 15. m
Casing Radius: 0.0625 m
Well Radius: 0.12 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 2.812 m/day
y0 = 0.3337 m



SLUG TEST EB08-PB1B (SLUG OUT)

Data Set: J:\...\EB08-PB1B_Slug Out_Hvorslev.aqt
Date: 02/17/09 Time: 11:20:51

PROJECT INFORMATION

Company: Golder Associates Pty Ltd
Client: Satori Resorts
Project: 087673031
Location: Ella Bay
Test Well: EB08-PB1B
Test Date: 12/12/2008

AQUIFER DATA

Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

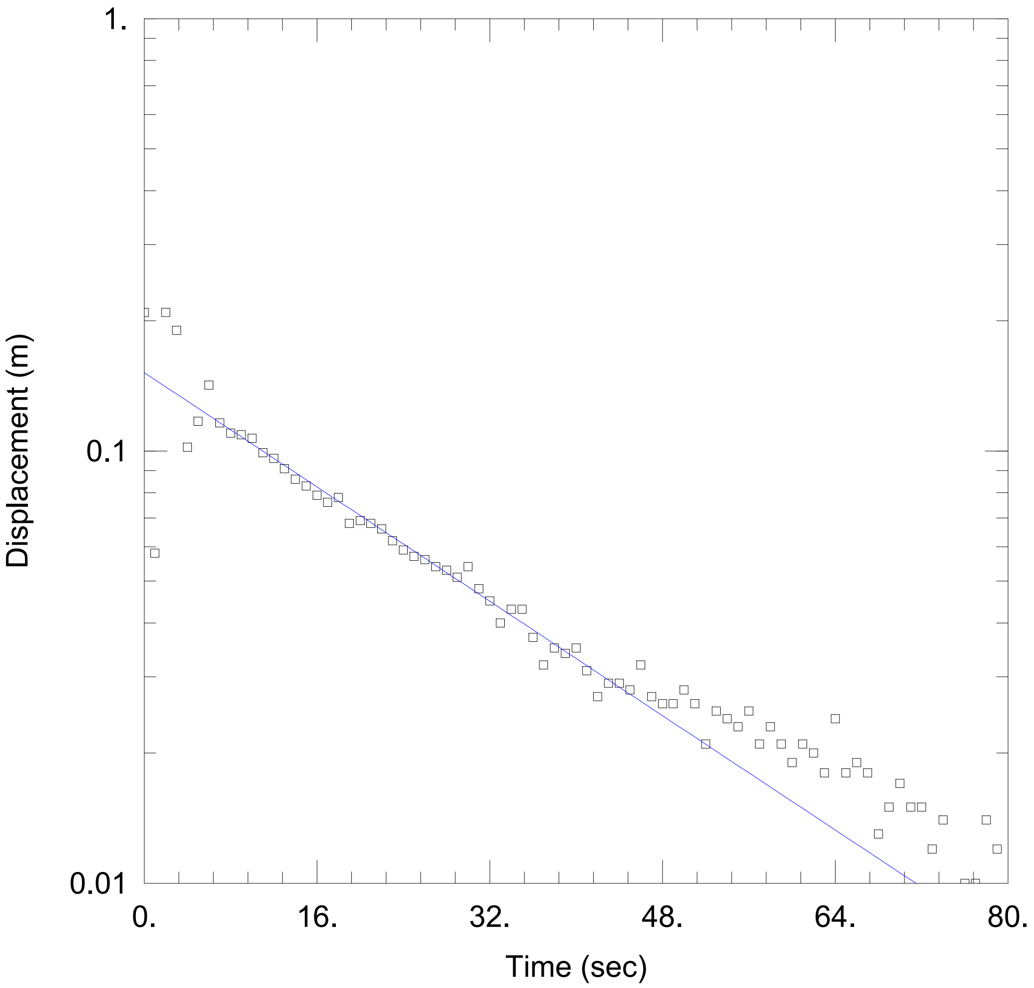
WELL DATA (EB08-PB1B)

Initial Displacement: 0.288 m
Static Water Column Height: 1. m
Total Well Penetration Depth: 20. m
Screen Length: 15. m
Casing Radius: 0.0625 m
Well Radius: 0.12 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 3.517 m/day
y0 = 0.3257 m



SLUG TEST EB08-PB3C (SLUG IN)

PROJECT INFORMATION

Company: Golder Associates Pty Ltd
Client: Satori Resorts
Project: 087673031
Location: Ella Bay
Test Well: EB08-PB3C
Test Date: 12/12/2008

AQUIFER DATA

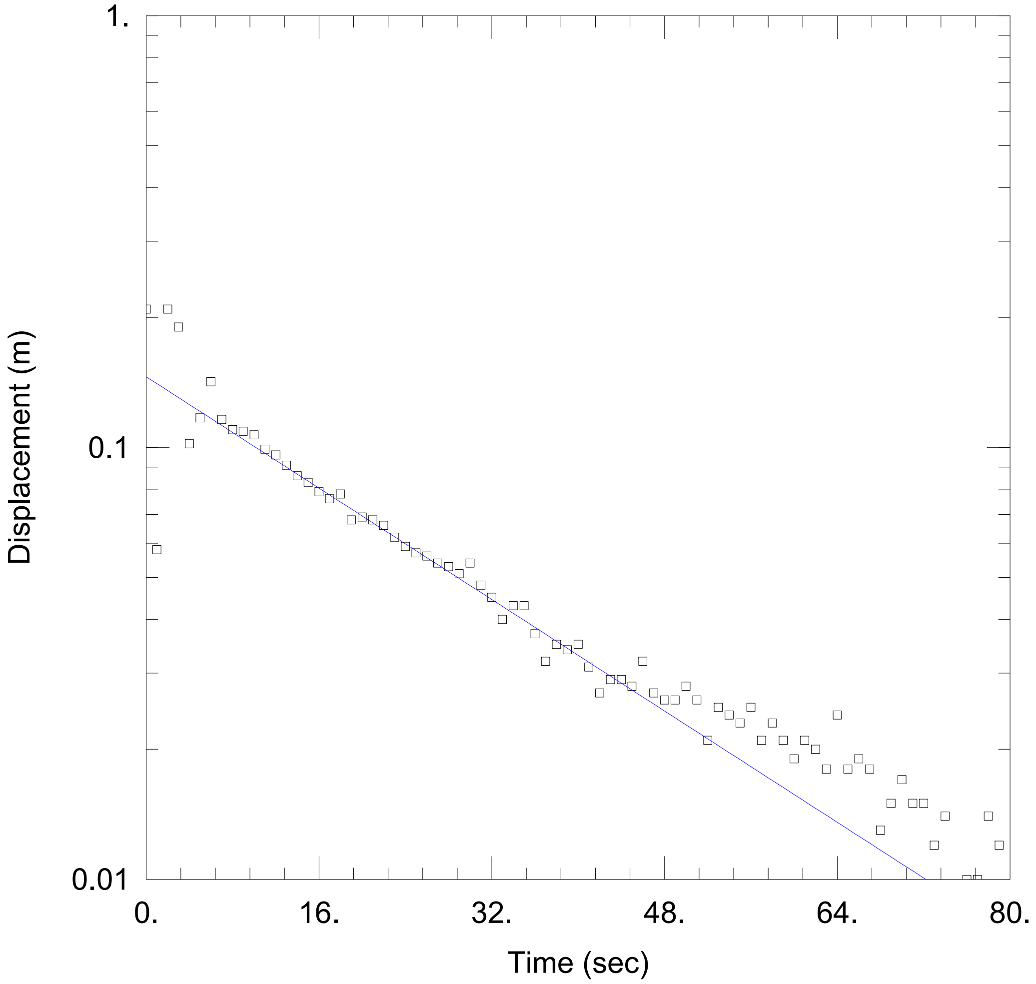
Saturated Thickness: 23. m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (EB08-PB3C)

Initial Displacement: 0.209 m
Total Well Penetration Depth: 12.5 m
Casing Radius: 0.0625 m
Static Water Column Height: 1. m
Screen Length: 9. m
Well Radius: 0.12 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 2.205 m/day
y0 = 0.1517 m



SLUG TEST EB08-PB3C (SLUG IN)

PROJECT INFORMATION

Company: Golder Associates Pty Ltd
Client: Satori Resorts
Project: 087673031
Location: Ella Bay
Test Well: EB08-PB3C
Test Date: 12/12/2008

