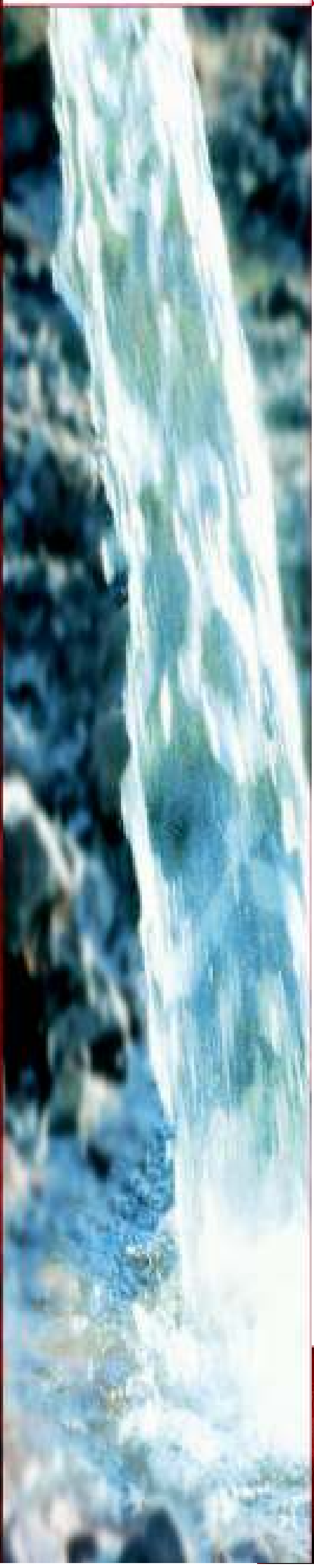
APPENDIX 18: GROUNDWATER ASSESSMENT – MYAMBA – ROCKWATER PTY. LTD. (2011)



Rockwater
PROPRIETARY LIMITED

PHILLIPS RIVER PROJECT

RESULTS OF HYDROGEOLOGICAL INVESTIGATIONS, TRILOGY POLYMETALLIC DEPOSIT

OCTOBER 2011

REPORT FOR
PHILLIPS RIVER MINING LTD

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1 INTRODUCTION

Phillips River Mining Ltd (previously Tectonic Resources NL) is planning to mine the Trilogy polymetallic deposit east of the Hopetoun - Ravensthorpe road, approximately 30 km south of Ravensthorpe (Fig. 1). A hydrogeological investigation programme was conducted in 2004 (Rockwater, 2004) to establish groundwater conditions and to assess pit dewatering requirements and the impacts of dewatering.

This report is an update of the 2004 report and a draft report prepared in December 2009; it includes the results of additional groundwater modelling to predict the fate of any water leaking from the planned integrated waste landform which will encompass the tailings storage facility (TSF); and a water storage facility (WSF), located as shown in Fig. 2. It is also planned to store tailings from the neighbouring Kundip deposits in the pit, once mining at Trilogy is completed.

2 HYDROGEOLOGICAL SETTING

2.1 CLIMATE

The Ravensthorpe area has a Mediterranean-type climate with cool winters and warm to hot summers. The average annual rainfall is 426 mm at Ravensthorpe (1901 to 2009) and 496 mm at Hopetoun North (1996 to 2009); potential annual evaporation is about 2,000 mm.

Monthly-average rainfalls at Ravensthorpe range from 22.6 mm (December) to 46.8 mm (July). Although there is generally more rainfall in winter, the weather is quite dry throughout the year.

2.2 GEOLOGY AND GROUNDWATER OCCURRENCE

The Trilogy deposit is located in an area of phyllitic schist and carbonaceous shale (with minor quartzite) of the Proterozoic Mount Barren Beds. These beds unconformably overlie Archaean rocks of the southern part of the Yilgarn Block.

The deposit lies in a relatively small fault block between the north-easterly trending Whoogarup Fault to the south and east, and an arcuate splay fault to the west and north (Witt, 1996).

The mineralisation occurs within a zone of silicified shale and minor sandstone that dips to the south-east at about 40 degrees. The hanging wall consists of laminated shale, which is vuggy and fractured in places: the footwall is more massive.

The siliceous mineralised zone forms the main aquifer. The permeability is associated with vugs and fractures, which also occur locally in the hanging wall and less commonly in the footwall (Fig. 3). The permeability is likely to decrease with increasing depth. The aquifer is assumed to extend along-strike to the south-west and north-east for an unknown distance – possibly as far as the faults described above. Generally there will be little groundwater flow in the footwall and other rocks of the Mount Barren Group that are away from the mineralised zone, other than possibly in the Kundip Quartzite, where it occurs.

The southern part of the TSF will overlie the mineralised zone, and the northern part of the WSF will overlie the hanging wall.

Groundwater levels are about 32 m below ground level.

3 EXPLORATORY DRILLING AND BORE CONSTRUCTION

Exploratory drilling for groundwater was conducted in January 2004 by Resource Drilling using a Schram T66H rig. Eight exploration holes were drilled and completed as monitoring bores, and the results were used to select a site for a test-production bore. The locations of the bores are shown in Figure 2.

3.1 MONITORING BORES

The pilot holes for the monitoring bores were drilled to depths ranging from 76 m (Bores TMB2, TMB5 and TMB8) to 160 m (Bore TMB3). Down-hole hammer, reverse-circulation methods were used, drilling at 200 mm diameter to 3 m and installing 154 mm diameter steel surface casing before drilling at 140 mm diameter to total depth. The bores were cased with 50 mm diameter PVC, slotted over aquifer intervals, and sealed at the surface using quickset cement. The bore construction details are summarised in Table 1, and are presented with geological and hydrogeological data in Appendix I.

Maximum airlift yields ranged from a trace in Bore TMB8 to 240 m^3/day in Bore TMB4. The airlift yields might under-estimate potential water production because of the drilling technique employed (reverse circulation) and small hole diameter. A cross-over sub was put in the drill string at various intervals to airlift the holes using direct circulation, but made no observable difference to flows.

The groundwater flows that were measured during drilling of TMB3 and TMB4 closely coincide with the silicified mineralised zone, indicating that this is the main water-bearing zone.

Static water levels ranged from about 51.34 m AHD in the north-west (TMB8) to 55.24 m AHD in the east (TMB6), indicating that the groundwater flows to the north-west towards tributaries of the Steere River; water-level contours are shown in Figure 4. The hydraulic gradient appears to be contrary to local and regional topography. This will need to be confirmed with water-levels measured in future monitoring events, as the water levels may have been affected by low recovery rates and/or air-entrainment.

The direction of groundwater flow is probably irrelevant to the planned mining at Trilogy, as the aquifer is interpreted to be isolated within rocks of very low permeability, and so any groundwater flow will be very slow and of low volume.

Salinities (by electrical conductivity) ranged from 15,200 mg/L TDS in TMB5 to 25,400 mg/L TDS in TMB4. Field pH measurements ranged from 3.3 in the mineralised zone to 8.0 in one of the regional monitoring bores (Table 1).

3.2 TEST PRODUCTION BORE

The test-production bore site (TPB1) was selected on the basis of the maximum airlift yield measured during the drilling of the monitoring bores. It is located about 10 m north-east of monitoring bore TMB4, where an airlift yield of 240 m^3/day was measured at 94 m depth. Bore TPB1 was drilled using down-hole hammer methods at 330 mm diameter to 6 m, with 254 mm diameter mild steel surface casing installed before drilling at 254 mm diameter to total depth (95.5 m).

The hole was cased with 152 mm diameter, Schedule 40 steel, slotted over the basal 30 m (64.8 m to 94.8 m) and open at the base. An annular seal, comprising a rubber ring attached to a steel flange, was installed above the slotted interval at 64.8 m to prevent the overlying clays from falling down the annulus and blocking the slots. The annulus was sealed at ground level with Gypset cement.

The bore was developed for three hours until the water was reasonably clear and free of fine drill cuttings. The final airlift yield was 255 m^3/d with salinity approximately 25,000 mg/L TDS (by electrical conductivity) and field pH about 3.8.

Bore construction details are provided in Appendix II and are shown in Figure 5.

Table 1 – Summary of Monitoring Bore Details

Bore	Exploration Site	Location (MGA)		Elevation	Depth Drilled	Slotted Interval	Top of Casing	Static Water Level	Maximum Airlift Yield	Salinity	Average Field pH[4]
		(mN)	(mE)	(m AHD)	(m bgl)	(m bgl)	(m agl)	(m btc[1])	(m^3/d)	(mg/L TDS)[2]	
TMB1	A	6 261 661	241 797	85.90	100	64 - 100	0.14	33.52	40	22,200	6.9
TMB2	F	6 262 136	242 037	89.58	76	46 - 76	0.32	37.57	40	16,400	8.0
TMB3	C	6 261 402	241 687	84.19	160	101 - 155	-	31.72	120	23,300	3.9
TMB4	D	6 261 441	241 619	85.64	100	58 - 94	0.36	33.56	240	25,400	4.4
TMB5	B	6 261 309	241 530	85.64	76	52 - 76	0.39	33.48	40	15,200	4.7
TMB6	G	6 261 406	242 267	86.37	82	58 - 82	0.5	31.93	35	16,900	6.2
TMB7	H	6 260 641	242 397	80.87	88	64 - 88	0.44	27.23	40	23,100	6.5
TMB8	E	6 261 841	240 877	90.26	76	46 - 76	0.31	39.61	Trace	16,500	6.8

1. Top of PVC casing, 28/1/2004
2. By electrical conductivity
3. Measured 1/2/04
4. Measured with pH paper.

4 WATER QUALITY

Water samples collected immediately before the end of the TPB1 constant-rate pumping test were analysed by SGS Laboratories – the sample analysed for metals was filtered and acidified. The results are presented in Appendix III. They indicate that water from the bore is saline (18,000 mg/L TDS) and of sodium-chloride type with relatively high concentrations of magnesium and sulphate.

The water was also very acidic, with a laboratory pH of 2.8, and it contained elevated levels of soluble iron (96 mg/L), zinc (160 mg/L) and lead (7.7 mg/L). TPB1 is open to the aquifer from 64.8 to 94.8 m depth, and draws most of the water from 88 to 94 m depth.

Acidic water with a field pH of 3.3 to 3.8 was intersected below 90 m depth in TMB4, and below 110 m depth in TMB3, in the siliceous mineralised zone. The water was apparently less acidic higher in the mineralised zone in TMB4 (about 5.6), although this could be an artefact of low flows and high silt content of the water. Near neutral or slightly alkaline groundwater was present in the surrounding country rocks.

The low pH groundwater in the mineralised zone and footwall is associated with a high sulphur content resulting from the various forms of pyrite. Sulphur generally ranges from 9 to 15% in the mineralised zone, and up to 40% in the overlying supergene zone (Dave Jackson, pers. comm.). There is less sulphur in the country rocks, typically 1 to 2%, where the groundwater is circum-neutral. The low pH below 90 m depth in TMB3 and TMB4 is also related to the relatively high sulphur content, which is up to 15% in the lower part of TMB4 and about 9% in TMB3. These high sulphur zones are well below the base of oxidation at about 40 m depth.

Permeability is associated with the mineralised zone, particularly where transitional from weathered to fresh. Most of the water will be pumped from this zone, and it is predicted that the low pH will dominate disproportionately in mixtures of acidic to slightly acidic groundwater (Graeme Campbell, pers. comm.). For example, pumping a mixture of water of pH 3.3 and pH 5.6 could result in a pH of about 3.5 to 3.6.

Further samples were collected from the production bore (TPB1) and TMB1 to test treatment requirements for the groundwater. The samples had a pH of 5.2 and 7.4, respectively. The testing indicated that the groundwater could be neutralised readily and economically by the addition of lime. The results are shown in Figure 6.

5 PUMPING TESTS

The production bore TPB1 was test-pumped to determine long-term pumping rates and aquifer characteristics. Bennett Drilling carried out the pumping test between 27 and 30 January 2004 using an electric submersible pump. Water levels were measured manually in the production bore and observation bores using a graduated electronic probe.

5.1 STEP-RATE TEST

A step-rate pumping test was conducted on 27 January 2004 at four flow rates (75, 150, 250 and 350 m^3/day) each for an hour, to determine an appropriate pumping rate for the 48-hour constant rate test: a discharge rate of 300 m^3/day was selected. Data and analyses for the step-rate tests are included as Appendix IV.

Because of anomalous results obtained from the constant-rate pumping test (Section 5.2), the results from the step-test were also used to assess the production bore efficiency using the Bierschenk and Wilson, and Sheahan's analyses. The analyses indicated that well losses in the bore are between 70 and 90 % for flow rates of 300 m^3/d; i.e. up to 90 % of the water level drawdown observed during pumping could be due to turbulent flow losses as water enters the bore, rather than drawdown in the aquifer. Reduced bore efficiency can result from partial penetration of the aquifer, low open area of the slotted casing (e.g. from narrow slot aperture or widely spaced slots in the casing), or the effects of air or gas in the groundwater.

5.2 CONSTANT RATE TEST

Production bore TPB1 was pumped at a constant rate of 300 m^3/day for 48 hours from 28 January 2004. Water levels were monitored during the test in the pumped bore (Fig. 7), and in monitoring bores TMB1 to TMB6 and TMB8. Significant water level drawdowns were observed only in monitoring bores TMB3 to TMB5 (Fig. 8). Minor water level variations in bores TMB1, 2, 6 and 8 (Fig. 9) were most likely due to changes in barometric pressure.

Difficulties were experienced in maintaining a constant flow rate during the test because of unusually high gas content in the water (probably air entrained during drilling).

The final water level drawdown in the production bore was 23.2 m, compared to a drawdown of 2.1 m in monitoring bore TMB4, only 10 m away. Monitoring bore TMB4 is along-strike of the production bore and at that distance should have had similar water level drawdowns to those in the production bore. The large discrepancy is probably due mainly to reduced bore efficiency (see Section 5.1), and possibly restricted hydraulic connection between the two bores.

Similarly, water level drawdowns of only 0.45 m in monitoring bore TMB3 (about 75 m away) and 0.96 m in monitoring bore TMB5 (about 160 m away) are also likely to be the result of low aquifer drawdown around the production bore, and possibly restricted hydraulic connection between these monitoring bores and the production bore. In addition, the distribution of water level drawdown, with larger drawdowns observed in TMB5 than TMB3 which is closer to the production bore, suggests the aquifer is anisotropic with higher hydraulic conductivities occurring along-strike than across-strike. Contours of final water level drawdowns in the monitoring bores are illustrated in Figure 10.

The water level drawdown trends observed in monitoring bores TMB3 to 5 (Fig. 8) are typical of a strongly bounded aquifer, and suggest that the aquifer is of limited extent and is surrounded by rocks of low permeability. However, the water-level drawdown trend in the production bore is typical of a laterally-extensive aquifer (with no obvious boundary effects), and so the trends observed in the monitoring bores are probably due more to restricted hydraulic connection between the bores in the early stages of pumping, rather than aquifer response.

Analysis of the drawdown in TPB1 (Fig. 7) using Theis and Cooper-Jacob methods indicates a hydraulic conductivity of about of about 0.4 m/d, although assessment of water level data corrected for 70 % well loss and late time recovery data suggest the hydraulic conductivity could be higher, in the order of 1.5 to 4 m/d. Analysis of the drawdown in the observation bores using the same methods, indicates hydraulic conductivities ranging from about 0.8 to 17.4 m/d (average about 8 m/d), and storage coefficients ranging from 0.0008 and 0.001. The results are provided in Table 2. Variable hydraulic conductivity is typical in a fractured rock aquifer; however, some of the higher values are probably the result of the restricted hydraulic connection with the pumping bore, and are therefore higher than true values.

Table 2 – Calculated Hydraulic Conductivities and Storage Coefficients

Bore	Final Water Level Drawdown (m)	Hydraulic Conductivity (m/d)	Storage Coefficient
TPB1	23.29	0.4	-
TMB3	0.45	3.5	0.001
TMB4	2.11	0.8	0.002
TMB5	0.96	0.9	0.0008

A duty pumping rate of 250 m^3/d is recommended for bore TPB1.

