GINDALBIE GOLD NL

MINJAR FEASIBILITY STUDY

MINE SITE HYDROGEOLOGY AND WATER MANAGEMENT

P2167/2-BC

15 November 2000

Coffey

P2167/2-BC MOH:TS
15 November 2000

Gindalbie Gold NL
PO Box 512
WEST PERTH WA 6005

Attention: Mr A Viner

Dear Sir,

RE: MINJAR FEASIBILITY STUDY
MINE SITE HYDROGEOLOGY AND WATER MANAGEMENT

Attached please find out report on mine site hydrogeology and water management, carried out as part of the Minjar Feasibility Study.

Please do not hesitate to contact the undersigned should you have any queries concerning the content of this report.

For and on behalf of

COFFEY GEOSCIENCES PTY LTD

M O HILLMAN

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1. INTRODUCTION

Gindalbie Gold NL (Gindalbie) are developing the Minjar project, located in the Yalgoo Goldfields, Western Australia.

Coffey Geosciences Pty Ltd (Coffey) have been appointed by Gindalbie to undertake studies leading to a bankable feasibility document in the following areas:

- mine pit geotechnics;
- mine site hydrogeology and water management;
- tailings management;
- associated geotechnical engineering.

Five separate reports have been prepared by Coffey to address the above areas (one report for each pit under "mine pit geotechnics"). This current report has been prepared to advise on mine site hydrogeology and water management.

2. MINE WATER DEMAND

The overall feasibility study is based on a plant throughput of 500,000 dry tonnes of ore per year. During mine start up, with no water returns from tailings operations, and assuming process solids contents of 40% by weight, almost 2000kL/day of water will be required above initial ore moisture content for processing. Additional water supplies will be required:

- for domestic/gold room consumption (100kL/day)
- for dust suppression and other uses (400kL/day).

A start up mine water supply in the order of 2500kL/day will be required.

It is anticipated that as tailings water recovery from the tailings dams improves, water will be recycled to the plant at rates which will range from 200kL/day to 1500kL/day (depending on seasonal conditions), and as a result, mine water demand after recycling will fall to between 1000kL/day and 2300kL/day (note water balance for tailings dam, at Appendix A).

A reliable source of suitable water to meet process and dust suppression requirements for the mine site, has been identified. This source is mine dewatering water from the nearby Golden Grove mine. We are advised by Gindalbie that Golden Grove are prepared to allow Gindalbie access to this water and that it will be free of fines. Recovery of the water will occur prior to Golden Grove pumping the water to waste.

In addition to the above, however, it will be necessary for Gindalbie to dewater its mine pits and dispose of dewatering waters. These waters would also be suitable for mine process water and dust suppression. Studies have been undertaken to provide an initial assessment of the likely contribution of pit dewatering waters to mine supplies, and therefore the need to draw on Golden Grove supplies.

The comparatively small domestic water requirements could possibly be taken from M1 pit dewatering. It is more likely that a bore will be drilled to intersect a chert/BIF water yielding zone immediately west of the mine village site, to provide a good quality water supply.

3. FIELD TESTING

Field testing has comprised a number of separate programmes, as follows:

- airlifting of exploration boreholes following drilling of the boreholes, to provide an indication of regional water yielding conditions. Appendix B presents the results of the airlift programmes carried out by Gindalbie in August 2000;
- packer permeability testing in cored boreholes drilled at the two pits studied during the course of the feasibility study, M1 and Silverstone. Appendix C presents a summary of packer permeability test results conducted in HQ and PQ exploratory boreholes;
- soakage dissipation rate monitoring of water filled sumps (from pumping test, see below). Monitoring results are discussed in Appendix D;
- construction of groundwater pumping bores, and completion of pumping tests on these bores at M1 and Silverstone. Appendix E presents pumping test data.

4. LABORATORY TESTING

Water samples collected during pumping tests have been analysed to assess major anions, cations, pH, alkalinity, hardness, nitrogen, phosphorus and iron content. Laboratory test results are presented in Appendix F.

5. SITE CONDITONS

5.1 Geology

Reference should be made to reports P2167/2-BD and BE of October 2000 concerning geological descriptions of the M1 and Silverstone prospects. A summary of the site specific geology is presented below.