AQUIFER DATA

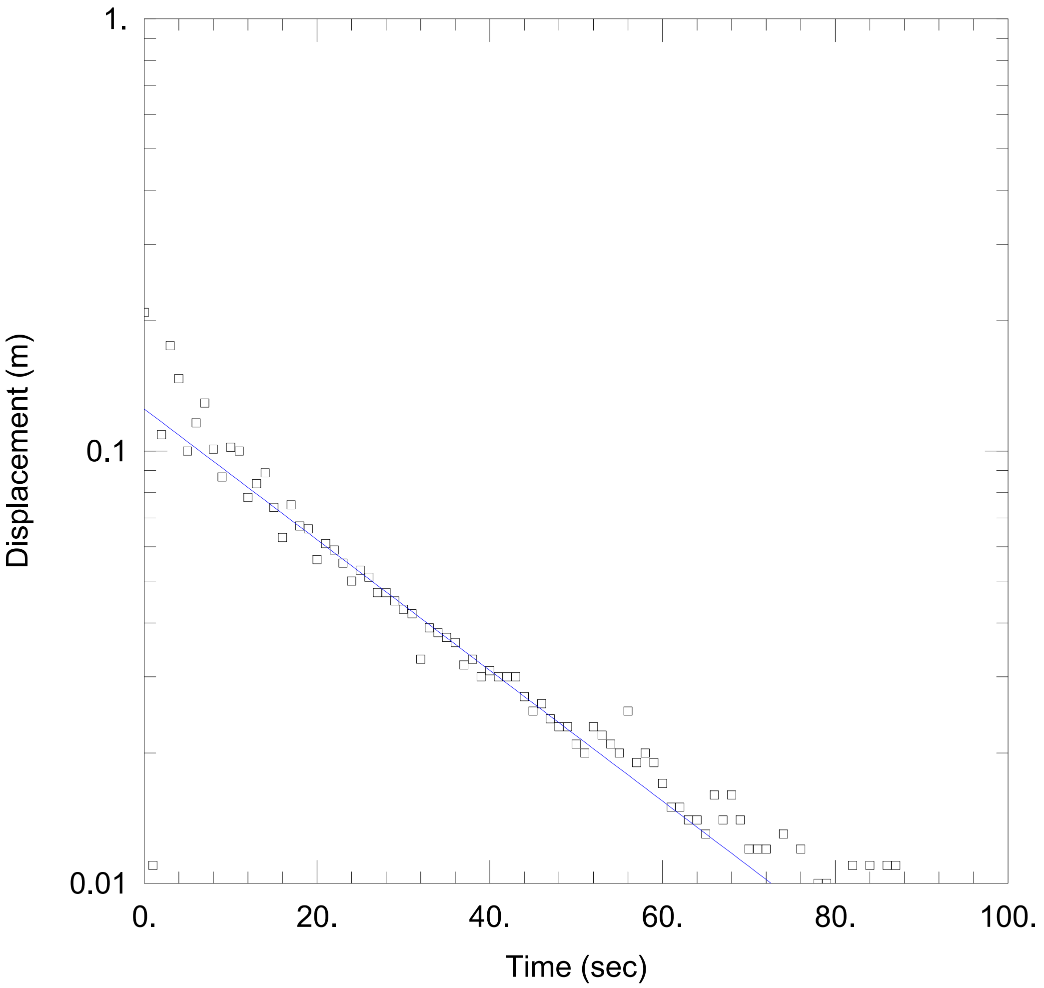
Saturated Thickness: 23. m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (EB08-PB3C)

Initial Displacement: 0.209 m
Total Well Penetration Depth: 12.5 m
Casing Radius: 0.0625 m
Static Water Column Height: 1. m
Screen Length: 9. m
Well Radius: 0.12 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev
K = 3.003 m/day
y0 = 0.1457 m



SLUG TEST EB08-PB3C (SLUG OUT)

PROJECT INFORMATION

Company: Golder Associates Pty Ltd
Client: Satori Resorts
Project: 087673031
Location: Ella Bay
Test Well: EB08-PB3C
Test Date: 12/12/2008

AQUIFER DATA

Saturated Thickness: 23. m
Anisotropy Ratio (Kz/Kr): 1.

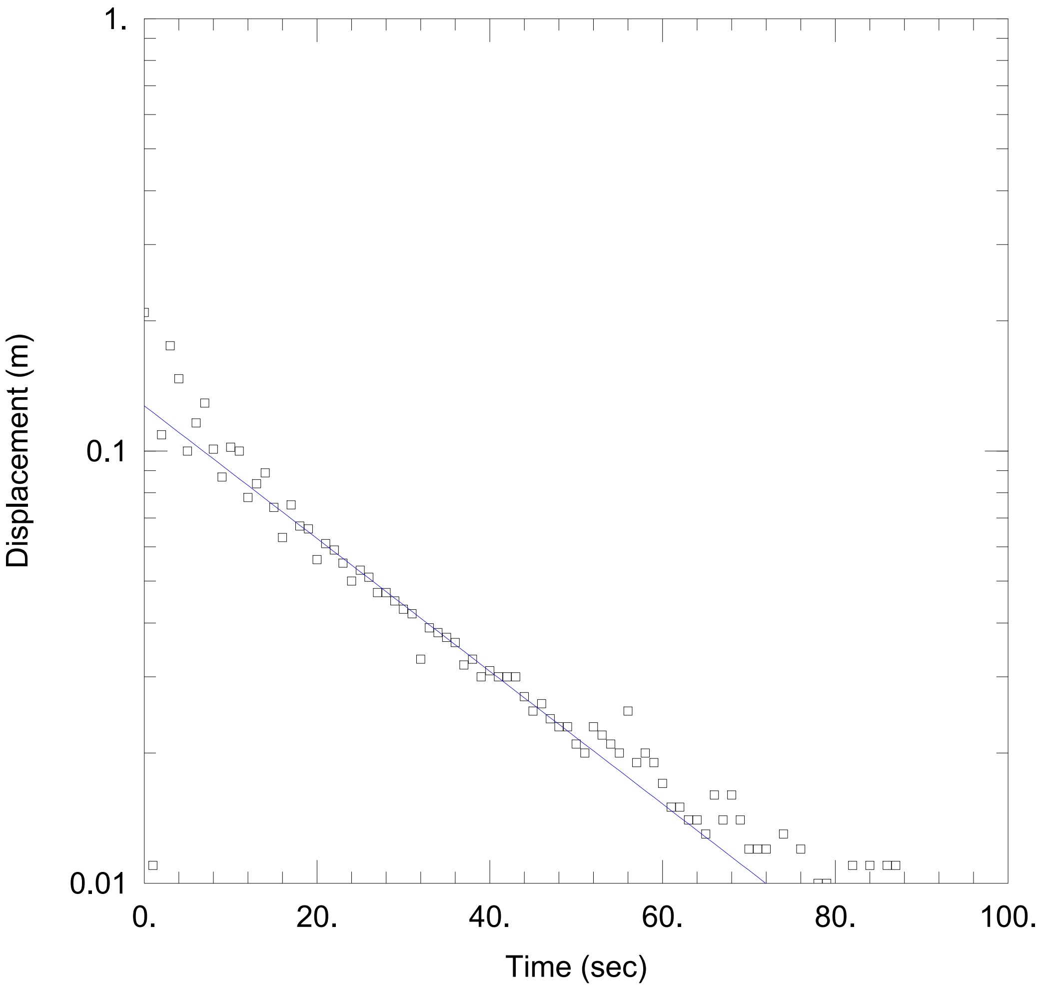
WELL DATA (EB08-PB3C)

Initial Displacement: 0.209 m
Total Well Penetration Depth: 12.5 m
Casing Radius: 0.0625 m
Static Water Column Height: 1. m
Screen Length: 9. m
Well Radius: 0.12 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 2.017 m/day
y0 = 0.125 m



SLUG TEST EB08-PB3C (SLUG OUT)

PROJECT INFORMATION

Company: Golder Associates Pty Ltd
Client: Satori Resorts
Project: 087673031
Location: Ella Bay
Test Well: EB08-PB3C
Test Date: 12/12/2008

AQUIFER DATA

Saturated Thickness: 23. m
Anisotropy Ratio (Kz/Kr): 1.

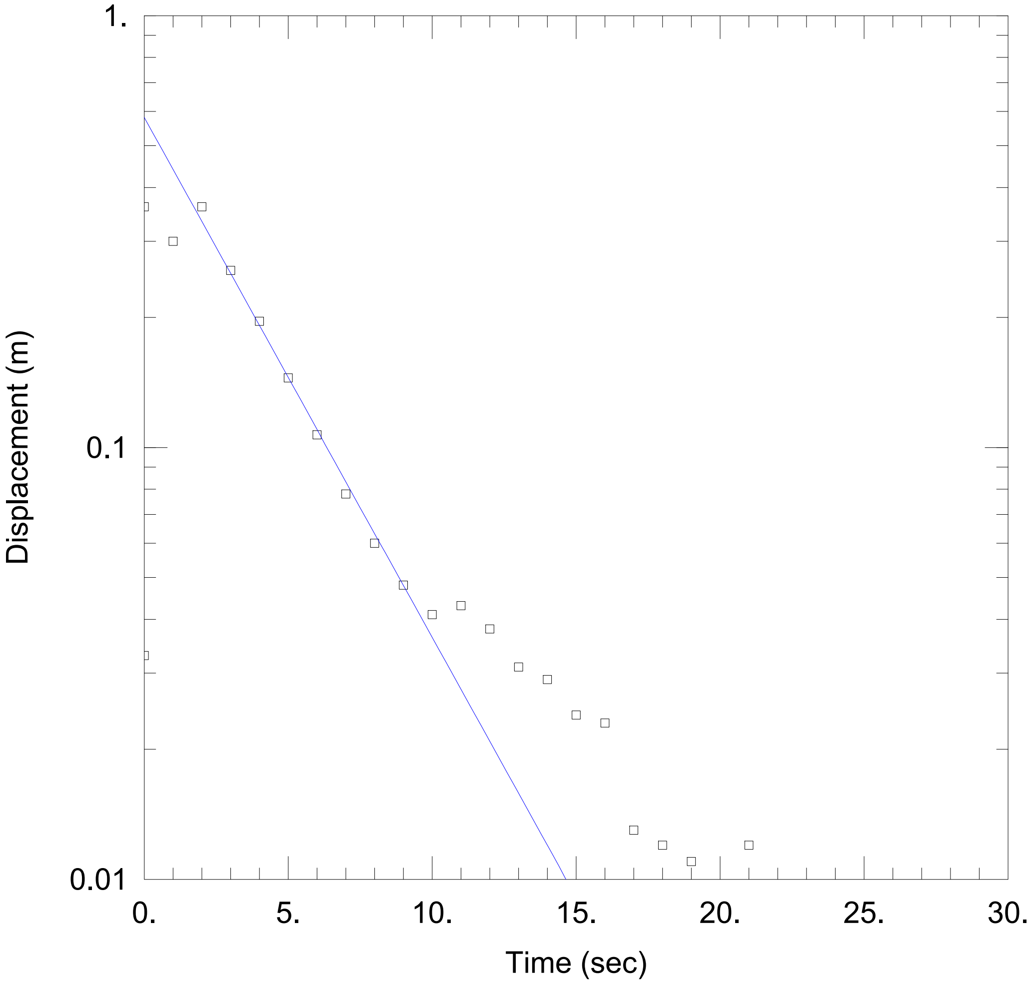
WELL DATA (EB08-PB3C)