6 NUMERICAL MODELLING OF PIT DEWATERING

It is planned to excavate the pit to about 140 m depth over a period of five years; followed by underground mining to 45 m depth below the pit over three years. The pit outline is shown in Figure 2. The underground workings and base of the pit (to 44 m below the current static water level) will be back-filled with tailings from the neighbouring Kundip project. It is likely that additional mining at Kundip will eventually result in tailings from Kundip backfilling the pit to above the static water level.

The numerical groundwater model was constructed using structural data provided by Tectonic Resources, data obtained from the water exploration drilling and pumping test, the Ravensthorpe 1:250,000 geological series map (Thom et al, 1977), and qualitative information derived from inspection of cores and from core logs. The model was designed to estimate likely dewatering pumpage requirements, and the impacts of dewatering pumping and infiltration from the TSF and WSF.

6.2 DESCRIPTION OF GROUNDWATER MODEL

The groundwater model uses Processing Modflow Pro, which incorporates Modflow, the industry-standard finite-difference groundwater modelling software designed by the U.S. Geological Survey (McDonald and Harbaugh, 1988). It consists of a variable rectangular grid of 59 rows, 53 columns and two layers covering an area 5.2 km east-west by 4.4 km north-south centred on Trilogy (Fig. 11). Model cells range in size from 25 m x 25 m at Trilogy, to 500 m x 500 m in some peripheral areas.

Layer 1 represents the phyllitic schist and schistose black shales of the footwall to 60 m depth; weathered mineralised zone to 50 m depth; and the hanging-wall rocks, all of which did not yield any significant water flows during drilling. Layer 2 represents the footwall to 100 m depth; fractured water-bearing zones, predominantly in the siliceous mineralised zone and overlying supergene zone of the planned pit area to 280 m depth; as well as unfractured shale of the hanging-wall to the east. The aquifer interval was contoured from water intersections identified during drilling, and is between 6 m and 40 m thick. Groundwater levels were assumed to be at 32 m below ground level (bgl).

Model boundaries were assumed to be no-flow boundaries, except for constant heads on the north-western and south-eastern boundaries in Layer 1 to represent flow into and out of the modelled area.

Values of hydraulic conductivity and storage coefficient derived from the pumping test results (Table 2) were used as initial values in the model, and varied during calibration.

Other assumptions made in assigning initial aquifer parameters include:

- The aquifer is areally extensive;
- The aquifer is anisotropic, with higher hydraulic conductivities along-strike than across-strike;
- Recharge to the aquifer is insignificant over the period of dewatering – sensitivity analysis using the model indicates that recharge would be less than 2 % of the annual rainfall;
- Vertical hydraulic conductivity is one tenth of horizontal hydraulic conductivity.

Values of hydraulic conductivity, storage coefficient and anisotropy were varied during the model calibration, as described in Section 6.2. Adopted model parameters after calibration are given in Table 3.

Table 3 – Adopted Model Parameters

Parameter		**Trilogy Deposit**	**Adjoining Areas**
Horizontal Hydraulic Conductivity (K_H):	Layer 1	0.1 m/d	0.1 m/d
	Layer 2	0.2 to 1.4 m/d	0.1 to 0.2 m/d
Specific Yield:	Layer 1	0.01	0.01
	Layer 2	0.01	0.01
Storage Coefficient:	(Layer 2)	0.004	0.004
Anisotropic Ratio (= K_H across strike/K_H along strike)	Layer 2	0.08	0.08
Recharge:		0 mm/d	0 mm/d
Static Groundwater Level:		53 m AHD	48–57 m AHD

6.3 MODEL CALIBRATION

After steady-state calibration to measured static water levels, the model was calibrated in transient mode to the pumping test results for TPB1 using the water level drawdowns in monitoring bores TMB3 to TMB5, and the drawdown trend (but not the drawdowns themselves) observed in the production bore after adjustment for well losses. Model-calculated water level drawdowns after calibration are compared with measured drawdowns and extrapolated trends in Figure 12, and modelled water-level contours after 48-hours pumping are shown in Figure 13.

The results indicate an acceptable correlation between the extrapolated and modelled drawdown trends, particularly in bores TMB3 and TMB5. There was almost 2 m difference in calculated and measured water levels in TMB4 at the end of the test, but extrapolated trends indicate the two curves may converge with extended pumping. It is difficult to model drawdowns at such a close distance to the pumped bore. Also, there was very little drawdown measured in TMB1, whereas about 0.5 m was predicted by the model

(Fig. 13) as would be expected from the 0.96 m drawdown measured in TMB5 at a slightly smaller distance from the pumped bore and also along-strike. It is likely that TMB1 is only partially open to the fractures intersected by the pumped bore.

The duration of the pumping test was limited by the practicability of providing a suitable storage for the saline water pumped during the test. It is difficult to adequately calibrate a groundwater model to such a pumping test because:

- The modelling software is designed for a homogeneous aquifer with primary porosity, whereas the Trilogy aquifer is highly heterogeneous; and
- The aquifer could not be stressed sufficiently to see water-level changes in the mineralised zone and in surrounding country rocks except close to the pumping bore.

For this and other similar projects the model predictions are used to obtain a first estimate of likely dewatering flows and impacts. Sensitivity analyses are used to determine the likely range of flows. The model should be re-calibrated to monitoring data once dewatering has been underway for several months so that more-accurate predictions can be made.

6. 4 MODEL RUNS

The Trilogy pit is planned to be mined over five years to a total depth of 140 m, with the pit depth increasing by 20 m to 50 m each year. Underground workings will then continue for a further 45 m below the base of the pit over three years.

There are permeable fractures and vugs in the mineralised zone, and to a lesser degree in the hanging-wall, extending down to 150 m depth, and there could be other open fractures at greater depths. Dewatering was simulated using Modflow's well package to simulate pumping from bore TPB1 and two additional bores located on the edge of the ramp and screened in the mineralised horizon. The total pumping capacity of the three bores might be about 550 m^3/d initially, decreasing as water levels are lowered. It is very unlikely that bores alone can be used for dewatering, and to lower groundwater levels ahead of mining. Modflow's drain package was used to estimate flows that will report to pit and underground drains and sumps.

The model was also used to assess the potential impacts of any water leaking from the TSF and WSF. The storages are to be lined with compacted clay and there will also be an under-drainage system in the TSF. These features will greatly restrict unrecovered seepage rates: Coffey Mining (2011) calculated that unrecovered seepage from the TSF will be 19 m^3/d; and that from the WSF will be 35 m^3/d. These rates were used as inputs in the model.

Tailings from the Kundip project are planned to be placed back in the Trilogy pit to a level 44 m below the current static water level, i.e. about 76 m below ground level. The model was used to calculate groundwater inflows to the pit at various stages of water-level recovery following mining, and these were used with other components of the water balance to assess the nature of the final mine void.

Ultimately, the pit may be backfilled with tailings to 5 m or more above the water-table level. This will result in the water-table recovering to around its current level (or possibly higher due to enhanced recharge conditions) and will prevent the continued oxidation of rocks in the pit walls.

6.4.1 Modelling Results

Dewatering Flows

The modelling results indicate that average (annual) pumping rates of up to 2,800 m^3/d – from bores and/or in-pit sumps – will be needed to dewater the pit ahead of mining (Table 4).

Table 4 – Estimated Average Dewatering Flow Rates (m^3/d)

Year	Lowest Mine Level		Av. Flow
	(m RL)	(m Depth)	m^3/d
-1	1,070	15	600
1	1,020	65	2060
2	995	90	2330
3	975	110	2560
4	930	155	2380
5	900	185	2550
6	900	185	2750

Pumping rates in the later stages of mining will depend to some degree on the extent of fractures that transport groundwater towards the pit. Also, flow rates could be significantly less than calculated in Years 4 to 6 if the base of the aquifer is at 150 m depth, as has been assumed (the model uses the same aquifer parameters for the entire model layer, and cannot replicate any decrease in permeability with depth).

Water-Level Drawdowns

The modelling results suggest that water-level drawdowns could be 14 to 15 m at a distance of 2.5 km along-strike of the mine to the south-west and north-east; and up to 1 to 2 m at a distance of 1.6 to 1.7 km across-strike to the south-east and north-west. There is a lot of uncertainty in these estimates – the actual magnitude and extent of drawdowns will depend on the continuity of rock units, cross-cutting faults, variations in permeability and storativity, and recharge from rainfall and streamflows. However, it is unlikely that there will be any measurable drawdowns at the nearest house located across-strike, about 2.5 km to the south-south-east.

Impact of Planned TSF and WSF

The numerical groundwater model was also used to assess the impact of the planned tailings (TSF) and water (WSF) storage facilities, using the seepage rates provided by Coffey Mining. Water from the tailings will drain to the northern end of the TSF, and so any seepage would be from that end.

PMPATH (Pollock, 1989), particle-tracking software, was used to determine the fate of any water leaking from the TSF and WSF. The results (Fig. 14) show that any water leaking from these storages would flow to the pit. Minimum travel times are indicated to be nine years from the TSF and three years from the WSF. Flows from these storages will decrease as they dry out and the thickness of tailings increases; and if the pit is back-filled with tailings and the water table recovers to around its current level.

6.4.2 Sensitivity Analysis

The model was run to test the sensitivity of the calculated dewatering pumping rates to variations in aquifer parameters for the adopted case of mostly no-flow (barrier) boundaries; and if all the boundaries were represented as constant-head (C.H.) boundaries. The results are shown in Table 5.

Table 5: Results of Sensitivity Analysis

Year	Adopted (Barriers) m^3/d	All C.H. Boundaries m^3/d	SY * 3 m^3/d	SY / 2 m^3/d	KH * 3 m^3/d	KH / 3 m^3/d	KV / 3 m^3/d	Sc * 3 m^3/d	Sc / 3 m^3/d
-1	600	600	600	600	600	600	600	600	600
1	2064	2067	2732	1822	4593	976	1934	2351	1881
2	2331	2343	2851	2134	5214	1086	2130	2607	2224
3	2563	2600	3180	2354	6250	1130	2528	2814	2452
4	2384	2445	2727	2264	6144	970	2376	2473	2346
5	2546	2623	2823	2431	6657	990	2497	2623	2493
6	2746	2860	3064	2624	7280	991	2449	2889	2688

The results show that the predicted dewatering flows are most sensitive to horizontal hydraulic conductivity (KH) and that annual average peak flows could possibly range from

1,100 to 7,000 m^3/d. The next sensitive parameter is specific yield (SY), followed by the storage coefficient (SC) for Layer 2. The model is insensitive to the nature of the model boundaries, and to vertical hydraulic conductivity (KV).

6.4.3 Nature of Final Void

The numerical groundwater model was used with a water balance to assess the nature of the final pit void.

Groundwater inflows to the mined-out pit, back-filled with tailings to about 76 m below ground level, were estimated by allowing groundwater levels to recover in the numerical model and calculating the inflows at various pit water levels. These are included in the water balance given in Table 6.

Table 6: Pit Void Water Balance at Various Water Levels

RLWL (m) Mine Datum	Inflows (m^3/d)	Rainfall (m^3/d)	Evaporation (m^3/d)	Balance (m^3/d)
1007	237	209	210	236
1010	195	209	235	169
1020	95	209	291	13
1030	45	209	381	-127
1040	13	209	469	-247
1045	5	209	493	-279
1047	3	209	502	-290

The values in the last column “Balance” are groundwater inflows plus rainfall accumulation minus evaporative losses.

The rainfall accumulation value is 80 percent of the average annual rainfall within the planned pit perimeter, on a daily basis. Evaporation losses are taken to be the average dam evaporation rate (Luke, Burke and O’Brien, 1988) over the area of open water for each pit water level.

It can be seen from Table 5 that inputs and outputs are in balance when the pit water level is at about 1021 m RL, i.e. about 32 m below the natural water table level. The final pit void as planned will, therefore, be a permanent groundwater sink. It is calculated that it will take about 20 years for the water level in the final void to reach its equilibrium level.

The magnitude of water-level drawdowns around the final void is uncertain as the drawdowns will depend on recharge rates and the continuity and extent of aquifers. It is estimated that they will be about 8 m at a distance of 2.5 km along-strike of the mine to the south-west and north-east; and about 1 m at a distance of 1.6 to 1.7 km across-strike to the south-east and north-west.

6.5 DISCUSSION OF MODELLING RESULTS

The modelling results assume that the aquifer extends about 2.3 km along-strike to the north-east and south-west of the planned pit (although it is modelled as having lower permeability outside of the Trilogy area). The model was calibrated to the drawdown trend observed during test-pumping of the production bore for two days. After an extended period of pumping, the rate of water-level decline could increase if the expanding drawdown cone intersects other, less-distant boundaries to the aquifer. If that was the case, then the average dewatering rates could be lower: around half of those indicated. Conversely, pumping rates could be higher if the zone of high permeability extends further along-strike of the Trilogy deposit; or if the rocks are more permeable or contain more water in storage than has been assumed.

The model should be re-calibrated to monitoring data after dewatering has been in progress for several months and the predicted dewatering flows updated.

It is very unlikely that dewatering bores alone will be capable of achieving the dewatering required, and so in-pit and underground drains and sumps will be needed. There will be seepages in the pit walls unless horizontal drain holes are installed to reduce heads behind the walls.

The seepage rates calculated by Coffey Mining indicate that the TSF and WSF will retain almost all of the water they contain until it is evaporated or used for mining purposes. The minor seepage is indicated to flow slowly towards the Trilogy Pit.

Tailings from the Kundip deposits that are to be placed in the Trilogy pit will be below the long-term water level in the pit. If mining at Kundip is more extensive than planned tailings could be deposited in the Trilogy pit to above the current static water level which would then be similar to the long-term post-mining water level. Any tailings to be placed above the final pit water level should be Non Acid Forming (NAF).

The final pit void as planned will become a permanent groundwater sink. Water in the pit will be acidic, contain metals and gradually become more saline, but there will be no potential for water to flow away from the pit. Should the pit be filled with tailings to above the natural static water level it could potentially become a groundwater through-flow feature. However, it is surrounded by rocks of low permeability and will be filled with low-permeability tailings and so it is very unlikely there would be any significant seepage of groundwater away from the back-filled pit. Also, there are no known groundwater users or groundwater-dependent ecosystems that could be impacted by the pit and tailings storage. Consequently, the pit should be suitable for tailings storage from a hydrogeological perspective.

It is recommended that existing monitoring bores and the planned dewatering bores be used to monitor groundwater levels and quality before, during and after mining. As a contingency measure, the dewatering bores could be pumped to recover any contaminated groundwater.

7 ADDITIONAL MONITORING BORES

Some additional monitoring bores are recommended to measure the impacts of dewatering and seepage from the WSF and TSF. The recommended positions (approximate) are shown in Figure 2 – these can be altered to suit planned mine-site infrastructure.

8 SUMMARY AND CONCLUSIONS

Eight groundwater exploration holes were drilled to test the carbonaceous shale host rock and fractured/mineralised zones of the Trilogy orebody, and rocks in the footwall and hanging-wall. Airlift yields from the holes ranged from less than 20 m^3/d to 240 m^3/d, with only two holes having airlift yields of more than 50 m^3/d. The groundwater is contained within fractures, joints and vugs in the silicified shales of the mineralized zone and overlying supergene zone.

The groundwater has a salinity of about 18,000 mg/L TDS. In the mineralised zone and underlying footwall the water is acidic, with pH as low as 2.8 in the deeper parts of the aquifer. The high acidity and mineralised nature of the aquifer has resulted in highly elevated concentrations of some metals, including soluble iron (96 mg/L), zinc (160 mg/L) and lead (7.7 mg/L). Groundwater outside of the mineralised zone is circum-neutral: mixing this water with low pH water from the mineralised zone is unlikely to result in a significant increase in pH of the pumped water.

Testing has indicated that treatment of the groundwater with lime is technically and economically feasible. If treatment is undertaken, water contained in the WSF will have a neutral pH, and therefore should have reduced metal concentrations.

A test production bore (TPB1) was constructed about 10 m along-strike of the highest yielding exploration hole (TMB4) and test-pumped. The pumping test results indicated low bore efficiency in the production bore, with water level drawdowns much greater than those observed in nearby TMB4. This may be due to factors such as small open-area of slotted casing, air entrainment in the aquifer and/or restricted hydraulic connection between the production bore and TMB4.

Numerical modelling results indicate that average pumping rates of up to 2,800 m^3/d could be needed to lower the groundwater levels during mining. In-pit bores and sumps will be needed to achieve the required dewatering – bores alone will not be sufficient. It may be feasible to install dewatering bores on the south-western and north-eastern sectors of the pit perimeter, or on the edge of the pit ramp. Horizontal drillholes will be needed to lower heads behind the pit walls.

Sensitivity analyses indicate that actual pumping rates could be significantly higher or lower than indicated by the modelling, depending on the hydraulic conductivities and specific yield. It is recommended that pumpage, water levels and water quality be closely monitored during initial dewatering, so that the hydraulic characteristics and water chemistry of the site can be confirmed and if necessary the model can be re-calibrated to re-assess the pumping rates required.

Any water leaking from the tailings and water storages sub-surface is indicated to flow towards the pit rather than off-site. The seepage rates will be very low as the storages are to be lined with compacted clay of low permeability and there will be under-drains to collect seepage in the TSF. Water seeping from the TSF is indicated to take at least nine years to reach the pit.

The final pit void as planned will become a permanent groundwater sink. Water in the pit will be acidic, contain metals and gradually become more saline, but there will be no potential for water to flow away from the pit. Should the pit be filled with tailings to above the natural static water level it could become a groundwater through-flow feature. However, it is surrounded by rocks of low permeability and will be filled with low-permeability tailings and so it is very unlikely there would be any significant seepage of groundwater away from the back-filled pit. Also, there are no known groundwater users or groundwater-dependent ecosystems that could be impacted by the pit and tailings storage.

Dated: 4 October 2011 **Rockwater Pty Ltd**

K J Rattray
Principal Hydrogeologist

P H Wharton
Principal

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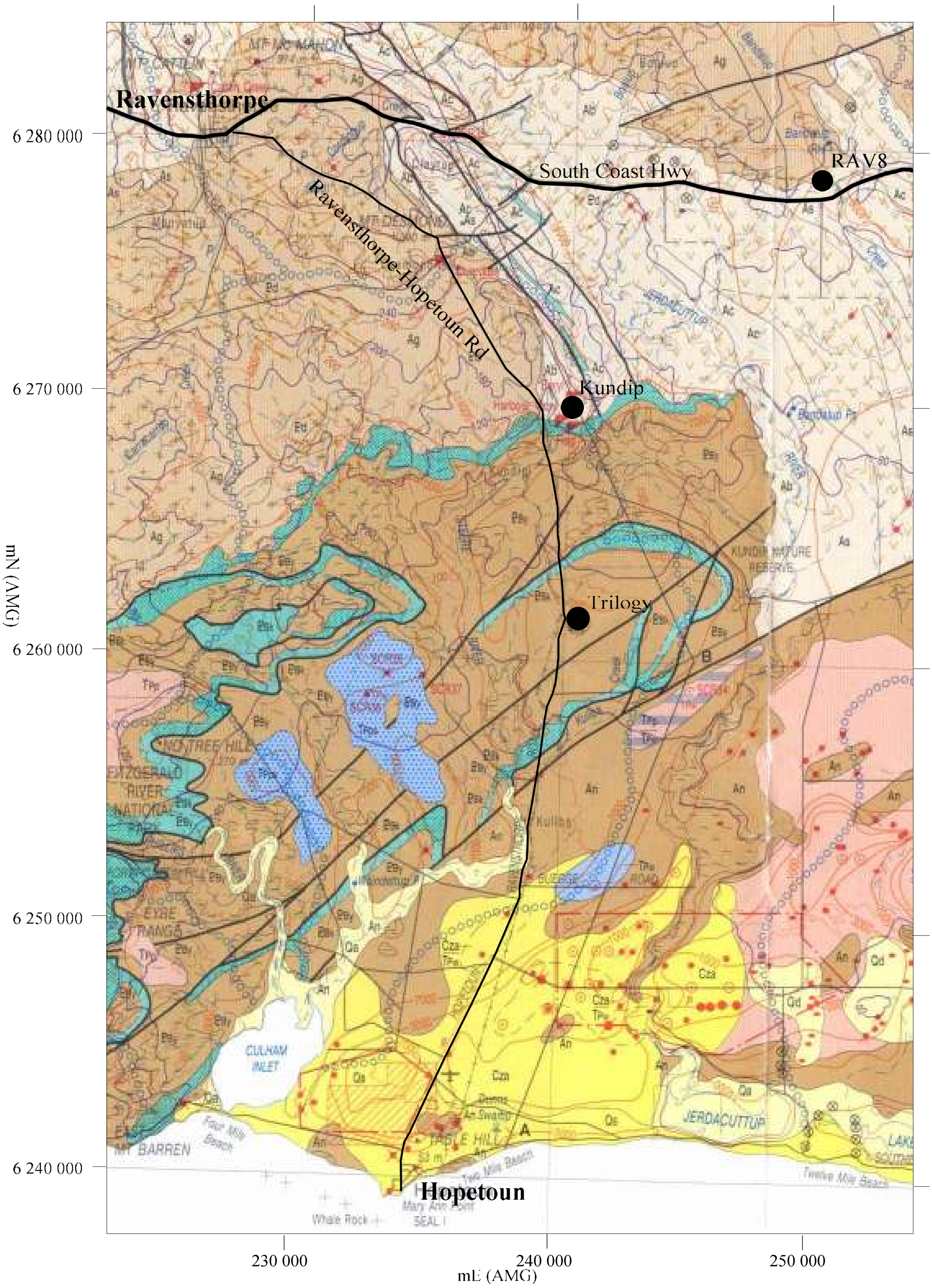
Thom R., Lipple SL. and Sanders CC., 1977, 1:250,000 Geological Series Explanatory Notes – Ravensthorpe, Western Australia. Geological Survey of Western Australia Sheet SI/51-5.

Witt, W. K., 1996, Ravensthorpe, W.A. Sheet 2930: Western Australia Geological Survey 1:100 000 Geological Series.

FIGURES

Figure 1



Geol Locmap.srf

Base map from GSWA 1:250,000 Series Hydrogeological Map - Ravensthorpe

CLIENT: Tectonic Resources NL

PROJECT: Phillips River (Trilogy)

DATE: January 2011

Dwg. No: 253.1/11/1-1

TRILOGY DEPOSIT
LOCATION MAP

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Figure 2

TPB1 Production bore

TMB1 Monitoring bore

Rec. Additional Monitoring Bore

SCALE 1:15 000

0m 200m 400m

A A' Section Line Fig. 3

site location plan.srf

CLIENT: Tectonic Resources NL

PROJECT: Phillips River (Trilogy)

DATE: September 2011

Dwg No: 253.1/11/1-2

TRILOGY LOCATION PLAN

Rockwater Pty Ltd

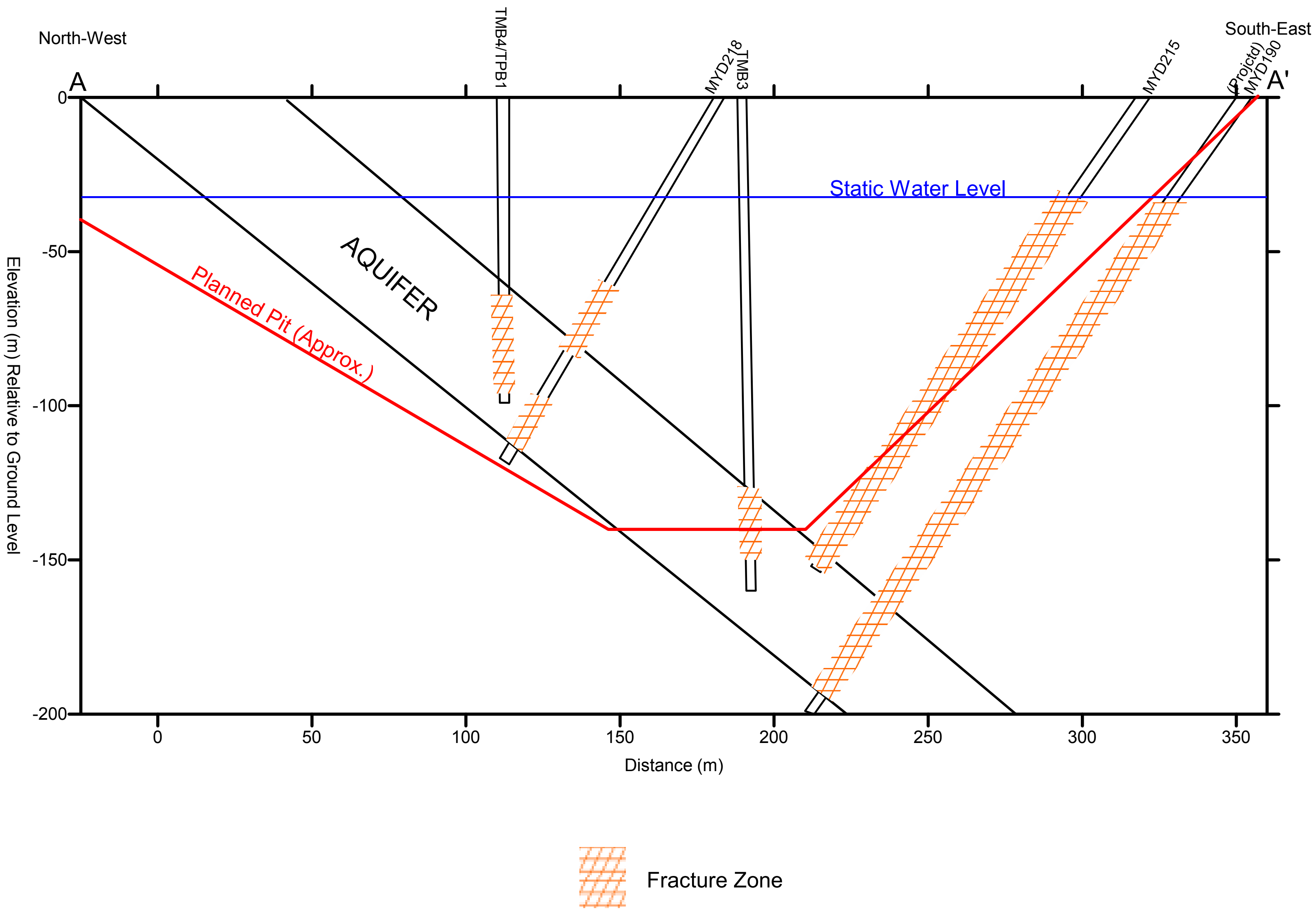

Figure 3

section.srf

CLIENT: Tectonic Resources NL

PROJECT: Phillips River (Trilogy)

DATE: August 2011

Dwg No: 253.1/11/1-3

HYDROGEOLOGICAL SECTION

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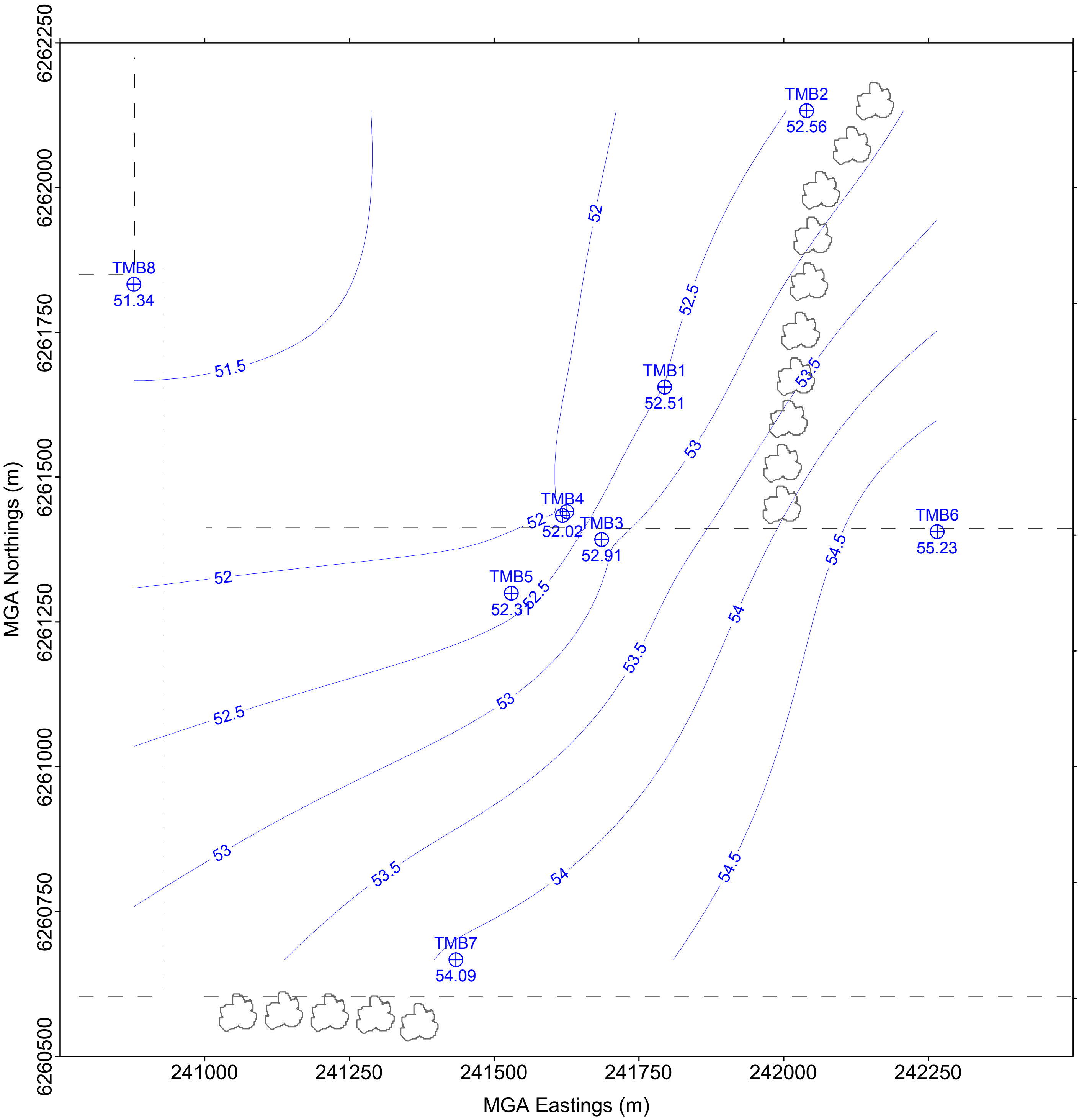
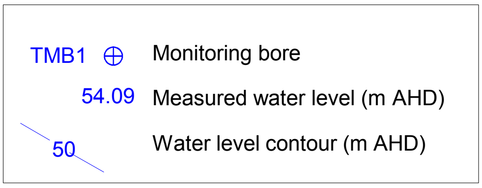
Figure 4