Initial Displacement: 0.209 m
Total Well Penetration Depth: 12.5 m
Casing Radius: 0.0625 m
Static Water Column Height: 1. m
Screen Length: 9. m
Well Radius: 0.12 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 2.862 m/day
y0 = 0.1272 m



SLUG TEST: EB08-MB1B-01 (SLUG IN)

Data Set: J:\...\EB08-MB1B-01_Slug In_BouwerRice.aqt
Date: 02/17/09 Time: 11:16:08

PROJECT INFORMATION

Company: Golder Associates Pty Ltd
Client: Satori Resorts
Project: 087673031
Location: Ella Bay
Test Well: EB08-MB1B-01
Test Date: 12/12/2008

AQUIFER DATA

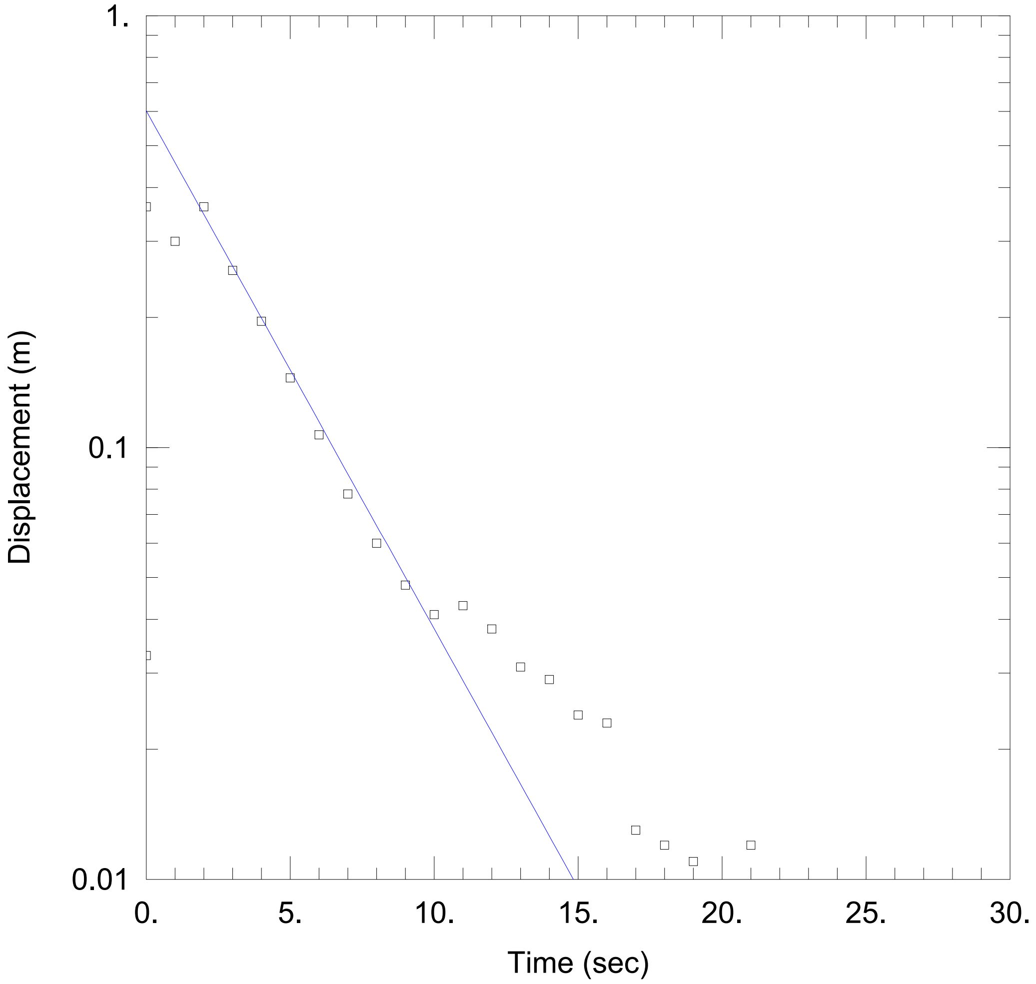
Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (EB08-MB1B-01)

Initial Displacement: 0.361 m
Static Water Column Height: 1. m
Total Well Penetration Depth: 12. m
Screen Length: 10. m
Casing Radius: 0.025 m
Well Radius: 0.07 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 2.657 m/day
y0 = 0.5811 m



SLUG TEST: EB08-MB1B-01 (SLUG IN)

Data Set: J:\...\EB08-MB1B-01_Slug In_Hvorslev.aqt
Date: 02/17/09 Time: 11:17:47

PROJECT INFORMATION

Company: Golder Associates Pty Ltd
Client: Satori Resorts
Project: 087673031
Location: Ella Bay
Test Well: EB08-MB1B-01
Test Date: 12/12/2008

AQUIFER DATA

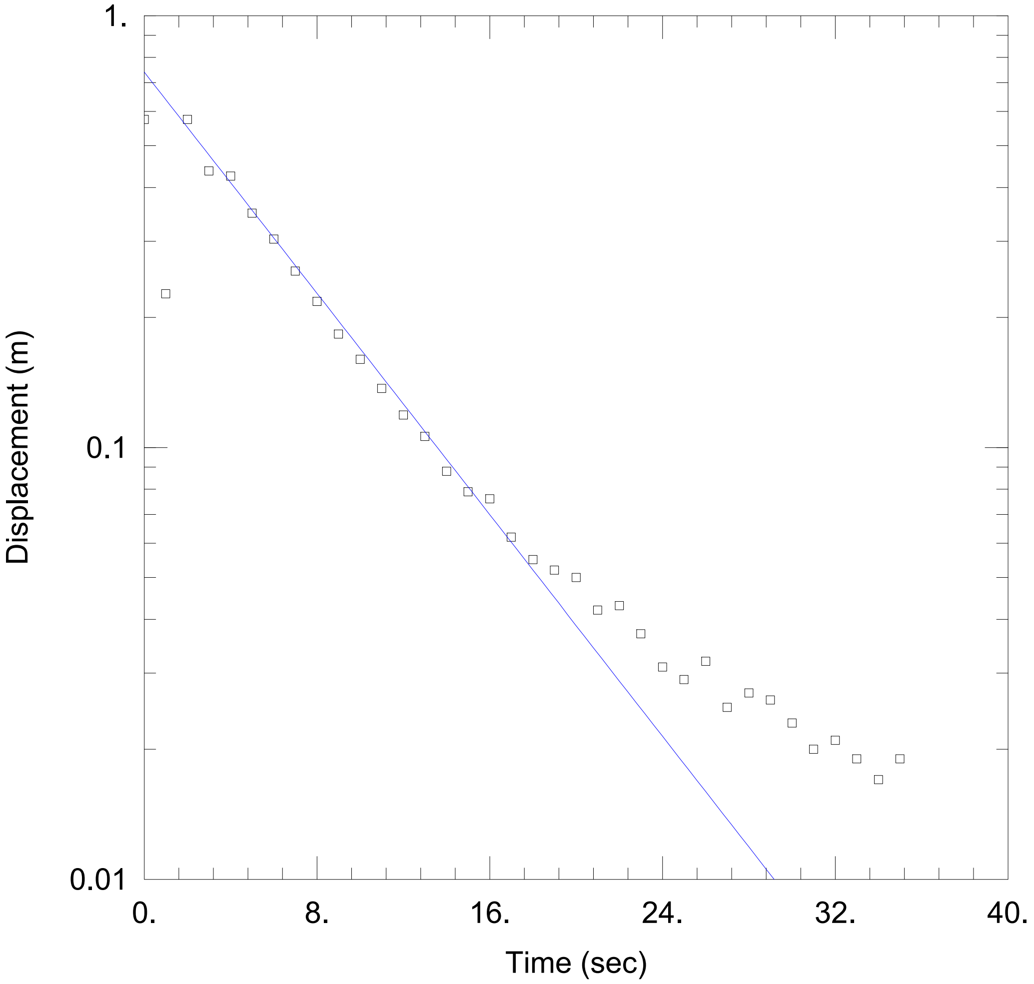
Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (EB08-MB1B-01)

Initial Displacement: 0.361 m
Static Water Column Height: 1. m
Total Well Penetration Depth: 12. m
Screen Length: 10. m
Casing Radius: 0.025 m
Well Radius: 0.07 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev
K = 3.7 m/day
y0 = 0.6018 m



SLUG TEST: EB08-MB1B-02

Data Set: J:\...\EB08-MB1B-02_Slug In_BouwerRice.aqt
Date: 02/17/09 Time: 11:18:15

PROJECT INFORMATION

Company: Golder Associates Pty Ltd
Client: Satori Resorts
Project: 087673031
Location: Ella Bay
Test Well: EB08-MB1B-02
Test Date: 12/12/2008