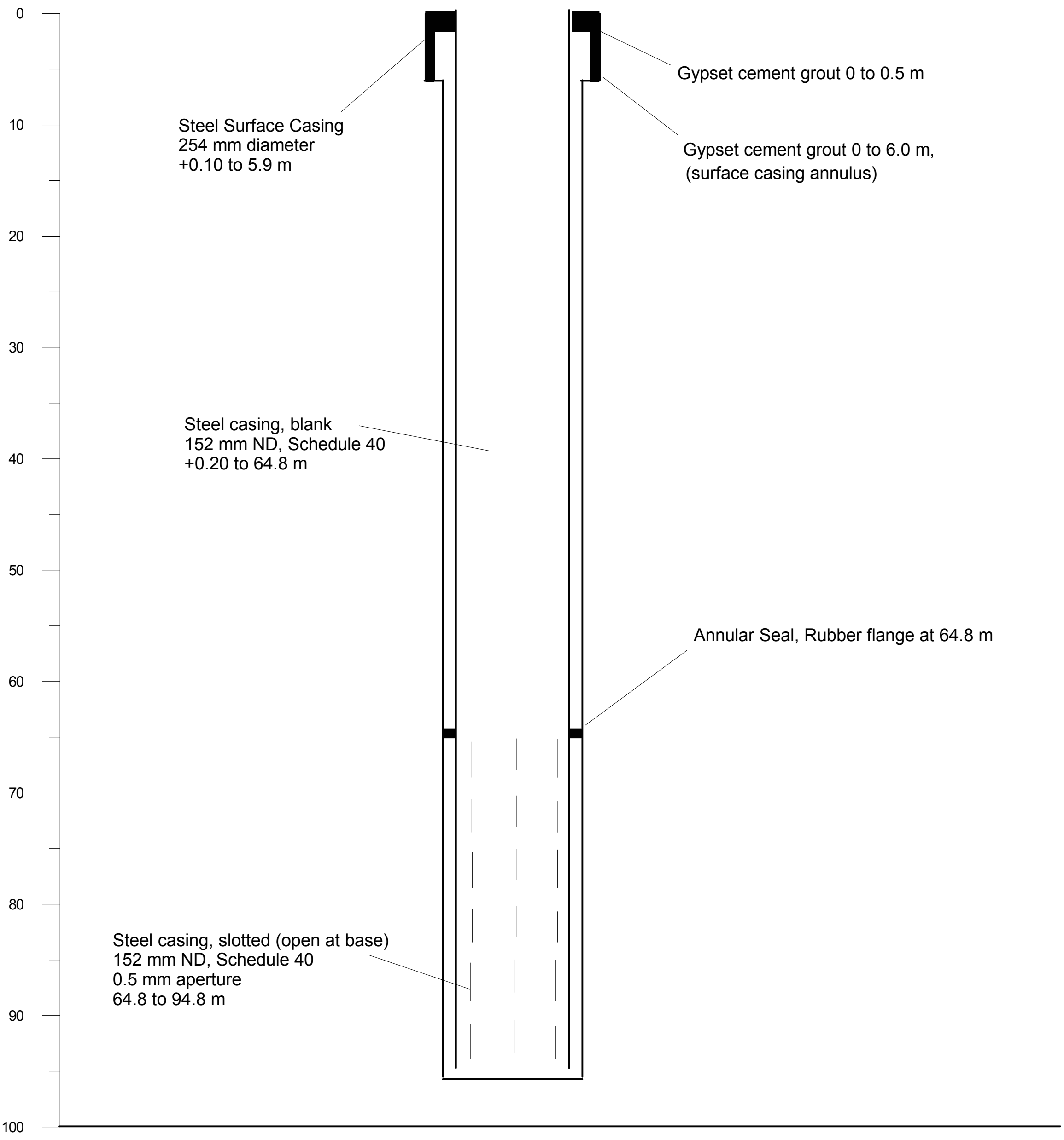
SCALE 1:10 000

0m 200m 400m

WL contours 2-2-04.srf

CLIENT: Tectonic Resources NL	TRILOGY WATER LEVEL CONTOURS (m AHD) 2 FEBRUARY 2004
PROJECT: Phillips River (Trilogy)	
DATE: August 2011	
Dwg No: 253.1/11/1-4	Rockwater Pty Ltd

Figure 5



DRILLING DETAILS

0 to 6 m	330 mm diameter down-hole hammer
6 to 95.5 m	254 mm diameter down-hole hammer

TPB1 diagram.grf

Client: Tectonic Resources NL

Project: Phillips River (Trilogy)

Date: August 2011

Dwg. No: 253.1/11/1-5

PRODUCTION BORE TPB1
BORE CONSTRUCTION DIAGRAM

Client: Tectonic Resources NL
Project : Phillips River (Trilogy)
Date : August 2011
Dwg. No: 253.1/11/1-6

GROUNDWATER TREATMENT
pH vs ALKALI DEMAND

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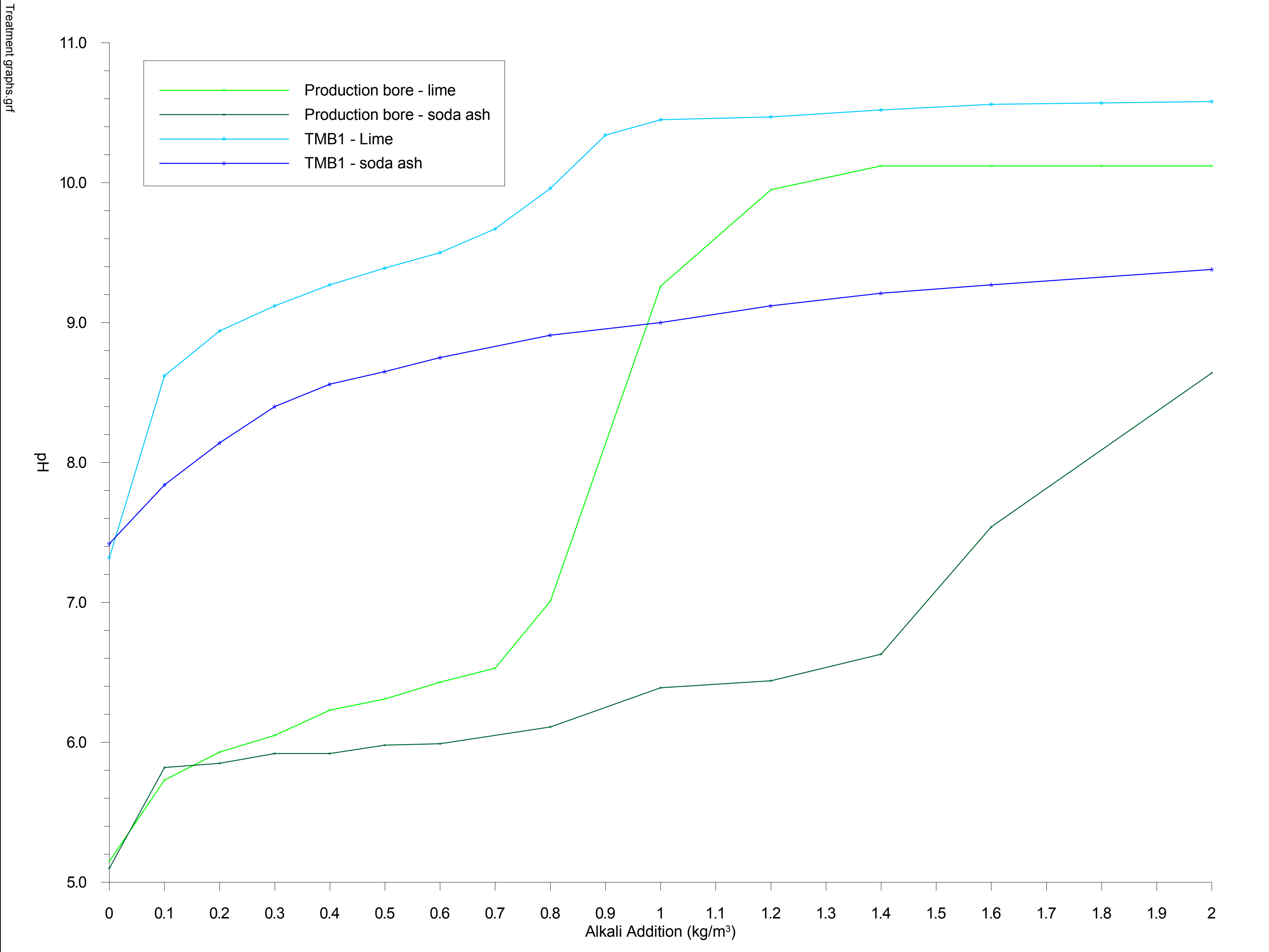
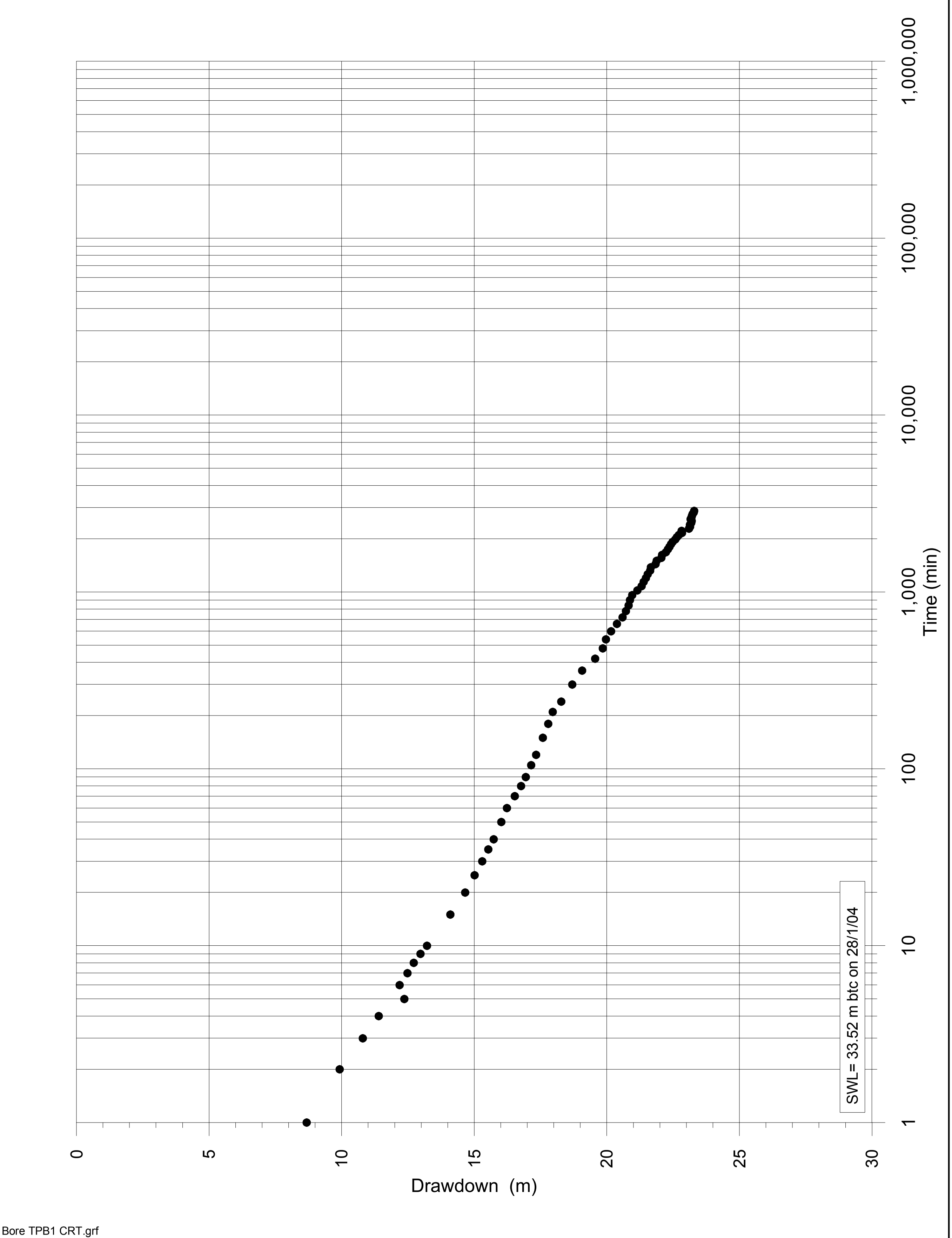


Figure 6

Figure 7



Bore TPB1 CRT.grf

Client: Tectonic Resources NL

Project : Phillips River (Trilogy)

Date : August 2011

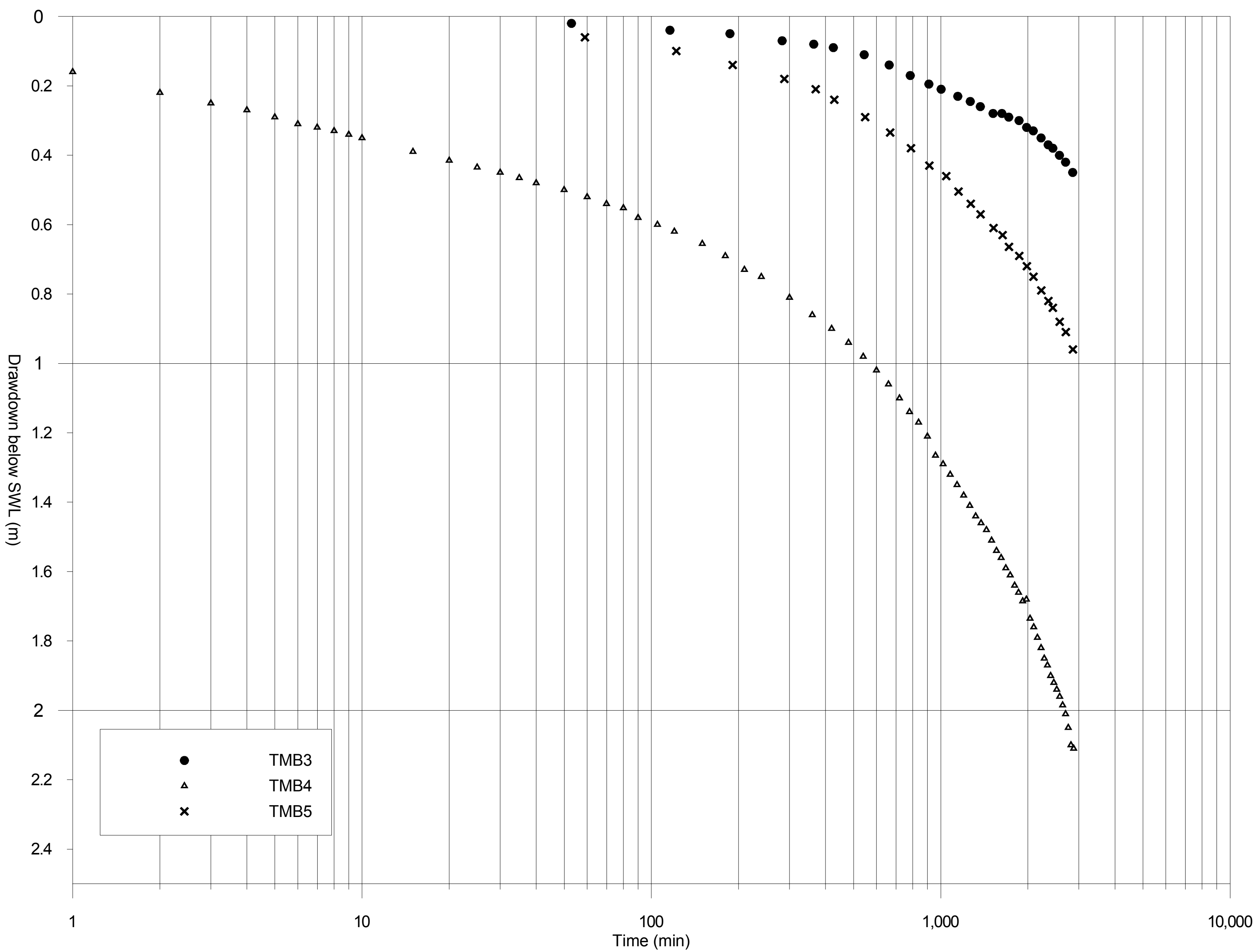
Dwg. No: 253.1/11/1-7

TPB1 CONSTANT RATE PUMPING TEST
DRAWDOWN IN PRODUCTION BORE
48 hours, 300 m^3/day

Rockwater Pty Ltd

Client: Tectonic Resources NL
Project : Philips River (Trilogy)
Date : February 2011
Dwg. No: 253.1/11/1-8

TMB3-5 mon CRT.grf



TPB1 CONSTANT RATE PUMPING TEST
Drawdown in Monitoring Bores TMB3, TMB4 & TMB5

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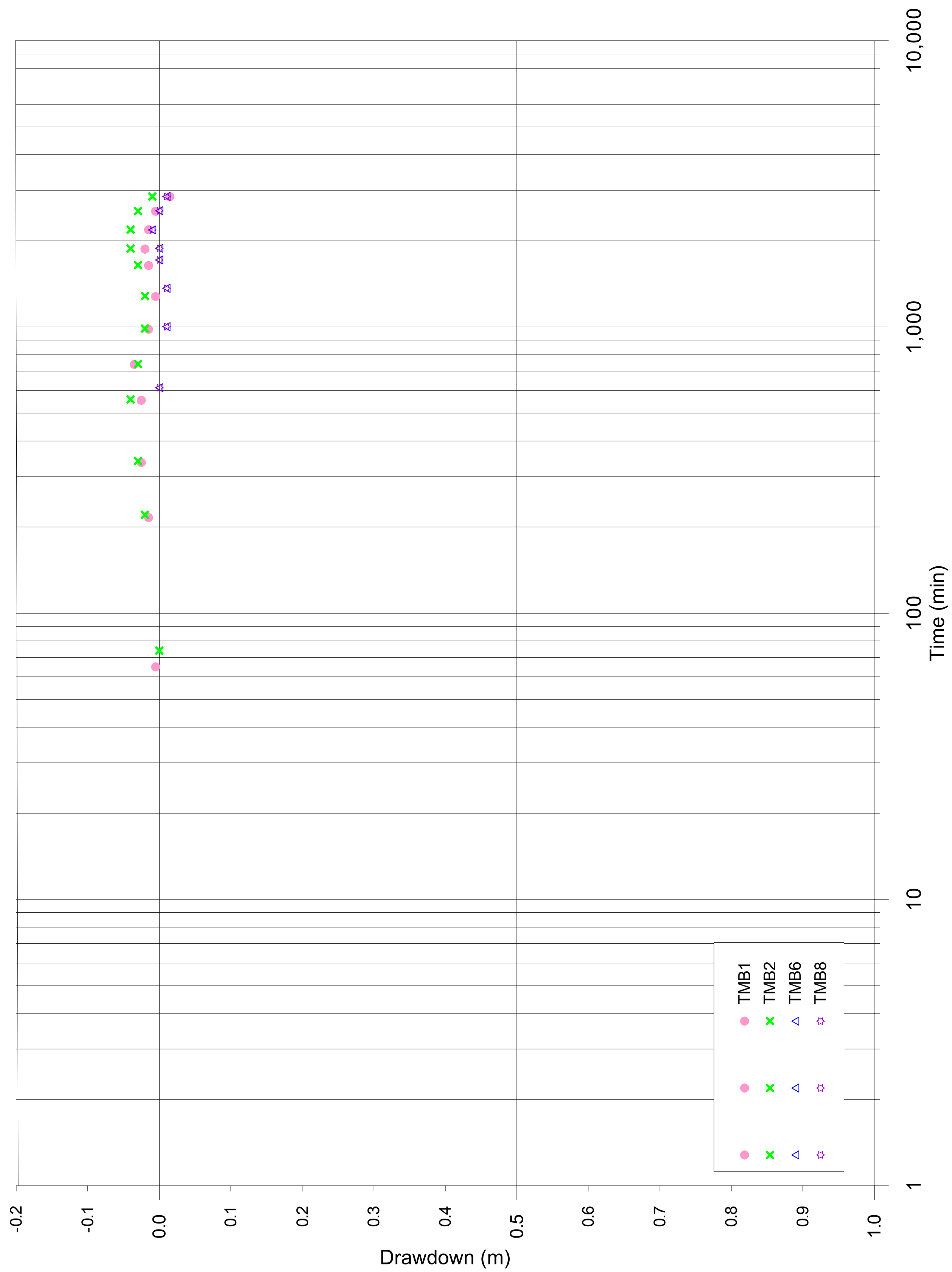
Figure 8

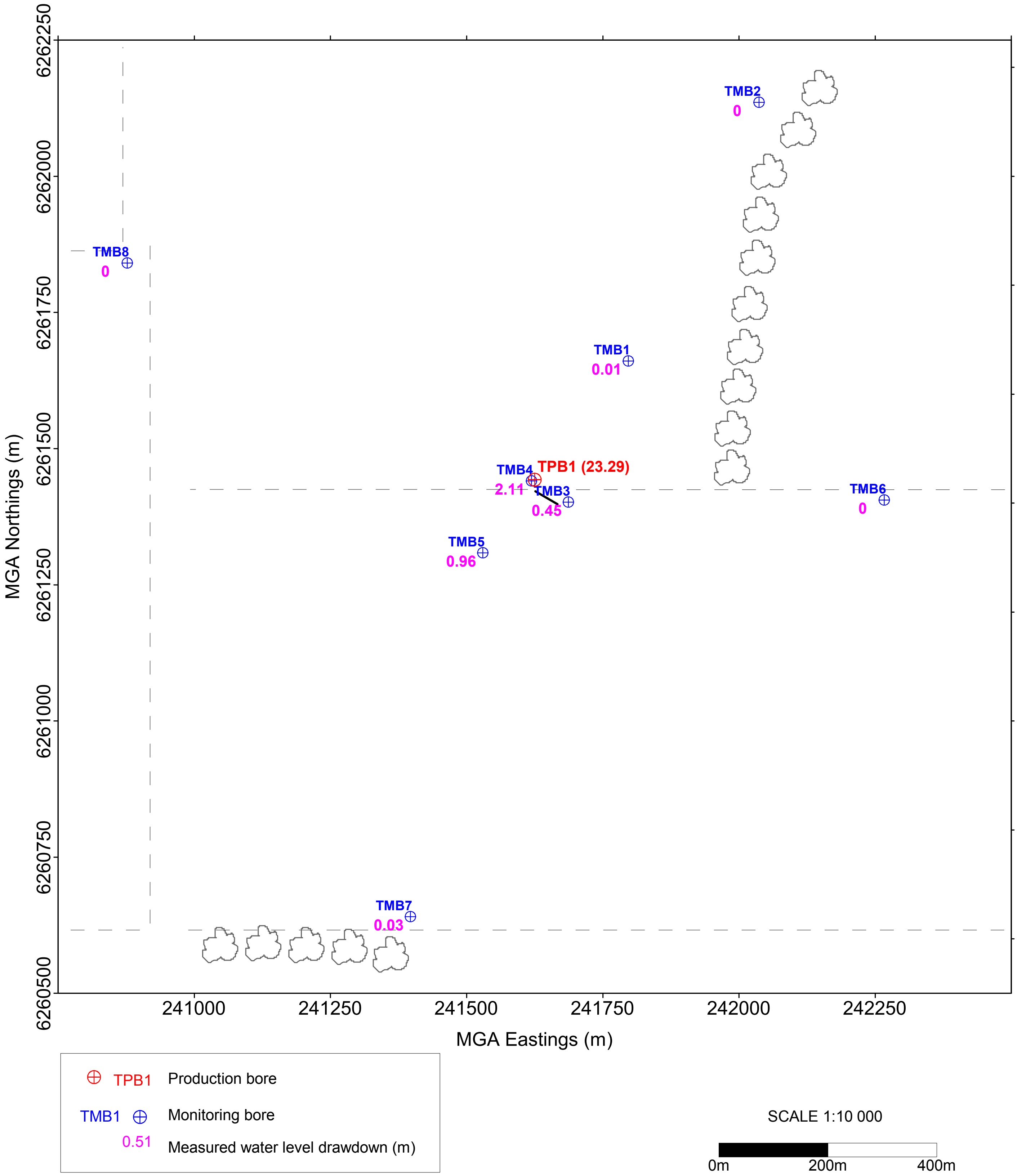
Figure 9



monitoring bores 1,2,6 &8 CRT.grf

Client: Tectonic Resources NL Project : Phillips River (Trilogy) Date : August 2011 Dwg. No: 253.1/11/1-9	TPB1 CONSTANT RATE PUMPING TEST DRAWDOWN IN MONITORING BORES TMB1, 2, 6 & 8 Rockwater Pty Ltd

Figure 10



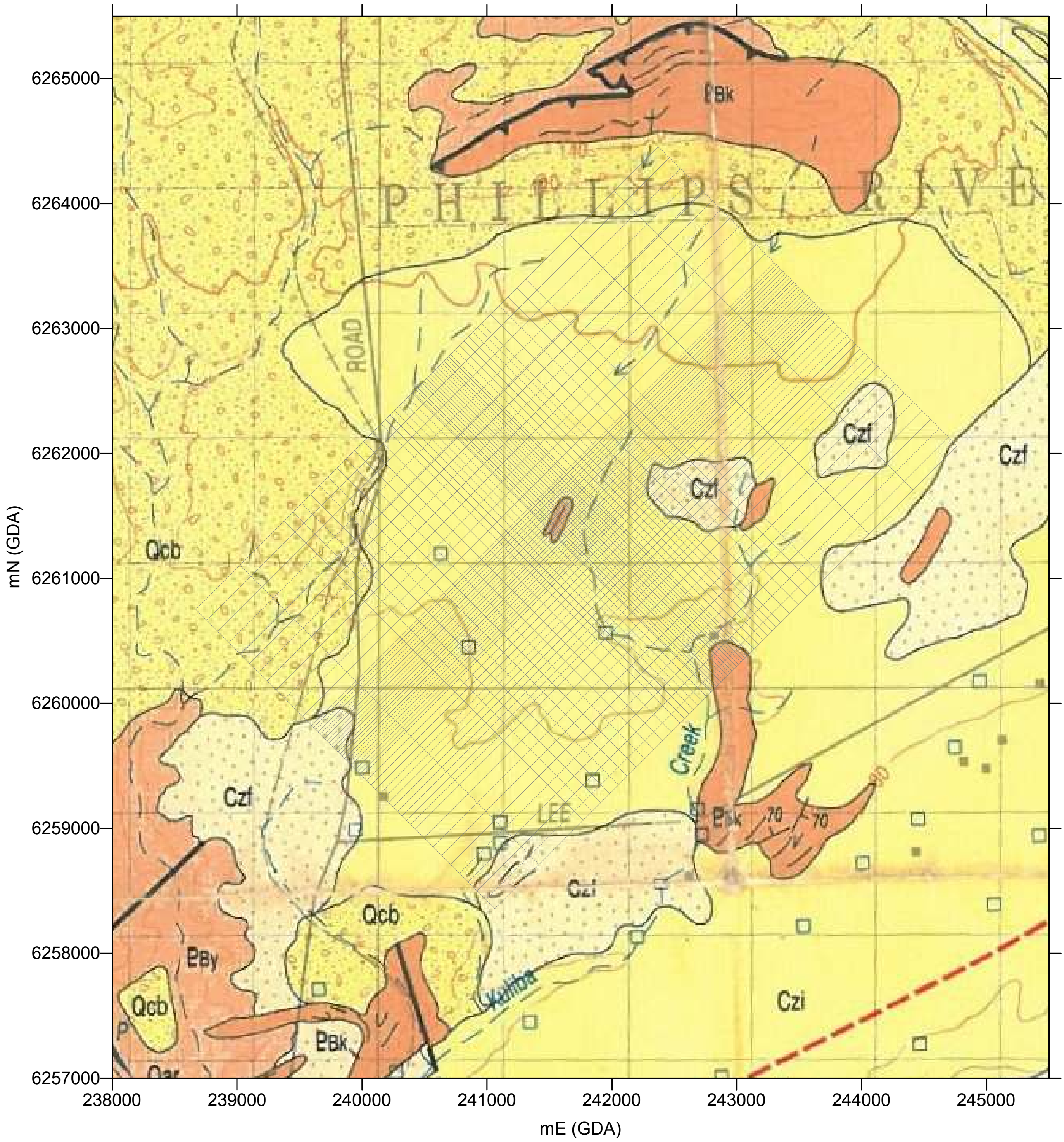
48 hr dd .srf

CLIENT:	Tectonic Resources NL
PROJECT:	Phillips River (Trilogy)
DATE:	August 2011
Dwg No:	253.1/11/1-10

DRAWDOWN (m) AFTER 48 HOURS
PUMPING AT 300 m3/d

Rockwater Pty Ltd

Figure 11

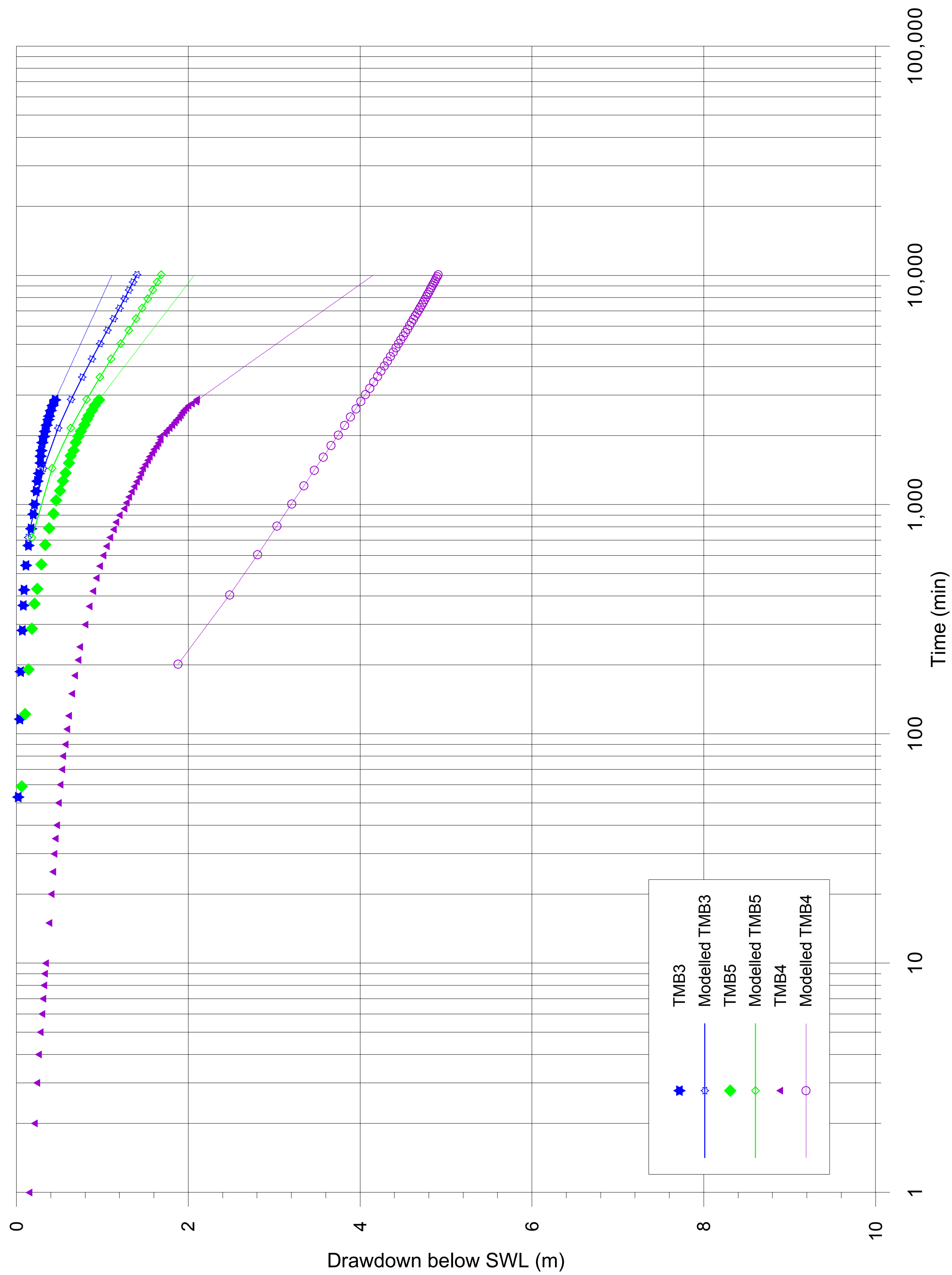


Model Grid.srf

Base Map: 1:100 000 Geology (Witt, 1996)