AQUIFER DATA

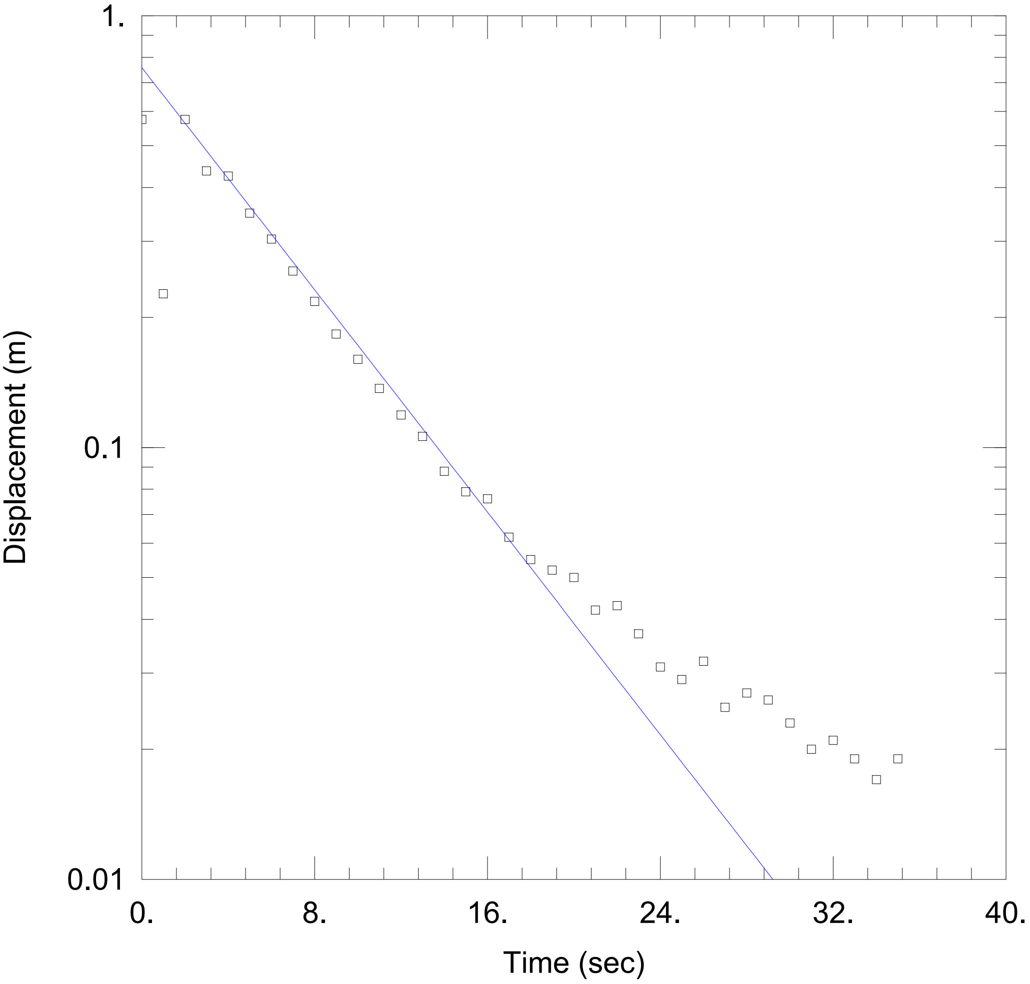
Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (EB08-MB1B-02)

Initial Displacement: 0.575 m
Static Water Column Height: 1. m
Total Well Penetration Depth: 9. m
Screen Length: 9. m
Casing Radius: 0.025 m
Well Radius: 0.07 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 1.478 m/day
y0 = 0.7401 m



SLUG TEST: EB08-MB1B-02

Data Set: J:\...\EB08-MB1B-02_Slug In_Hvorslev.aqt
Date: 02/17/09 Time: 11:18:47

PROJECT INFORMATION

Company: Golder Associates Pty Ltd
Client: Satori Resorts
Project: 087673031
Location: Ella Bay
Test Well: EB08-MB1B-02
Test Date: 12/12/2008

AQUIFER DATA

Saturated Thickness: 21. m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (EB08-MB1B-02)

Initial Displacement: 0.575 m
Static Water Column Height: 1. m
Total Well Penetration Depth: 9. m
Screen Length: 9. m
Casing Radius: 0.025 m
Well Radius: 0.07 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 2.466 m/day
y0 = 0.7579 m

APPENDIX D

SGS LABORATORY WATER ANALYSIS REPORTS

SGS

LABORATORY REPORT COVERSHEET

Date: 29 December 2008

To: Golder Associates Pty Ltd
PO Box 5823
CAIRNS QLD 4870

Attention: Robin Davis

Your Reference: 087673031 - Ella Bay
Laboratory Report No: 62126
Samples Received: 15/12/2008
Samples / Quantity: 1 Water

The above samples were received intact and analysed according to your written instructions. Unless otherwise stated, solid samples are reported on a dry weight basis and liquid samples as received.

Jon Dicker
Manager
CAIRNS

SGoddard
Shey Goddard
Administration Manager
CAIRNS

CLIENT: Golder Associates Pty Ltd
PROJECT: 087673031 - Ella Bay **Laboratory Report No:** 62126

LABORATORY REPORT

-------- **Our Reference** **Your Reference** **Date Sampled** **Type of Sample**	**Units**	**62126-1** **EB08-PB1B-01** **14/12/2008** **Water**
Date Extracted		15/12/2008
Date Analysed		15/12/2008
pH	pH Units	5.6
Electrical Conductivity @ 25°C	µS/cm	52
Bicarbonate Alkalinity	mg/L $CaCO_3$	10
Carbonate Alkalinity	mg/L $CaCO_3$	<5
Total Alkalinity	mg/L $CaCO_3$	10
Acidity to pH8.3 #	mg/L $CaCO_3$	<5
Turbidity	NTU	11
Total Dissolved Solids	mg/L	82
Chloride, Cl	mg/L	11
Sulphate, SO_4	mg/L	<2
Fluoride, F	mg/L	<0.05
Calcium, Ca	mg/L	<0.5
Magnesium, Mg	mg/L	3.4
Sodium, Na	mg/L	6.4
Potassium, K	mg/L	1.4
Silicon, Si #	mg/L	6
Silica, SiO_3	mg/L	16
Ammonia Nitrogen NH_3 as N	mg/L	<0.05
Total Oxidised Nitrogen (as N)	mg/L	0.27
Total Kjeldahl Nitrogen (as N)	mg/L	1.1
Total Nitrogen	mg/L	1.4
Total Phosphorus	mg/L	<0.02
Nitrite (NO_2) (as N)	mg/L	<0.005
Nitrate (LIMS Calc)	mg/L	0.27
E. coli #	CFU/100 mL	<1
Total Coliforms #	CFU/100 mL	307
Faecal Coliforms #	CFU/100 mL	<1

LABORATORY REPORT

Heavy Metals Suite-12 (ANZECC) Our Reference Your Reference Date Sampled Type of Sample	Units	62126-1 EB08-PB1B-01 14/12/2008 Water
Date Extracted		15/12/2008
Date Analysed		15/12/2008
Manganese, Mn	mg/L	<0.05
Aluminium, Al ^	mg/L	0.05
Iron, Fe	mg/L	0.15
Lead, Pb ^	mg/L	<0.001
Arsenic, As ^	mg/L	<0.003
Cadmium, Cd ^	mg/L	<0.0001
Copper, Cu ^	mg/L	<0.001
Zinc, Zn	mg/L	<0.005
Barium, Ba	mg/L	<0.005
Mercury, Hg	mg/L	<0.0002
Molybdenum, Mo ^	mg/L	<0.005
Antimony, Sb ^	mg/L	0.003
Selenium, Se ^	mg/L	<0.003
Silver, Ag	mg/L	0.003
Nickel, Ni ^	mg/L	<0.002
Chromium, Cr ^	mg/L	<0.001

LABORATORY REPORT

TEST PARAMETERS	UNITS	LOR	METHOD
Date Extracted			
Date Analysed			
pH	pH Units	0.1	AN101
Electrical Conductivity @ 25°C	µS/cm	5	AN106
Bicarbonate Alkalinity	mg/L $CaCO_3$	5	AN135 CEI-012
Carbonate Alkalinity	mg/L $CaCO_3$	5	AN135 CEI-012
Total Alkalinity	mg/L $CaCO_3$	5	AN135 CEI-012
Acidity to pH8.3 #	mg/L $CaCO_3$	5	AN140 CEI-013
Turbidity	NTU	0.5	AN119 CEI-007
Total Dissolved Solids	mg/L	10	AN113
Chloride, Cl	mg/L	2	AN274 CEA-020
Sulphate, SO_4	mg/L	2	AN275 CEA-021
Fluoride, F	mg/L	0.05	AN141
Calcium, Ca	mg/L	0.5	AN300 CEI-200
Magnesium, Mg	mg/L	0.5	AN300 CEI-200
Sodium, Na	mg/L	0.5	AN300 CEI-200
Potassium, K	mg/L	0.5	AN300 CEI-200
Silicon, Si #	mg/L	1	AN320
Silica, SiO_3	mg/L	5	Calculation
Ammonia Nitrogen NH_3 as N	mg/L	0.05	AN280 CEA-022
Total Oxidised Nitrogen (as N)	mg/L	0.05	AN248 CEA-001
Total Kjeldahl Nitrogen (as N)	mg/L	0.05	AN281 CEA-016
Total Nitrogen	mg/L	0.05	Calculation
Total Phosphorus	mg/L	0.02	AN279 CEA-015
Nitrite (NO_2) (as N)	mg/L	0.005	AN277 CEA-019
Nitrate (LIMS Calc)	mg/L	0.05	Calculation
E. coli #	CFU/100 mL	1	Other
Total Coliforms #	CFU/100 mL	1	AN704 CEI-101
Faecal Coliforms #	CFU/100 mL	1	AN700 CEI-100