CLIENT: Tectonic Resources NL PROJECT: Phillips River (Trilogy) DATE: August 2011 Dwg No: 253.1/11/1-11	**EXTENT OF MODEL GRID** Rockwater Pty Ltd

Figure 12



Pumping test and modelled results

Client: Tectonic Resources NL

Project : Phillips River (Trilogy)

Date : August 2011

Dwg. No: 253.1/11/1-12

COMPARISON BETWEEN MODELLED AND EXTRAPOLATED WATER LEVEL DRAWDOWN TRENDS

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Figure 13

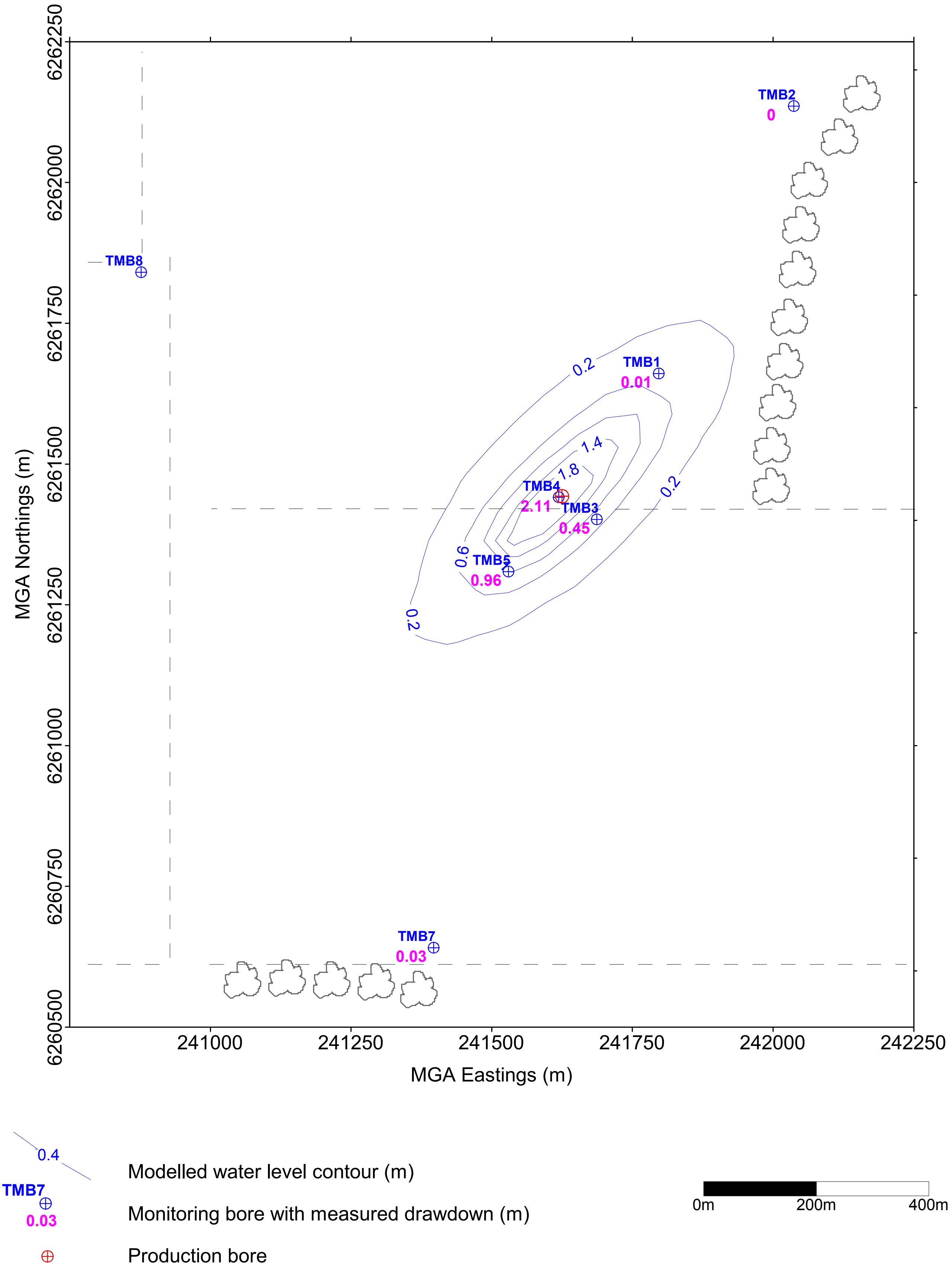
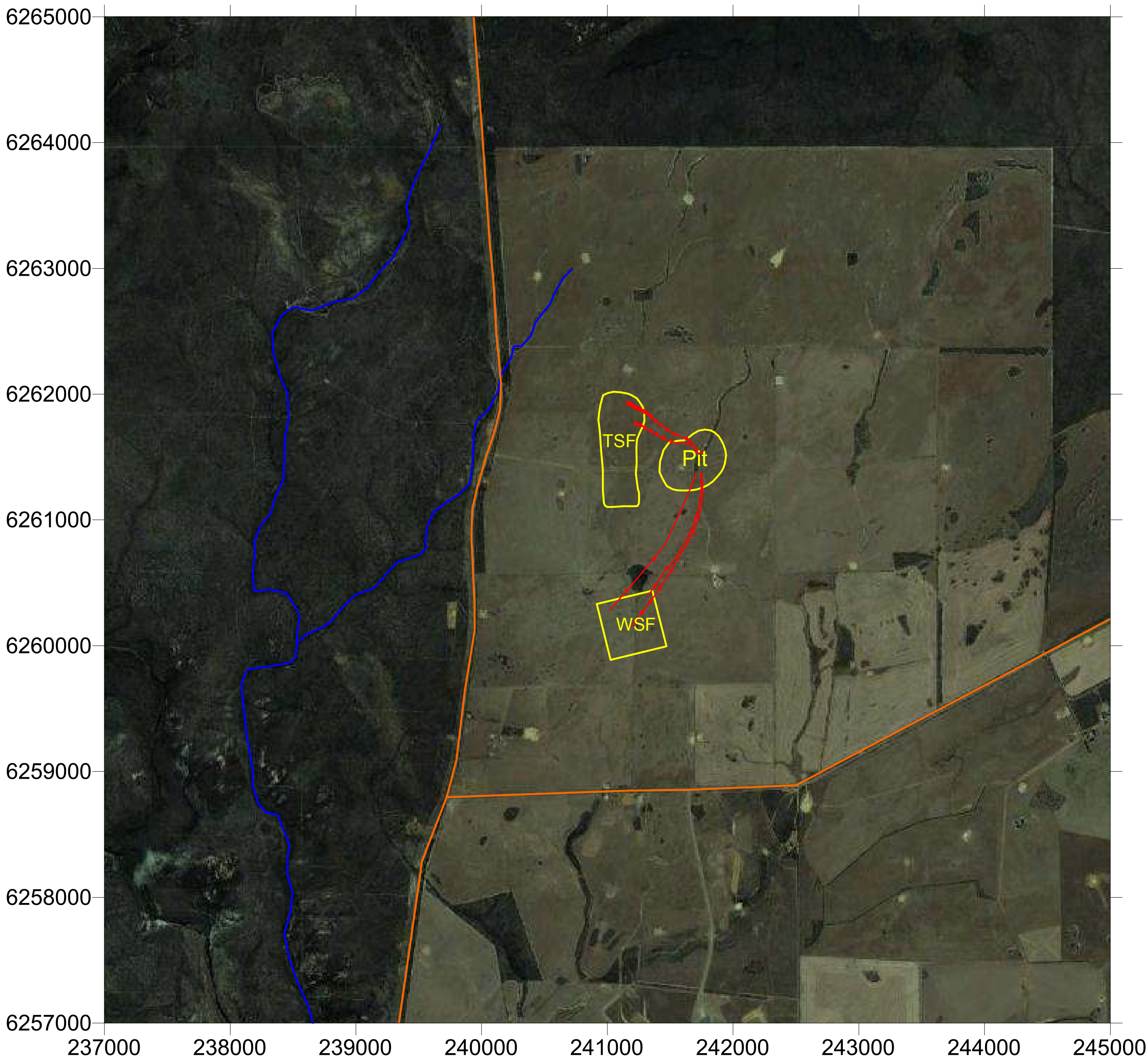


Fig 13.srf

CLIENT: Tectonic Resources NL PROJECT: Phillips River (Trilogy) DATE: August 2011 Dwg No: 253.1/11/1-13	COMPARISON BETWEEN MODELLED AND MEASURED DRAWDOWN (m) AFTER 48 HOURS PUMPING 300 m3/d Rockwater Pty Ltd

FIGURE 14



TSF Planned Tailings Storage

WSF Planned Water Storage

(Each Arrow-Head Represents One-Years Flow)

flowpaths.srf

CLIENT: Tectonic Resources

PROJECT: Phillips River (Trilogy)

DATE: September 2011

Dwg No: 253.1/11/1-14

MODEL-CALCULATED GROUNDWATER FLOW-PATHS FROM PLANNED WATER AND TAILINGS STORAGES

Rockwater Pty Ltd

APPENDIX I

TRILOGY MONITORING BORE COMPLETION DATA

APPENDIX I

BORE COMPLETION DATA

Project: **Tectonic Resources – Trilogy Deposit**

Hole No: **TMB1**

Location: Site A, north end of planned pit, along strike

MGA Co-ordinates: 241 797 mE, 6 261 661 mN

Status: Monitoring Bore

Date Commenced: 6/1/04 **Date Completed:** 6/1/04

Drilling Contractor: Resource Drilling

Drilling Rig: Schram T66H

Depth Drilled: 100 m

Drilling Details: 0 – 3 m 200 mm hammer
3 – 100 m 140 mm hammer

Casing Details:

0 – 3 m	154 mm steel surface casing
+0.14 – 64 m	50 mm ND Class 9 uPVC Blank
64 – 100 m	50 mm ND Class 9 UPVC slotted (0.5 mm aperture)

Static Water Level: 33.67 m below toc (15/1/04)

Hydro Data:

Depth (m)	Airlift Rate (m³/d)	EC (µS/cm)	Temp (°C)	TDS (mg/L)	pH	Comments
58	Water Cut	-		-	-	
64	Trace	-		-	-	
70	17	31 700	24.8	21 400	6.8	Black
76	30	32 500	21.4	23 800	6.8	Black, silty
82	35	33 800	23.8	23 400	7.0	Black, silty
88	43	33 800	23.0	23 900	7.0	Black, silty

BORE COMPLETION DATA TMB1 (cont.)

Depth (m)	Airlift Rate (m^3/d)	EC (µS/cm)	Temp (°C)	TDS (mg/L)	pH	Comments
92	43	28 900	23.7	19 900	7.0	Poss. erroneous reading from cyclone
100	26	35 000	27.7	22 200	7.0	Black, silty

Lithology:

Depth (m)	Lithology	Description
0 - 2	Clay	Brown, soft, gritty.
2 - 10	Clay / Highly Weathered schist	Brown (grey – yellow – pinkish), micaceous and soft with weathered rock fragments: grey, very fine grained, schistose, oxidised (pink and orange), micaceous sheen, quartz veining 8 – 9 m.
10 - 11	Weathered schist	Light brown – grey, Light grey to dark grey, very fine grained, schistose, micaceous sheen.
11 - 18	(Phyllite) Schist	Light grey to dark grey, black, very fine grained, schistose, fresh.
18 - 33	(Phyllite) Schist	Black (some grey and red), fine grained, slightly silicified in part, slightly to moderately oxidised, schistose, becoming more massive with increasing depth.
33 - 100	Shale	Black, fine grained, graphitic, micaceous sheen, slightly silicified from 43 – 95 m (thin quartz veining), grain size coarsening in part from 50 m, pyrite mineralisation from 50 - 53 m, oxidisation at 63 m (red).
100	EOH	

APPENDIX I

BORE COMPLETION DATA

Project: **Tectonic Resources – Trilogy Deposit**

Hole No: **TMB2**

Location: Site F, Regional monitoring bore on drainage line

MGA Co-ordinates: 242 037 mE, 6 262 136 mN

Status: Monitoring Bore

Date Commenced: 6/1/04 **Date Completed:** 6/1/04

Drilling Contractor: Resource Drilling

Drilling Rig: Schram T66H

Depth Drilled: 76 m

Drilling Details: 0 – 3 m 200 mm hammer
3 – 76 m 140 mm hammer

Casing Details:

0 – 3 m	154 mm steel surface casing
+0.32 – 46 m	50 mm ND Class 9 uPVC Blank
46 – 76 m	50 mm ND Class 9 UPVC slotted (0.5 mm aperture)

Static Water Level: 37.85 m below toc (15/1/04)

Hydro Data:

Depth (m)	Airlift Rate (m^3/d)	EC (µS/cm)	Temp (°C)	TDS (mg/L)	pH	Comments
58	Minor	24 000	28.7	14 500	8.0	
64	<43	24 600	25.1	16 200	8.0	
70	22	26 200	26.3	16 900	8.0	
76	22	25 400	26.0	16 400	8.0	

APPENDIX I

BORE COMPLETION DATA TMB2 (cont.)

Lithology:

Depth (m)	Lithology	Description
0 - 1	Clay	Cream, soft, gritty.
1 - 7	Clay / Highly Weathered schist	Cream to buff, soft, gritty with bedrock fragments: oxidised schist, light grey to pink, very fine grained, micaceous sheen, platy fracture.
7 - 11	Weathered schist	Grey to pink, very fine to fine-grained. Minor Quartzite?, small vugs, lineations.
11 - 14	Quartzite? / Schist	Grey, fine grained, siliceous, weathered, slight to moderate schistosity.
14 - 33	Schist / Quartzite?	Grey to pink, very fine to fine-grained, oxidised 14 – 19 m, 24 – 25 m (pink), quartz veining 25 – 26 m.
33 - 76	Shale	Dark grey to black, very fine to fine-grained, lineations, micaceous sheen, platy, graphitic, slightly more massive 38 – 40 m, 44 – 46 m, 48 – 50 m, 51 – 52m, red oxidation 38 – 39 m, 46 – 48 m, 55 – 56 m, 64 – 65 m. fresher from ~60 m.
76	EOH	

APPENDIX I

BORE COMPLETION DATA

Project: **Tectonic Resources – Trilogy Deposit**

Hole No: **TMB3**

Location: Site C, Down-dip on high wall of planned pit

MGA Co-ordinates: 241 687 mE, 6 261 402 mN

Status: Monitoring Bore

Date Commenced: 7/1/04 **Date Completed:** 8/1/04

Drilling Contractor: Resource Drilling

Drilling Rig: Schram T66H

Depth Drilled: 160 m

Drilling Details: 0 – 3 m 200 mm hammer
3 – 160 m 140 mm hammer

Casing Details:

0 – 3 m	154 mm steel surface casing
+1.11 – 101 m	50 mm ND Class 9 uPVC Blank
101 – 155 m	50 mm ND Class 9 UPVC slotted (0.5 mm aperture)

Static Water Level: 22.47 m below toc (15/1/04)

Hydro Data:

Depth (m)	Airlift Rate (m^3/d)	EC (µS/cm)	Temp (°C)	TDS (mg/L)	pH	Comments
70	Trace	-	-	-	-	On rod change
94	Trace	-	-	-	-	On rod change
106	Minor	-	-	-	-	On rod change
112	Minor	-	-	-	-	On rod change
116	Trace	-	-	-	-	Water flow into hole during drilling
118	52	35 500	20.2	26 800	3.8	Black, silty

APPENDIX I

BORE COMPLETION DATA TMB3 (cont.)