LABORATORY REPORT

TEST PARAMETERS	UNITS	LOR	METHOD
Date Extracted			
Date Analysed			
Manganese, Mn	mg/L	0.05	AN300 CEI-200
Aluminium, Al ^	mg/L	0.05	AN318
Iron, Fe	mg/L	0.05	AN300 CEI-200
Lead, Pb ^	mg/L	0.001	AN318
Arsenic, As ^	mg/L	0.003	AN318
Cadmium, Cd ^	mg/L	0.0001	AN318
Copper, Cu ^	mg/L	0.001	AN318
Zinc, Zn	mg/L	0.005	AN300 CEI-200
Barium, Ba	mg/L	0.005	AN318
Mercury, Hg	mg/L	0.0002	AN312 CEI-202
Molybdenum, Mo ^	mg/L	0.005	AN318
Antimony, Sb ^	mg/L	0.003	AN318
Selenium, Se ^	mg/L	0.003	AN318
Silver, Ag	mg/L	0.001	AN318
Nickel, Ni ^	mg/L	0.002	AN318
Chromium, Cr ^	mg/L	0.001	AN318

LABORATORY REPORT

QUALITY CONTROL	UNITS	Blank	Duplicate Sm#	Duplicate Sample||Duplicate	Spike Sm#	Spike Recovery
Date Extracted		-	62126QC-1	15/12/2008	Batch Spike	-
Date Analysed		-	62126QC-1	15/12/2008	Batch Spike	-
pH	pH Units	-	62126QC-1	5.6	Batch Spike	-
Electrical Conductivity @ 25^{o}C	µS/cm	-	62126QC-1	52	Batch Spike	-
Bicarbonate Alkalinity	mg/L $CaCO_3$	-	62126QC-1	10	Batch Spike	-
Carbonate Alkalinity	mg/L $CaCO_3$	-	62126QC-1	<5	Batch Spike	-
Total Alkalinity	mg/L $CaCO_3$	-	62126QC-1	10	Batch Spike	-
Acidity to pH8.3 #	mg/L $CaCO_3$	-	62126QC-1	<5	Batch Spike	-
Turbidity	NTU	-	62126QC-1	11	Batch Spike	-
Total Dissolved Solids	mg/L	-	62126QC-1	82	Batch Spike	99%
Chloride, Cl	mg/L	-	62126QC-1	11	Batch Spike	99%
Sulphate, SO_4	mg/L	-	62126QC-1	<2	Batch Spike	100%
Fluoride, F	mg/L	-	62126QC-1	<0.05	Batch Spike	109%
Calcium, Ca	mg/L	-	62126QC-1	<0.5	Batch Spike	100%
Magnesium, Mg	mg/L	-	62126QC-1	3.4	Batch Spike	101%
Sodium, Na	mg/L	-	62126QC-1	6.4	Batch Spike	100%
Potassium, K	mg/L	-	62126QC-1	1.4	Batch Spike	101%
Silicon, Si #	mg/L	-	62126QC-1	6	Batch Spike	96%
Silica, SiO_3	mg/L	-	62126QC-1	16	[NR]	[NR]
Ammonia Nitrogen NH_3 as N	mg/L	-	62126QC-1	<0.05	Batch Spike	102%
Total Oxidised Nitrogen (as N)	mg/L	-	62126QC-1	0.27	Batch Spike	101%
Total Kjeldahl Nitrogen (as N)	mg/L	-	62126QC-1	1.1	Batch Spike	105%
Total Nitrogen	mg/L	-	62126QC-1	1.4	Batch Spike	-
Total Phosphorus	mg/L	-	62126QC-1	<0.02	Batch Spike	106%
Nitrite (NO_2) (as N)	mg/L	-	62126QC-1	<0.005	Batch Spike	107%
Nitrate (LIMS Calc)	mg/L	-	62126QC-1	0.27	Batch Spike	-
E. coli #	CFU/100 mL	-	62126QC-1	<1	Batch Spike	-
Total Coliforms #	CFU/100 mL	-	62126QC-1	307	Batch Spike	-

LABORATORY REPORT

QUALITY CONTROL	UNITS	Blank	Duplicate Sm#	Duplicate Sample||Duplicate	Spike Sm#	Spike Recovery
Faecal Coliforms #	CFU/100 mL	-	62126QC-1	<1	Batch Spike	-
QUALITY CONTROL	**UNITS**	**Blank**	**Duplicate Sm#**	**Duplicate Sample||Duplicate**	**Spike Sm#**	**Spike Recovery**
Date Extracted		-	62126QC-1	15/12/2008	Batch Spike	-
Date Analysed		-	62126QC-1	15/12/2008	Batch Spike	-
Manganese, Mn	mg/L	-	62126QC-1	<0.05	Batch Spike	100%
Aluminium, Al ^	mg/L	-	62126QC-1	0.05	Batch Spike	101%
Iron, Fe	mg/L	-	62126QC-1	0.15	Batch Spike	100%
Lead, Pb ^	mg/L	-	62126QC-1	<0.001	Batch Spike	111%
Arsenic, As ^	mg/L	-	62126QC-1	<0.003	Batch Spike	110%
Cadmium, Cd ^	mg/L	-	62126QC-1	<0.0001	Batch Spike	103%
Copper, Cu ^	mg/L	-	62126QC-1	<0.001	Batch Spike	91%
Zinc, Zn	mg/L	-	62126QC-1	<0.005	Batch Spike	100%
Barium, Ba	mg/L	-	62126QC-1	<0.005	Batch Spike	98%
Mercury, Hg	mg/L	-	62126QC-1	<0.0002	Batch Spike	107%
Molybdenum, Mo ^	mg/L	-	62126QC-1	<0.005	Batch Spike	104%
Antimony, Sb ^	mg/L	-	62126QC-1	0.003	Batch Spike	117%
Selenium, Se ^	mg/L	-	62126QC-1	<0.003	Batch Spike	101%
Silver, Ag	mg/L	-	62126QC-1	0.003	Batch Spike	102%
Nickel, Ni ^	mg/L	-	62126QC-1	<0.002	Batch Spike	97%
Chromium, Cr ^	mg/L	-	62126QC-1	<0.001	Batch Spike	97%

LABORATORY REPORT

NOTES:
LOR - Limit of Reporting.
This test is not covered by our current NATA accreditation.
^ This analysis was determined at our Sydney Laboratory, their reference 66362.

Analysis Date: **Between** 15/12/08 **and** 29/12/08

SGS Terms and Conditions are available at www.au.sgs.com

Geneva Legal Comment

ISO 17025

LABORATORY REPORT COVERSHEET

Date: 9 February 2009

To: Golder Associates Pty Ltd
PO Box 5823
CAIRNS QLD 4870

Attention: Robin Davis

Your Reference:	087673031 - Ella Bay Groundwater Exploration
Laboratory Report No:	62206R
Samples Received:	22/12/2008
Samples / Quantity:	1 Water

The above samples were received intact and analysed according to your written instructions. Unless otherwise stated, solid samples are reported on a dry weight basis and liquid samples as received.
This report cancels and supersedes the final report issued 13/01/09
by SGS Environmental Services, Cairns.

Please find additional Hardness Calculation.

Jon Dicker
Manager
CAIRNS

SGoddard
Shey Goddard
Administration Manager
CAIRNS

LABORATORY REPORT

-------- **Our Reference** **Your Reference** **Date Sampled** **Type of Sample**	**Units**	**62206R-1** **EB08-PB1B-02** **21/12/2008** **Water**
Date Extracted		22/12/2008
Date Analysed		22/12/2008
pH	pH Units	5.8
Electrical Conductivity @ 25^{o}C	µS/cm	51
Bicarbonate Alkalinity	mg/L $CaCO_3$	11
Carbonate Alkalinity	mg/L $CaCO_3$	<5
Total Alkalinity	mg/L $CaCO_3$	11
Acidity to pH8.3 #	mg/L $CaCO_3$	<5
Turbidity	NTU	6.9
Total Dissolved Solids	mg/L	55
Calcium, Ca	mg/L	<0.5
Magnesium, Mg	mg/L	3.7
Hardness (as $CaCO_3$)	mg/L $CaCO_3$	15
Potassium, K	mg/L	20
Sodium, Na	mg/L	6.8
Silicon, Si #	mg/L	6
Silica, SiO_3	mg/L	16
Chloride, Cl	mg/L	10
Sulphate, SO_4	mg/L	2
Fluoride, F	mg/L	0.05
Ammonia Nitrogen NH_3 as N	mg/L	<0.05
Total Oxidised Nitrogen (as N)	mg/L	0.25
Total Kjeldahl Nitrogen (as N)	mg/L	<0.05
Total Nitrogen	mg/L	0.25
Total Phosphorus	mg/L	<0.02
Nitrite (NO_2) (as N)	mg/L	<0.005
Nitrate (LIMS Calc)	mg/L	0.25
E. coli #	CFU/100 mL	<1
Total Coliforms #	CFU/100 mL	220
Faecal Coliforms #	CFU/100 mL	<1