Depth (m)	Airlift Rate (m^3/d)	EC (µS/cm)	Temp (°C)	TDS (mg/L)	pH	Comments
130	65	38 000	22.5	27 300	3.8	Black, silty
136	86	38 200	21.4	28 200	3.8	Black, silty
142	86	40 500	20.5	30 600	3.8	Black, silty
148	121	38 700	22.1	28 100	3.8	Black, silty
154	121	38 200	20.9	28 500	3.8	Black, silty
160	86	37 500	28.8	23 300	4.4	Black, silty

Lithology:

Depth (m)	Lithology	Description
0 - 2	Clay / Highly Weathered schist	Light orange brown, soft, gritty, micaceous sheen, bedrock fragments: light to medium grey, very fine grained, siliceous.
2 - 11	Weathered schist	Light to dark grey, orange and pink oxidation, platy, silicified.
11 - 35	(Phyllite) Schist	Light to dark grey, slightly to moderately weathered (pink to red oxidation), freshening with depth, very fine grained, platy, siliceous, micaceous sheen, oxidation 14 – 15 m, 17 – 18 m, 24 – 26 m, 30 – 31, quartz veining 26 – 29 m.
35 - 45	Shale	Dark grey to black, very fine grained, micaceous sheen, platy, graphitic, slightly vuggy, some red oxidation, thin quartz veins throughout (high quartz 37 – 45 m), slightly to moderately silicified.
45 - 160	Shale	Dark grey to black, very fine grained, micaceous sheen, platy, becoming more massive with depth, graphitic, quartz veining throughout (high quartz 114 – 116m, 119 – 120 m, 144 – 145 m, 150 – 151 m, 157 – 158 m), remnant folding ~80 m, broken/vuggy ground ~102 m, pyrite mineralisation from 54 m (increasing 100 – 105 m, 110 – 111 m, 114 – 115 m, 118 – 119 m, 129 – 130 m, 139 – 142 m, 148 – 149 m).
160	EOH	

APPENDIX I

BORE COMPLETION DATA

Project: **Tectonic Resources – Trilogy Deposit**

Hole No: **TMB4**

Location: Site D, In planned pit, reported very wet zone

MGA Co-ordinates: 241 619 mE, 6 261 441 mN

Status: Monitoring Bore

Date Commenced: 8/1/04 **Date Completed:** 9/1/04

Drilling Contractor: Resource Drilling

Drilling Rig: Schram T66H

Depth Drilled: 100 m

Drilling Details: 0 – 3 m 200 mm hammer
3 – 100 m 140 mm hammer

Casing Details:
0 – 3 m 154 mm steel surface casing
+0.36 – 58 m 50 mm ND Class 9 uPVC Blank
58 – 94 m 50 mm ND Class 9 UPVC slotted (0.5 mm aperture)

Static Water Level: 33.59 m below toc (15/1/04)

Hydro Data:

Depth (m)	Airlift Rate (m^3/d)	EC (µS/cm)	Temp (°C)	TDS (mg/L)	pH	Comments
64	Trace	-	-	-	-	
70	Trace	-	-	-	-	
76	22	18 000	22.7	12 300	5.6	Grey muddy water
82	43	18 000	23.6	12 000	5.3	Grey muddy water
88	35	-	-	-	-	

APPENDIX I

BORE COMPLETION DATA TMB4 (cont.)

Depth (m)	Airlift Rate (m^3/d)	EC (μS/cm)	Temp (°C)	TDS (mg/L)	pH	Comments
94	238	34 100	23.6	23 800	3.3	Grey muddy water
100	190	36 700	24.1	25 400	3.5	Grey muddy water

Lithology:

Depth (m)	Lithology	Description
0 - 2	Clay / Highly Weathered schist	Light orange-brown, soft and gritty, bedrock fragments: grey, very fine grained, platy, minor subangular quartz.
2 - 6	Weathered schist	Light to dark grey (minor orange oxidation), very fine grained, platy, micaceous sheen, siliceous, some subangular quartz grains.
6 - 21	(Phyllite) Schist	Light to dark grey, slight to moderate weathering (yellow and red oxidation), very fine grained, platy, siliceous, quartz veins 7 – 10 m, 11 – 14 m, 15 – 18 m, 19 – 21 m.
21 - 25	Highly Weathered Shale	Greyish-orange, massive, siliceous, quartz rich.
25 - 32	Quartzite? / schist	Grey, fine grained, slightly weathered, platy to massive, siliceous, quartz rich.
32 – 34	Shale / quartz	Dark grey to black, slightly weathered (orange oxidation), fine grained, platy to massive, siliceous, graphitic, quartz veins, traces of azurite and malachite.
34 - 100	Shale	Dark grey to black, very fine grained, platy (tending to massive from 54 m), micaceous sheen, graphitic, minor schist (to 40 m- contamination?), slight to moderate weathering (orange and red oxidation) 34 – 42 m, 44 – 47 m, 54 – 55 m, quartz veins 40 – 100 m, trace Azurite, pyrite mineralisation (increasing from 73 m) 44 – 100 m.
100	EOH	

APPENDIX I

BORE COMPLETION DATA

Project: **Tectonic Resources – Trilogy Deposit**

Hole No: **TMB5**

Location: Site B, South end of pit, along strike

MGA Co-ordinates: 241 530 mE, 6 261 309 mN

Status: Monitoring Bore

Date Commenced: 9/1/04 **Date Completed:** 10/1/04

Drilling Contractor: Resource Drilling

Drilling Rig: Schram T66H

Depth Drilled: 76 m

Drilling Details: 0 – 3 m 200 mm hammer
3 – 76 m 140 mm hammer

Casing Details:

0 – 3 m	154 mm steel surface casing
+0.39 – 52 m	50 mm ND Class 9 uPVC Blank
52 – 76 m	50 mm ND Class 9 UPVC slotted (0.5 mm aperture)

Static Water Level: 35.52 m below toc (15/1/04)

Hydro Data:

Depth (m)	Airlift Rate (m^3/d)	EC (µS/cm)	Temp (°C)	TDS (mg/L)	pH	Comments
45	Trace					After resumption from breakdown
46	-	-	-	-	-	
52	Trace	-	-	-	-	
58	Trace	-	-	-	-	
64	43	16 600	19.6	12 100	4.7	
70	22	22 200	22.3	15 500	4.7	

APPENDIX I

BORE COMPLETION DATA TMB5 (cont.)

Lithology:

Depth (m)	Lithology	Description
0 - 2	Clay / Highly Weathered schist	Dark grey, soft, gritty, bedrock fragments: orange to brown.
2 - 7	Weathered schist	Grey to orange brown, slightly to highly weathered, very fine grained, platy to massive, minor quartz veining, freshening with increasing depth.
7 - 22	(Phyllite) Schist	Light to dark grey (orange and brown oxidation), slightly to moderately weathered (freshening with increasing depth), platy, micaceous sheen, quartz veining 7 – 13 m, 17 – 19 m (quartz rich 11 – 12 m).
22 - 33	Schist/Shale	Grey to Black (minor orange and red oxidation), very fine grained, soft and platy, schistose, micaceous sheen, slightly siliceous, quartz veining 24 – 27 m, 28 – 33 m.
33 - 76	Shale	Black (rare orange weathering throughout contamination?), very fine grained, soft, platy (becoming massive from 54 m), graphitic, micaceous sheen, siliceous, oxidation 40 – 43 m, increasing hardness from 60 m, quartz rich 57 – 60 m , 61 – 65 m, 67 – 72 m, pyrite mineralisation 43 – 76 m.
76	EOH	

APPENDIX I

BORE COMPLETION DATA

Project: **Tectonic Resources – Trilogy Deposit**

Hole No: **TMB6**

Location: Site G, Regional bore, near fenceline

MGA Co-ordinates: 242 267 mE, 6 261 406 mN

Status: Monitoring Bore

Date Commenced: 10/1/04 **Date Completed:** 10/1/04

Drilling Contractor: Resource Drilling

Drilling Rig: Schram T66H

Depth Drilled: 82 m

Drilling Details: 0 – 3 m 200 mm hammer
3 – 82 m 140 mm hammer

Casing Details:

0 – 3 m	154 mm steel surface casing
+0.50 – 58 m	50 mm ND Class 9 uPVC Blank
58 – 82 m	50 mm ND Class 9 UPVC slotted (0.5 mm aperture)

Static Water Level: 32.30 m below toc (15/1/04)

Hydro Data:

Depth (m)	Airlift Rate (m³/d)	EC (µS/cm)	Temp (°C)	TDS (mg/L)	pH	Comments
64	Water Cut	-	-	-	-	
70	Trace	-	-	-	-	
76	22	30 400	23.4	21 100	6.2	Pale brown, quite clean
82	35	29 800	32.1	16 900	6.2	Pale brown, quite clean

APPENDIX I

BORE COMPLETION DATA TMB6 (cont.)

Lithology:

Depth (m)	Lithology	Description
0 - 5	Clay / Highly Weathered schist	Pale pinkish orange, soft, gritty, bedrock fragments: orange, red and grey, very fine grained, massive.
5 - 36	(Phyllite) Schist	Pale to dark grey, moderately weathered from 5 – 10 m, 25 – 28 m, 33 – 36 m (orange and red oxidation), very fine grained, platy, micaceous sheen, soft, quartz veining 11 – 14 m, 15 – 24 m (quartz rich 34 – 35 m).
36 - 82	Shale	Black, very fine grained, platy (more massive from 58 m), micaceous sheen, graphitic, soft, some oxidation (red discolouration), slightly siliceous, quartz veining 42 – 46 m, 51 – 56 m, 62 – 82 m, becoming harder from 60 m, Malachite 65 – 66 m, 67 – 68 m, minor pyrite mineralisation 65 – 82 m, copper? mineralisation ~60 – 82 m (copper coloured, shiny, like a coating, not crystalline?).
82	EOH	

APPENDIX I

BORE COMPLETION DATA

Project: **Tectonic Resources – Trilogy Deposit**

Hole No: **TMB7**

Location: Site H, Regional bore, near fenceline

MGA Co-ordinates: 241 397 mE, 6 260 641 mN

Status: Monitoring Bore

Date Commenced: 10/1/04 **Date Completed:** 10/1/04

Drilling Contractor: Resource Drilling

Drilling Rig: Schram T66H

Depth Drilled: 88 m

Drilling Details: 0 – 3 m 200 mm hammer
3 – 88 m 140 mm hammer

Casing Details:

0 – 3 m	154 mm steel surface casing
+0.44 – 64 m	50 mm ND Class 9 uPVC Blank
64 – 88 m	50 mm ND Class 9 UPVC slotted

Static Water Level: 27.66 m below toc (15/1/04)

Hydro Data:

Depth (m)	Airlift Rate (m^3/d)	EC (µS/cm)	Temp (°C)	TDS (mg/L)	pH	Comments
76	Water Cut	-	-	-	-	
82	17	24 300	25.6	15 800	-	Muddy
88	43	36 700	28.3	23 100	6.5	Muddy

APPENDIX I

BORE COMPLETION DATA TMB7 (cont.)

Lithology:

Depth (m)	Lithology	Description
0 - 5	Clay / Highly Weathered schist	Dark grey to pale pinkish orange, soft, gritty, bedrock fragments: red and brown, very fine grained, massive.
5 - 34	(Phyllite) Schist	Pale to dark grey, slight to moderate weathering (more-weathered from 26 – 29 m, 33 – 34 m: orange and red oxidation), very fine grained, platy, micaceous sheen, soft, quartz veining throughout (quartz rich 6 – 7 m), pyrite mineralisation 32 – 33 m.
34 - 88	Shale	Black, very fine grained, platy, micaceous sheen, graphitic, soft, some oxidation (red discolouration, maybe copper mineralisation?) freshening with increasing depth from 57 m (red oxidation from 77 – 79 m), siliceous, quartz veining 34 – 52 m, 55 - 88 m (quartz rich 64 – 65 m), pyrite mineralisation 78 – 85 m.
88	EOH	

APPENDIX I

BORE COMPLETION DATA

Project: **Tectonic Resources – Trilogy Deposit**

Hole No: **TMB8**

Location: Site E, Regional bore, near fenceline

MGA Co-ordinates: 240 877 mE, 6 261 841 mN

Status: Monitoring Bore

Date Commenced: 11/1/04 **Date Completed:** 11/1/04

Drilling Contractor: Resource Drilling

Drilling Rig: Schram T66H

Depth Drilled: 76 m

Drilling Details: 0 – 3 m 200 mm hammer
3 – 76 m 140 mm hammer

Casing Details:

0 – 3 m	154 mm steel surface casing
+0.31 – 46 m	50 mm ND Class 9 uPVC Blank
46 – 76 m	50 mm ND Class 9 UPVC slotted

Static Water Level: 39.61 m below toc (15/1/04)

Hydro Data:

Depth (m)	Airlift Rate (m^3/d)	EC (µS/cm)	Temp (°C)	TDS (mg/L)	PH	Comments
46	Water Cut	-	-	-	-	
52	Trace	-	-	-	-	
58	Trace	-	-	-	-	Slight increase in flow
64	Trace	-	-	-	-	Same flow as at 58 m
70	Trace	-	-	-	-	Same flow as at 58 m
76	Trace	27 900	30.2	16 500	6.8	Same flow as at 58 m

APPENDIX I

BORE COMPLETION DATA TMB8 (cont.)

Lithology:

Depth (m)	Lithology	Description
0 - 3	Clay / Highly Weathered schist	Dark reddish-grey to orange-red, soft, gritty, bedrock fragments: red and brown, very fine grained, massive, some quartz.
3 - 31	(Phyllite) Schist	Pale to medium grey, slight to moderate weathering 12 – 14 m, 17 – 25 m, 28 – 31 m (orange and red oxidation) freshening with increasing depth, very fine grained, platy, micaceous sheen, siliceous, soft, quartz veining 3 - 8 m, 11 – 16 m.
31 - 76	Shale	Black, very fine grained, platy to massive, micaceous sheen, graphitic, siliceous, hard, some oxidation (red discolouration, maybe copper mineralisation?) freshening with increasing depth 31 – 40 m, 52 – 54 m, 62 – 66 m, 75 – 76 m, siliceous, quartz veining 33 – 76 m), pyrite mineralisation 69 – 72 m, 75 – 76 m.
76	EOH	

APPENDIX II

PRODUCTION BORE COMPLETION DATA

APPENDIX II

PRODUCTION BORE COMPLETION DATA

Project:	**Tectonic Resources – Trilogy Deposit**		
Hole No:	**TPB1**		
Location:	Site D, In-pit, very wet zone		
MGA Co-ordinates:	~241 619 mE, ~6 261 441 mN		
Status:	Production Bore		
Date Commenced:	21/1/04	**Date Completed:**	25/1/04
Drilling Contractor:	Resource Drilling		
Drilling Rig:	Schram T66H		
Depth Drilled:	95.5 m		
Drilling Details:	0 – 6 m 330 mm hammer 3 – 100 m 254 mm hammer		
Casing Details:	+0.1 – 5.9 m 254 mm mild steel surface casing +0.2 – 64.8 m 152 mm steel, Schedule 40 blank 64.8 m Annular seal – rubber flange 64.8 – 94.8 m 152 mm steel, Schedule 40 slotted (1.5 mm aperture) (Hole collapsed - 0.7 m lost during casing)		
Static Water Level:	N/D		
Maximum Airlift Yield:	255 m^3/day		
Water Salinity:	Approx. 25 000 mg/L TDS (by electrical conductivity)		
Water pH:	3.8		

APPENDIX II

PRODUCTION BORE COMPLETION DATA (cont.)

Lithology:

Depth (m)	Lithology	Description
0 - 2	Clay / Highly Weathered schist	Light orange-brown, soft and gritty, bedrock fragments: grey, very fine grained, platy, minor subangular quartz.
2 - 21	Weathered schist	Light to dark grey, slight to moderate weathering (yellow and red oxidation), very fine grained, platy, micaceous sheen, siliceous, quartz veins throughout.
21 - 34	Weathered Shale / Quartzite or quartz	Greyish-orange to black, slightly weathered, platy to massive, siliceous, quartz rich, graphitic 32 – 34 m, traces of azurite and malachite at base.
34 – 95.5	Shale	Dark grey to black, very fine grained, platy (tending to massive from 54 m), micaceous sheen, graphitic, slight to moderate weathering (orange and red oxidation) 34 – 55 m, quartz veins throughout, trace Azurite, pyrite mineralisation traces from 44 m (increasing from ~75 m).
95.5	EOH	

APPENDIX III

WATER ANALYSES TPB1

SGS

LABORATORY REPORT COVERSHEET

DATE:	20 February 2004
TO:	Rockwater Pty Ltd
	PO Box 201
	WEMBLEY WA 6913
ATTENTION:	Ms Miranda Taylor
YOUR REFERENCE:	253.1 Tectonic Resources
OUR REFERENCE:	78274
SAMPLES RECEIVED:	02/02/04
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.

pp JANICE VENNING
Manager, Perth

PETER BAMFORD
Manager Laboratory Services

This report supersedes our preliminary results that were reported by facsimile.