LABORATORY REPORT

Heavy Metals Suite-12 (ANZECC) **Our Reference** **Your Reference** **Date Sampled** **Type of Sample**	**Units**	**62206R-1** **EB08-PB1B-02** **21/12/2008** **Water**
Date Extracted		24/12/2008
Date Analysed		24/12/2008
Manganese, Mn	mg/L	<0.05
Aluminium, Al ^	mg/L	0.59
Iron, Fe	mg/L	0.39
Lead, Pb ^	mg/L	<0.001
Arsenic, As ^	mg/L	<0.003
Cadmium, Cd ^	mg/L	<0.0001
Copper, Cu ^	mg/L	<0.001
Zinc, Zn	mg/L	0.009
Barium, Ba	mg/L	<0.005
Mercury, Hg	mg/L	<0.0002
Molybdenum, Mo ^	mg/L	<0.005
Antimony, Sb ^	mg/L	<0.003
Selenium, Se ^	mg/L	<0.003
Silver, Ag ^	mg/L	<0.001
Nickel, Ni ^	mg/L	<0.002
Chromium, Cr ^	mg/L	<0.001

LABORATORY REPORT

TEST PARAMETERS	UNITS	LOR	METHOD
Date Extracted			
Date Analysed			
pH	pH Units	0.1	AN101
Electrical Conductivity @ 25^{o}C	µS/cm	5	AN106
Bicarbonate Alkalinity	mg/L $CaCO_3$	5	AN135 CEI-012
Carbonate Alkalinity	mg/L $CaCO_3$	5	AN135 CEI-012
Total Alkalinity	mg/L $CaCO_3$	5	AN135 CEI-012
Acidity to pH8.3 #	mg/L $CaCO_3$	5	AN140 CEI-013
Turbidity	NTU	0.5	AN119 CEI-007
Total Dissolved Solids	mg/L	10	AN113
Calcium, Ca	mg/L	0.5	AN300 CEI-200
Magnesium, Mg	mg/L	0.5	AN300 CEI-200
Hardness (as $CaCO_3$)	mg/L $CaCO_3$	5	AN124
Potassium, K	mg/L	0.5	AN300 CEI-200
Sodium, Na	mg/L	0.5	AN300 CEI-200
Silicon, Si #	mg/L	1	AN320
Silica, SiO_3	mg/L	5	Calculation
Chloride, Cl	mg/L	2	AN274 CEA-020
Sulphate, SO_4	mg/L	2	AN275 CEA-021
Fluoride, F	mg/L	0.05	AN141
Ammonia Nitrogen NH_3 as N	mg/L	0.05	AN280 CEA-022
Total Oxidised Nitrogen (as N)	mg/L	0.05	AN248 CEA-001
Total Kjeldahl Nitrogen (as N)	mg/L	0.05	AN281 CEA-016
Total Nitrogen	mg/L	0.05	Calculation
Total Phosphorus	mg/L	0.02	AN279 CEA-015
Nitrite (NO_2) (as N)	mg/L	0.005	AN277 CEA-019
Nitrate (LIMS Calc)	mg/L	0.05	Calculation
E. coli #	CFU/100 mL	1	Other
Total Coliforms #	CFU/100 mL	1	AN704 CEI-101
Faecal Coliforms #	CFU/100 mL	1	AN700 CEI-100

LABORATORY REPORT

TEST PARAMETERS	UNITS	LOR	METHOD
Date Extracted			
Date Analysed			
Manganese, Mn	mg/L	0.05	AN300 CEI-200
Aluminium, Al ^	mg/L	0.05	AN318
Iron, Fe	mg/L	0.05	AN300 CEI-200
Lead, Pb ^	mg/L	0.001	AN318
Arsenic, As ^	mg/L	0.003	AN318
Cadmium, Cd ^	mg/L	0.0001	AN318
Copper, Cu ^	mg/L	0.001	AN318
Zinc, Zn	mg/L	0.005	AN300 CEI-200
Barium, Ba	mg/L	0.005	AN318
Mercury, Hg	mg/L	0.0002	AN312 CEI-202
Molybdenum, Mo ^	mg/L	0.005	AN318
Antimony, Sb ^	mg/L	0.003	AN318
Selenium, Se ^	mg/L	0.003	AN318
Silver, Ag ^	mg/L	0.001	AN318
Nickel, Ni ^	mg/L	0.002	AN318
Chromium, Cr ^	mg/L	0.001	AN318

CLIENT: Golder Associates Pty Ltd

PROJECT: 087673031 - Ella Bay Groundwater Exploration **Laboratory Report No:** 62206R

LABORATORY REPORT

QUALITY CONTROL	UNITS	Blank	Duplicate Sm#	Duplicate Sample||Duplicate	Spike Sm#	Spike Recovery
Date Extracted		22/12/08	[NT]	[NT]	Batch Spike	-
Date Analysed		22/12/08	[NT]	[NT]	Batch Spike	-
pH	pH Units	-	[NT]	[NT]	Batch Spike	-
Electrical Conductivity @ 25°C	µS/cm	-	[NT]	[NT]	Batch Spike	-
Bicarbonate Alkalinity	mg/L $CaCO_3$	-	[NT]	[NT]	Batch Spike	-
Carbonate Alkalinity	mg/L $CaCO_3$	-	[NT]	[NT]	Batch Spike	-
Total Alkalinity	mg/L $CaCO_3$	-	[NT]	[NT]	Batch Spike	-
Acidity to pH8.3 #	mg/L $CaCO_3$	<5	[NT]	[NT]	Batch Spike	-
Turbidity	NTU	-	[NT]	[NT]	Batch Spike	-
Total Dissolved Solids	mg/L	<10	[NT]	[NT]	Batch Spike	106%
Calcium, Ca	mg/L	<0.5	[NT]	[NT]	Batch Spike	100%
Magnesium, Mg	mg/L	<0.5	[NT]	[NT]	Batch Spike	100%
Hardness (as $CaCO_3$)	mg/L $CaCO_3$	-	[NT]	[NT]	Batch Spike	-
Potassium, K	mg/L	<0.5	[NT]	[NT]	Batch Spike	100%
Sodium, Na	mg/L	<0.5	[NT]	[NT]	Batch Spike	98%
Silicon, Si #	mg/L	<1	[NT]	[NT]	Batch Spike	100%
Silica, SiO_3	mg/L	-	[NT]	[NT]	[NR]	[NR]
Chloride, Cl	mg/L	<2	[NT]	[NT]	Batch Spike	101%
Sulphate, SO_4	mg/L	<2	[NT]	[NT]	Batch Spike	103%
Fluoride, F	mg/L	<0.05	[NT]	[NT]	Batch Spike	98%
Ammonia Nitrogen NH_3 as N	mg/L	<0.05	[NT]	[NT]	Batch Spike	104%
Total Oxidised Nitrogen (as N)	mg/L	<0.05	[NT]	[NT]	Batch Spike	-
Total Kjeldahl Nitrogen (as N)	mg/L	<0.05	[NT]	[NT]	Batch Spike	101%
Total Nitrogen	mg/L	-	[NT]	[NT]	[NR]	[NR]
Total Phosphorus	mg/L	<0.02	[NT]	[NT]	Batch Spike	100%
Nitrite (NO_2) (as N)	mg/L	<0.005	[NT]	[NT]	Batch Spike	100%
Nitrate (LIMS Calc)	mg/L	-	[NT]	[NT]	[NR]	[NR]

LABORATORY REPORT

QUALITY CONTROL	UNITS	Blank	Duplicate Sm#	Duplicate Sample||Duplicate	Spike Sm#	Spike Recovery
E. coli #	CFU/100 mL	<1	[NT]	[NT]	Batch Spike	-
Total Coliforms #	CFU/100 mL	<1	[NT]	[NT]	Batch Spike	-
Faecal Coliforms #	CFU/100 mL	<1	[NT]	[NT]	Batch Spike	-
QUALITY CONTROL	**UNITS**	**Blank**	**Duplicate Sm#**	**Duplicate Sample||Duplicate**	**Spike Sm#**	**Spike Recovery**
Date Extracted		24/12/08	[NT]	[NT]	Batch Spike	-
Date Analysed		24/12/08	[NT]	[NT]	Batch Spike	-
Manganese, Mn	mg/L	<0.05	[NT]	[NT]	Batch Spike	107%
Aluminium, Al ^	mg/L	<0.05	[NT]	[NT]	Batch Spike	95%
Iron, Fe	mg/L	<0.05	[NT]	[NT]	Batch Spike	109%
Lead, Pb ^	mg/L	<0.001	[NT]	[NT]	Batch Spike	104%
Arsenic, As ^	mg/L	<0.003	[NT]	[NT]	Batch Spike	107%
Cadmium, Cd ^	mg/L	<0.0001	[NT]	[NT]	Batch Spike	92%
Copper, Cu ^	mg/L	<0.001	[NT]	[NT]	Batch Spike	100%
Zinc, Zn	mg/L	<0.005	[NT]	[NT]	Batch Spike	109%
Barium, Ba	mg/L	<0.005	[NT]	[NT]	Batch Spike	108%
Mercury, Hg	mg/L	<0.0002	[NT]	[NT]	Batch Spike	108%
Molybdenum, Mo ^	mg/L	<0.005	[NT]	[NT]	Batch Spike	98%
Antimony, Sb ^	mg/L	<0.003	[NT]	[NT]	Batch Spike	94%
Selenium, Se ^	mg/L	<0.003	[NT]	[NT]	Batch Spike	105%
Silver, Ag ^	mg/L	<0.001	[NT]	[NT]	Batch Spike	87%
Nickel, Ni ^	mg/L	<0.002	[NT]	[NT]	Batch Spike	105%
Chromium, Cr ^	mg/L	<0.001	[NT]	[NT]	Batch Spike	99%

LABORATORY REPORT

NOTES:
LOR - Limit of Reporting.
This test is not covered by our current NATA accreditation.
^ This analysis was determined at our Sydney Laboratory, their reference 66515.

Analysis Date: **Between** 22/12/08 **and** 9/02/09

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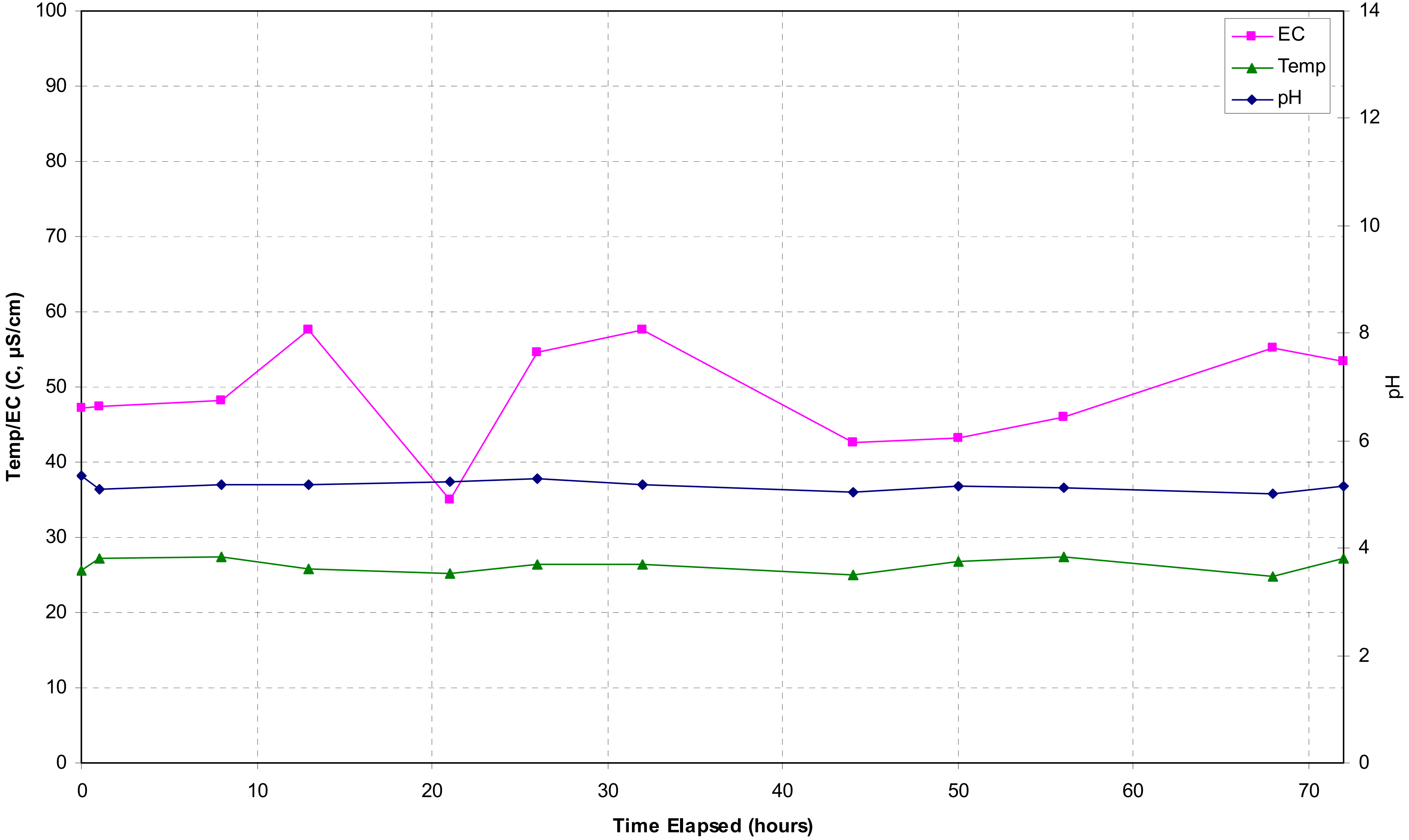
ACCREDITATION

APPENDIX E

FIELD WATER QUALITY SHEETS AND CHAIN OF CUSTUDY FORMS



CLIENT
Satori Resorts Ella Bay Pty Ltd

PROJECT
Ella Bay Groundwater Resource Evaluation

DRAWN SK
DATE Feb 2009
CHECKED
DATE

TITLE
Results of Water Quality Monitoring of PB1B During the 72 hour Pumping Test

SCALE Not to scale
PROJECT No 087673031
FIGURE No **APPEND-E1**
REV No **T**
A4

Golder Associates

216 Draper Street
CAIRNS QLD 4870

GROUNDWATER SAMPLING RECORD FORM
FIELD PARAMETER MEASUREMENTS

PROJECT INFORMATION

Client: Satori Resorts

Project No: 087673031

Project: Ella Bay Groundwater Exploration Program

Date of Sampling: 14/12/2008 1000

Location: Ella Bay, EB08- PB1B

Sampled By: Robin Davis (Brisbane)

GROUNDWATER BORE DATA

Diameter of Column (mm)	125
Diameter of Bore (mm)	150
Standing Water Level (m BGL)	13.60 *
Total Depth of Bore (m BGL)	29 m
Depth of Water in Column (m)	15.4
Standpipe stick up (m)	1

1 Bore volume =
189 L

BORE ID EB08- PB1B

Interface probe used?	Yes [✓ No]
Depth to product (m BGL)	NA
Depth to water (m BGL)	NA
Thickness of product (m BGL)	NA

PURGING RECORD

As a minimum purge 3 - 5 bore volumes or until 'dry' (for a 50 mm column and 150 mm bore, volume is ~ 7 L per m of water in the bore)

Volume Purged (L)	Dissolved Oxygen (mg/L)	Temperature (C)	TDS (ppm / ppt)	pH	Conductivity ([✓ uS], mS)	Redox Potential (mV)	Other	Other
21,600	—	26.7	—	5.13	48.3	—		

Total volume purged (L)	21,600	No. bore volumes purged	114	Purging Time (~~minutes~~)	2 hrs

(Prior to sampling consecutive measuements for pH vaule should be within 0.1 pH units, for conductivity, salinity and dissolved oxygen should be within 10% and temperature should be within 0.5 °C.)

SAMPLING RECORD

Samples Taken? [✓ YES] / NO
Duplicate sample taken? YES / [✓ NO]
Samples filtered? YES / [✓ NO] for Metals / other:
Filter Method: 0.45 µm filter & syringe / other :
Water Quality Meter type: Solinst model 101
Water Dipper type: TPS 90 - FLmV
Pumping Method: [✓ Submersible Pump] / Disposable Bailer / other:

Container:		**Preservation:**
Vial	☐	H_2SO_4 / other:
500ml Glass	☐	none / other:
500 ml Plastic	☐	none / other:
1 l Plastic	☐	H_2SO_4 / other:
200 ml Plastic	☐	NaOH / other:
200 mL Glass	☐	HNO_3 / other:

OBSERVATIONS

Samples: Colour: Clear
Odour: none
Turbidity [✓ Low] / Medium / High
Hydrocarbon sheen? Yes / [✓ No]

Weather Conditions: *Sampling Day* Rain 0 Temperature 33°
Previous Week Rain ~ 5 mm Temperature 33°

Notes: * Grab sample 2 hrs into 72-hour pumping test. Bore pumped at 3 L/S

Sampling procedures are based on AS/NZS 5667.11:1998 Water Quality - Sampling Part 11: Guidance on sampling of groundwaters

Golder Associates

216 Draper Street
CAIRNS QLD 4870

GROUNDWATER SAMPLING RECORD FORM
FIELD PARAMETER MEASUREMENTS

PROJECT INFORMATION

Client: Satori Resorts
Project No: 087673031
Project: Ella Bay Groundwater Exploration Program
Date of Sampling: 21/12/2008 1010
Location: Ella Bay EB08 - PB1B
Sampled By: Robin Davis (Brisbane)

GROUNDWATER BORE DATA

Diameter of Column (mm)	125
Diameter of Bore (mm)	150
Standing Water Level (m BGL)	13.60 *
Total Depth of Bore (m BGL)	29 m
Depth of Water in Column (m)	15.4
Standpipe stick up (m)	1

1 Bore vol = 189 L

BORE ID	EB06-PB1B

Interface probe used?	Yes [✓ No]
Depth to product (m BGL)	NA
Depth to water (m BGL)	NA
Thickness of product (m BGL)	NA

PURGING RECORD

As a minimum purge 3 - 5 bore volumes or until 'dry' (for a 50 mm column and 150 mm bore, volume is ~ 7 L per m of water in the bore)

Volume Purged (L)	Dissolved Oxygen (mg/L)	Temperature (C)	TDS (ppm / ppt)	pH	Conductivity ([✓ uS], mS)	Redox Potential (mV)	Other	Other
777,600	—	27.3	—	5.15	53.5	—		

Total volume purged (L)	777,600	No. bore volumes purged	4114	Purging Time (~~minutes~~)	72 hrs

(Prior to sampling consecutive measuements for pH vaule should be within 0.1 pH units, for conductivity, salinity and dissolved oxygen should be within 10% and temperature should be within 0.5 °C.)