SGS Australia Pty Ltd
ABN 44 000 964 278
Environmental Services 52 Murray Road, Welshpool 6106 Western Australia www.sgs.com
t +61 (0)8 9458 7278 f +61 (0)8 9451 3505

SGS

CLIENT: Rockwater Pty Ltd **OUR REFERENCE:** 78274
PROJECT: 253.1 Tectonic Resources

LABORATORY REPORT

Your Reference Our Reference Date Sampled Type of Sample	Units	TP B1 78274-1 30/01/2004 Water
pH	pH Units	2.8
Electrical Conductivity @ 25°C	µS/cm	25000
Total Dissolved Solids (grav) @ 180°C	mg/L	18000
Iron, Fe (soluble)	mg/L	96
Sodium, Na	mg/L	4800
Potassium, K	mg/L	120
Calcium, Ca	mg/L	54
Magnesium, Mg	mg/L	510
Chloride, Cl	mg/L	8800
Carbonate, CO_3	mg/L	<1
Bicarbonate, HCO_3	mg/L	<5
Sulphate, SO_4	mg/L	3900
Nitrate, NO_3	mg/L	0.5
Sum of Ions (calc.)	mg/L	18179

SGS

CLIENT: Rockwater Pty Ltd **OUR REFERENCE:** 78274
PROJECT: 253.1 Tectonic Resources

LABORATORY REPORT

TEST PARAMETERS	UNITS	LOR	METHOD
Standard 1			
pH	pH Units	0.1	PEI-001
Electrical Conductivity @ 25°C	µS/cm	1	PEI-032
Total Dissolved Solids (grav) @ 180°C	mg/L	10	PEI-002
Iron, Fe (soluble)	mg/L	0.05	PEM-001
Sodium, Na	mg/L	0.5	PEM-001
Potassium, K	mg/L	0.5	PEM-001
Calcium, Ca	mg/L	0.5	PEM-002
Magnesium, Mg	mg/L	0.5	PEM-002
Chloride, Cl	mg/L	1	PEI-020
Carbonate, CO_3	mg/L	1	PEI-006
Bicarbonate, HCO_3	mg/L	5	PEI-006
Sulphate, SO_4	mg/L	1	PEI-020
Nitrate, NO_3	mg/L	0.2	PEI-020
Sum of Ions (calc.)	mg/L		Calc.

NOTES:
LOR - Limit of Reporting.

SGS

LABORATORY REPORT COVERSHEET

DATE:	1 April 2004
TO:	Rockwater Pty Ltd PO Box 201 WEMBLEY WA 6913
ATTENTION:	Ms Miranda Taylor
YOUR REFERENCE:	253.1 Additional Analysis ex job 78274
OUR REFERENCE:	79525
SAMPLES RECEIVED:	02/02/04
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.
Gold was analysed by SGS Mineral Services, Welshpool, their report No.WM076942.

JANICE VENNING
Manager, Perth

PETER BAMFORD
Manager Laboratory Services

This report supersedes our preliminary results that were reported by facsimile.
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SGS Australia Pty Ltd ABN 44 000 964 278 | Environmental Services t +61 (0)8 9458 7278 | 52 Murray Road f +61 (0)8 9451 3505 | Welshpool 6106 | Western Australia | www.au.sgs.com

Member of the SGS Group

SGS

CLIENT: Rockwater Pty Ltd **OUR REFERENCE:** 79525
PROJECT: 253.1 Additional Analysis ex job 78274

LABORATORY REPORT

Your Reference Our Reference Date Sampled Type of Sample	Units	TPB 1 79525-1 30/01/2004 Water
Copper, Cu	mg/L	0.15
Nickel, Ni	mg/L	0.45
Zinc, Zn	mg/L	160
Lead, Pb	mg/L	7.7
Cadmium, Cd	mg/L	0.30
Silver, Ag	mg/L	<0.01
Gold, Au	mg/L	<0.001

TEST PARAMETERS	UNITS	LOR	METHOD

Copper, Cu	mg/L	0.05	PEM-001
Nickel, Ni	mg/L	0.05	PEM-001
Zinc, Zn	mg/L	0.05	PEM-001
Lead, Pb	mg/L	0.05	PEM-001
Cadmium, Cd	mg/L	0.005	PEM-001
Silver, Ag	mg/L	0.01	PEM-001
Gold, Au	mg/L	0.001	P657

NOTES:
LOR - Limit of Reporting.

APPENDIX IV

STEP-RATE TEST DATA AND ANALYSES

PUMPING TEST DATA

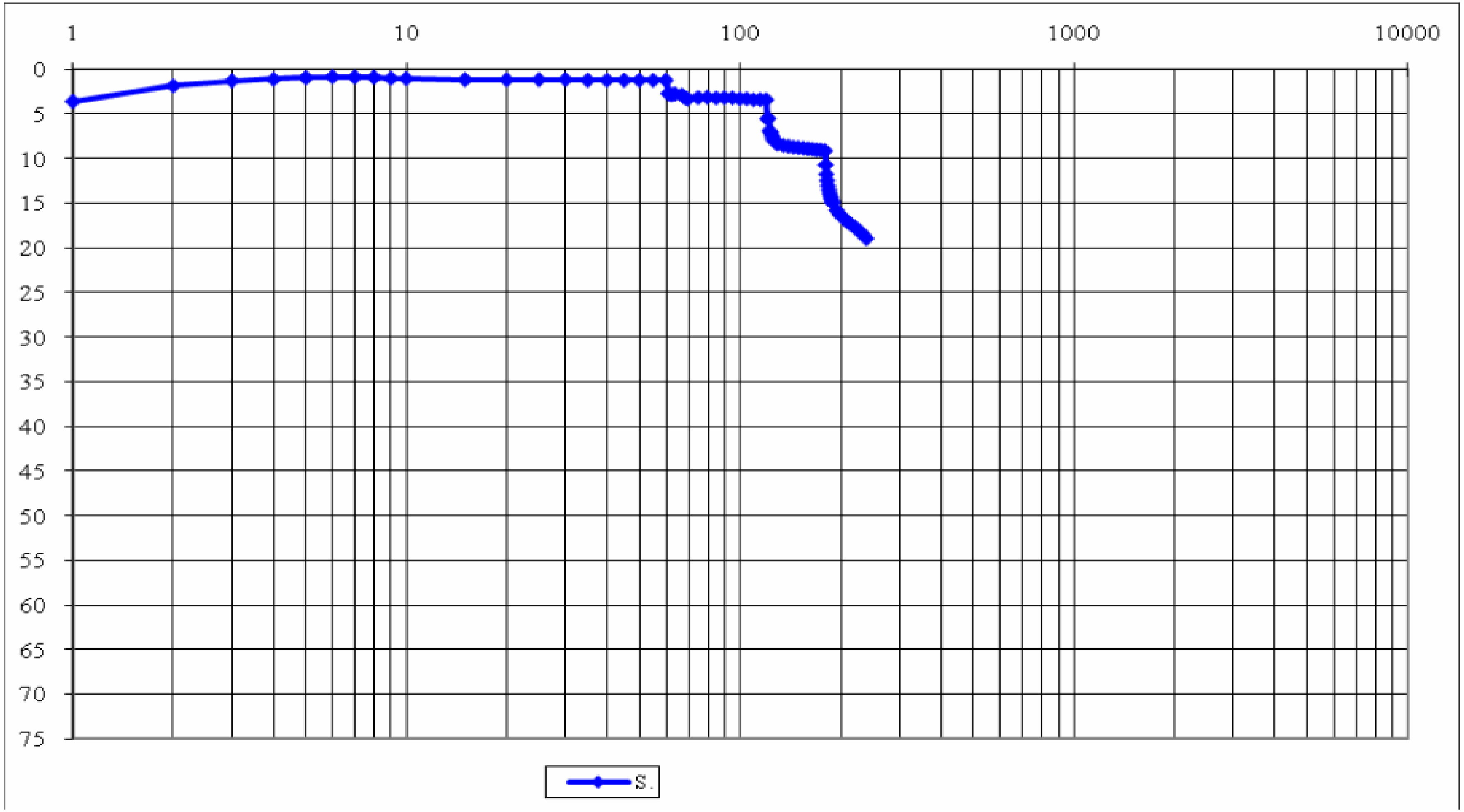
LOCATION		**START DATE**	27-Jan-04	**START TIME**	10:10	**hours**
BORE NUMBER	**TPB1**	**FINISH DATE**	27-Jan-04	**FINISH TIME**	14:10	**hours**

DURATION	4x1	**hours**
CONSTANT FLOW RATE	see below	**m^3/day**
DEPTH TO STATIC WATER REST LEVEL	33.44	**m on Beeper Tape**
DEPTH TO STATIC WATER REST LEVEL	-	**m on Air Gauge**
PUMP SUCTION	80	**m**
ORIFICE DIAMETER	1-2	**in**

Top of Production Casing Above Ground Level			0.2	**m**
Slotted/cased Interval	**from**	**to**		**m**
Test Carried out by	Bennett Drilling			

Time (t) minutes	Cummulative Time Sum (t) minutes	Total D/Down (s) m	Drawdown at various flow rates, Flow Rate (m3/day): 75 m	150 m	250 m	350 m	m
1	1	3.58	3.58	2.7	5.52	10.68	
2	2	1.83	1.83	2.83	5.5	11.73	
3	3	1.28	1.28	2.81	6.85	12.44	
4	4	1.11	1.11	2.73	7.07	13.02	
5	5	0.95	0.95		7.44	13.49	
6	6	0.83	0.83		7.79	13.87	
7	7	0.86	0.86	2.87	7.99	14.2	
8	8	0.89	0.89	3.07	8.12	14.47	
9	9	1.01	1.01	3.24	8.23	14.72	
10	10	1.04	1.04	3.31	8.32	14.94	
15	15	1.15	1.15	3.16	8.5	15.76	
20	20	1.16	1.16	3.12	8.6	16.25	
25	25	1.15	1.15	3.2	8.68	16.66	
30	30	1.13	1.13	3.17	8.74	17.01	
35	35	1.21	1.21	3.19	8.81	17.3	
40	40	1.21	1.21	3.29	8.88	17.58	
45	45	1.21	1.21	3.29	8.93	17.86	
50	50	1.21	1.21	3.41	9	18.15	
55	55	1.22	1.22	3.39	9.04	18.56	
60	60	1.22	1.22	3.4	9.1	18.92	
1	61	2.7					
2	62	2.83					
3	63	2.81					
4	64	2.73					
7	67	2.87					
8	68	3.07					
9	69	3.24					
10	70	3.31					
15	75	3.16					
20	80	3.12					
25	85	3.2					

Time (t) minutes	Cummulative Time Sum (t) minutes	Total D/Down (s) m	Drawdown at various flow rates				
			Flow Rate (m3/day)				
			75 m	150 m	250 m	350 m	m
30	90	3.17					
35	95	3.19					
40	100	3.29					
45	105	3.29					
50	110	3.41					
55	115	3.39					
60	120	3.4					
1	121	5.52					
2	122	5.5					
3	123	6.85					
4	124	7.07					
5	125	7.44					
6	126	7.79					
7	127	7.99					
8	128	8.12					
9	129	8.23					
10	130	8.32					
15	135	8.5					
20	140	8.6					
25	145	8.68					
30	150	8.74					
35	155	8.81					
40	160	8.88					
45	165	8.93					
50	170	9					
55	175	9.04					
60	180	9.1					
1	181	10.68					
2	182	11.73					
3	183	12.44					
4	184	13.02					
5	185	13.49					
6	186	13.87					
7	187	14.2					
8	188	14.47					
9	189	14.72					
10	190	14.94					
15	195	15.76					
20	200	16.25					
25	205	16.66					
30	210	17.01					
35	215	17.3					
40	220	17.58					
45	225	17.86					
50	230	18.15					
55	235	18.56					
60	240	18.92					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TRILOGY BORE TPB1

Sheahans Analysis

Step	Q	s 60	s/Q
1	75	1.22	0.016
2	150	3.28	0.022
3	250	8.7	0.035
4	350	17.86	0.051

P = 3

$s_{w(x)}/Q_x$ = 0.029

Q_x 200

From intercept of index line on log-log curve (Kruseman and de Ridder Pg 213)

$B = 0.5 \times s_{w(x)}/Q_x$

$C = (s_{w(x)}/Q_x)/2Q_x^{P-1}$

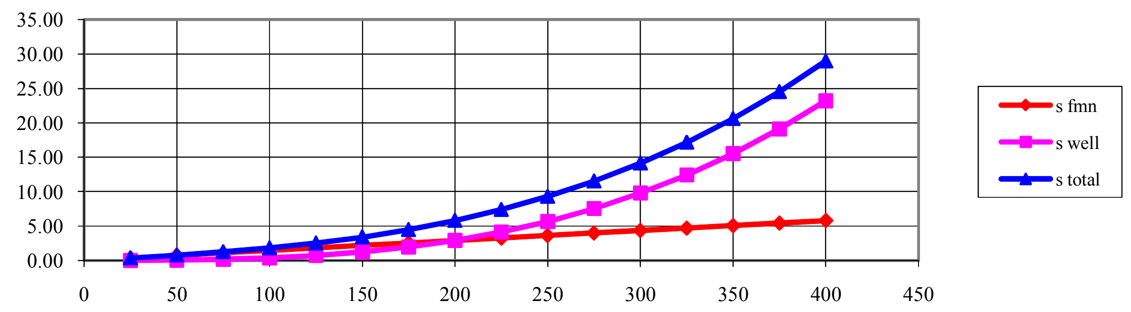
$s_w = BQ + CQ^{\wedge P}$

and B= 0.0145

C= 3.63E-07

P = 3.0

Q	s fmn	s well	s total	% well loss
25	0.36	0.01	0.37	1.5%
50	0.73	0.05	0.77	5.9%
75	1.09	0.15	1.24	12.3%
100	1.45	0.36	1.81	20.0%
125	1.81	0.71	2.52	28.1%
150	2.18	1.22	3.40	36.0%
175	2.54	1.94	4.48	43.4%
200	2.90	2.90	5.80	50.0%
225	3.26	4.13	7.39	55.9%
250	3.63	5.66	9.29	61.0%
275	3.99	7.54	11.53	65.4%
300	4.35	9.79	14.14	69.2%
325	4.71	12.44	17.16	72.5%
350	5.08	15.54	20.62	75.4%
375	5.44	19.12	24.55	77.9%
400	5.80	23.20	29.00	80.0%



TRILOGY BORE TPB1

Bierschenk & Wilson Analysis

Step	Q	s 60	s/Q
1	75	1.22	0.0163
2	150	3.4	0.0227
3	250	9.1	0.0364
4	350	18.92	0.0541

s = BQ + CQ^2
s/Q = B + CQ
or y = b + mx
Therefore s (total)=0.0038Q+1E-04Q^2
and B= 0.0038
C= 1.00E-04

Q	s fmn	s well	s total	% well loss
25	0.095	0.0625	0.1575	39.7%
50	0.19	0.25	0.44	56.8%
75	0.285	0.5625	0.8475	66.4%
100	0.38	1	1.38	72.5%
125	0.475	1.5625	2.0375	76.7%
150	0.57	2.25	2.82	79.8%
175	0.665	3.0625	3.7275	82.2%
200	0.76	4	4.76	84.0%
225	0.855	5.0625	5.9175	85.6%
250	0.95	6.25	7.2	86.8%
275	1.045	7.5625	8.6075	87.9%
300	1.14	9	10.14	88.8%
325	1.235	10.5625	11.7975	89.5%
350	1.33	12.25	13.58	90.2%
375	1.425	14.0625	15.4875	90.8%
400	1.52	16	17.52	91.3%