SAMPLING RECORD

Samples Taken? [✓ YES] / NO
Duplicate sample taken? YES / [✓ NO]
Samples filtered? YES / [✓ NO] for Metals / other:
Filter Method: 0.45 μm filter & syringe / other :
Water Quality Meter type: TPS 90- FLMV
Water Dipper type: Solinst model 101
Pumping Method: [✓ Submersible Pump] / Disposable Bailer / other:

Container:		**Preservation:**
Vial	☐	H_2SO_4 / other:
500ml Glass	☐	none / other:
500 ml Plastic	☐	none / other:
1 l Plastic	☐	H_2SO_4 / other:
200 ml Plastic	☐	NaOH / other:
200 mL Glass	☐	HNO_3 / other:

OBSERVATIONS

Samples: Colour: Clear
Turbidity [✓ Low] / Medium / High
Odour: none
Hydrocarbon sheen? Yes / [✓ No]

Weather Conditions: *Sampling Day* Rain Ø Temperature 33°
Previous Week Rain ~ 2 mm Temperature 33°

Notes: Grab sample from collection bucket, water was not running. water from bucket is representative (only 20 min expired)

Sampling procedures are based on AS/NZS 5667.11:1998 Water Quality - Sampling Part 11: Guidance on sampling of groundwaters

Contact
Email : rdavis@golder.com.au

62126

CHAIN OF CUSTODY/ANALYSIS REQUEST

Golder Associates
216 Draper Street, CAIRNS QLD 4870

Phone: (07) 4051 2033
Fax: (07) 4052 1546

Page 1
of 1

Job No.: 087673031
Location: Ella Bay
Order No.: CQ-
Sampled By: Robin Davis
Contact: Robin Davis

TEST LOCATION	SAMPLE No.	No. OF BAGS	SAMPLE DATE	pH, EC	TDS	Major Ions	Alkalinity, Acidity	HMAnzecc (see attached)	F	SiO_3	Turbidity	TN	NH_3	NO_2	NO_3	TP
Ella Bay	EB08-PB1B-01		14/12/08	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ella Bay			14/12/08													
Ella Bay			14/12/08													
Ella Bay			14/12/08													
		(10am)														

TColi, Ecoli, Thermo ✓

TO BE COMPLETED BY LABORATORY

Samples Received In:
(Please tick appropriate box)

. Appropriate Containers ☑
. Pretreated Containers ☐
. Chilled State ☑
. Ambient State ☐
. Other *(Comment)*

1 Sample
4 bottles. 1 micro
1 SLP
2xAW

Recived: KoRielly 9am.

Special Instructions: Results required within agreed 7 day turnaround period, penalty rates will apply if received outside of this time.

Relinquished by: Date: 15-12-08 Relinquished by: Date: 15-12-08
Organisation: Time: Organisation: Time:

Local - Regional - Global/Local Forms/Environmental Forms/COC.doc

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Version 1, 05/98

SGS

CHAIN OF CUSTODY & ANALYSIS REQUEST

Job Reference Number: 62206
(SGS use only)

Page 1 **of** 1

Laboratory ID	**Client SAMPLE ID**	**Sample Date**	**Matrix**				**Preservation Method**					**Analysis Required:**												**Comments:**
			SOIL	**WATER**	**OTHER**		**NONE**	**ICE**	**ACID**	**OTHER**	pH, EC, TDS	major Ions	Alkalinity, Acidity	HMunzecc	F	SiO_3	Turbidity	~~[illegible]~~ TN	NH_3	NO_2	NO_3	TP	T coli, E coli, thermo	
	EB08-PBIB-02 1010 am.	21/12/08		✓				✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	

Company Name: Golder Associates
Address: 216 Draper Street
Cairns QLD 4870
Contact Name: James Begg / Robin Davis
Email address: rdavis@golder.com.au
Telephone: 07 4051 2033 **Facsimile:** 07 4052 1546

Client Order Number: 62126
Project Name: Ella Bay Groundwater Exploration
Project Number: 087673031
Results Required By: Normal Turn-around time

Laboratory Contact:
Total Number of Containers/Bottles: 4
Total Number of Samples/Sites: 1

Relinquished by: Robin Davis **Date:** 22/12/08 **Time:** 0945 **Received by:** **Date:** 22-12-08 **Time:** 9.45 am

Relinquished by: **Date:** **Time:** **Received by:** **Date:** **Time:**

* Circle whichever is applicable

Sample Cooler Sealed: [✓ YES]/NO*	**Samples Intact:** [✓ YES]/NO*	**Correct Sample Bottles Used:** [✓ YES]/NO*	**Temperature:** ~~AMBIENT~~/[✓ CHILLED]*

Comments including subcontracting details:

Hand copy

Please provide client with details ☐
Consent given for subcontracting ☐

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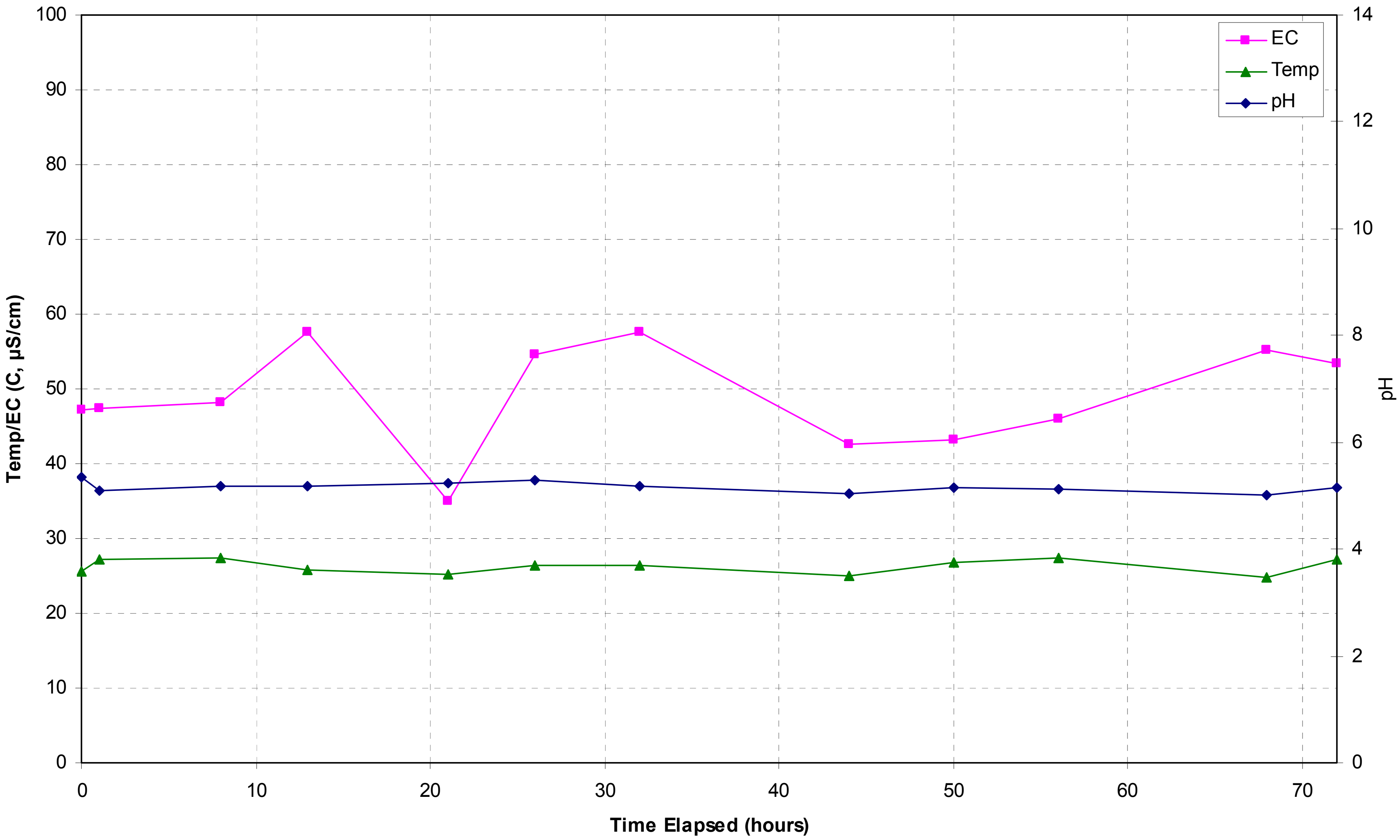
Ref: PF(AU)-[ENV]-[CAI]-OFF-16 / ver 9 / 20.02.07 / p1 of 1

SGS Australia Pty Ltd
ABN 44 000 964 278

Environmental Services Unit 2, 58 Comport Street, PORTSMITH QLD 4870 www.sgs.com
t +61(0)7 4035 5111. f +61(0)7 4035 5122 *e-mail:* shey.goddard@sgs.com

Member of the SGS Group

pls refer last job 62126



Golder Associates	CLIENT Satori Resorts Ella Bay Pty Ltd		PROJECT Ella Bay Groundwater Resource Evaluation	
	DRAWN SK	DATE Feb 2009	TITLE **Results of Water Quality Monitoring of PB1B During the 72 hour Pumping Test**	
	CHECKED RWD	DATE Mar 2009		
	SCALE Not to scale		PROJECT No 087673031	FIGURE No **APPEND-E1** REV No **T** **A4**

J:\Cairns.08\087673031_Ella_Bay\REPORT\Report Figures\Report Figures Landscape.ppt

APPENDIX F

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Golder Associates