5.1.1 Regional Setting

The South Murchison Project is located within the Yalgoo-Singleton Greenstone Belt in the Southern Murchison Province of the Yilgarn Block of Western Australia. The Greenstone Belt strikes approximately north-south and comprises a sequence of varibly foliated Archaean sedimentary and volcanic rocks. The greenstone belt contains a number of regional scale shear zones, some of which are associated with mineralisation. Both the M1 and Silverstone mineralisation are inferred to be associated with the north-northwest trending Mouggooderra shear zone. The Siverstone mineralisation is located within the main Mouggooderra shear and M1, located 8km to the north-northwest, is adjacent to the west of the main shear structure.

Lower lying areas are overlain by a comparatively thin ferricrete horizon comprising both ferruginised bedrock and transported soils, in turn overlain by uncemented sandy gravels and surficial silty sands.

5.1.2 M1 Prospect

Mineralisation at M1 occurs within a talc-silica-carbonate zone of alteration trending north-northwest and dipping to the west at an overall angle of about 50°. Hangingwall units comprise high magnesium basalt, thin Banded Iron Formation (BIF) and metasediments, dolerite and ultramafic units. The footwall consists of metabasalt and gabbro. The footwall and hanging sequences have been deformed to produce variably foliated schists.

Mineralisation is restricted to one main lens situated near the footwall of the altered zone. In the primary zone, the main lens averages about 3m wide, but increases to approximately 20m wide within the high grade supergene zone extending down to 50m below ground surface.

Gindalbie are currently compiling plans of the structural geology encompassing the M1 pit, which show faulting across the ore zone and other structural features.

5.2 Silverstone Prospect

Mineralisation at Silverstone occurs within a talc-carbonate-massive silica alteration zone trending north-south and dipping steeply to the west. Hanging wall units consist of mafic, ultramafic and minor metasediments units. The footwall consists of black shale and metasediments. Mineralisation occurs within a main ore zone located adjacent to the hangingwall side of the black shale unit and also a discontinuous zone of mineralisation within the hangingwall. As with M1, the units at Silverstone have been variably foliated to produce schistose rocks.

5.3 Groundwater

Groundwater was intersected at approximately 20m vertical depth below ground surface at both M1 and Silverstone Pits (note groundwater elevations Appendix E, Table E1). Airlift yields from exploratory boreholes for both pits showed water yielding conditions (primarily associated with the ore zones) which were consistent along strike, and suggest continuity of water yielding conditions along strike.

Packer permeability testing showed the bedrock in both footwall and hangingwall sequences to generally be low yielding. Very low permeabilities are evident in the clays (top of oxide profile).

High groundwater yields were encountered within the ore zone and in close proximity to it (eg in the upper 5m of the footwall – note MJDD022 at 55m inclined depth, and MJDD021 at 58m inclined depth). Packer permeability testing was not targeted at the ore zone, because airlift testing had shown this zone to be high water yielding.

Comparatively high groundwater yields were also encountered in discontinuities in the hangingwall sequences. Thus water yielding conditions were evident in M1DD20 from 50 to 70m inclined depth, associated with cross cutting quartz veins in moderately to slightly weathered rock. It can be anticipated that generally small groundwater yields will be found near the base of the rock weathering profile, associated with rock stress release zones, and where the rock fabric has not weathered sufficiently to act like a clay.

Pumping test results demonstrated significant water storage, and very high permeabilities associated with the ore zone. Drawdown responses were measured hundreds of metres along strike in response to pumping tests (note M1 test, observation site M1WB01), providing further evidence in support of the airlift test results, that water yielding conditions are continuous along strike within the pit, and are not compartmentalised.

The water table was generally below the base of the ferricrete/above the bedrock subcrop, at both M1 and Silverstone. However at a proposed (now abandoned) tailings disposal site immediately northwest of M1, the subcrop of the clayey oxide rock was some 20m below ground surface, and overlain by a weakly to uncemented sand zone which in turn was overlain by ferricrete. Airlifting during sterilisation drilling at that site established significant groundwater yields in a third water yielding zone, which is judged to be perching on the clayey oxide subcrop. This third zone is unlikely to have direct hydraulic content with the main water yielding zone, given the low permeability clayey soils that underlie it. Monitoring of soakage rates from the sumps at MI and at Silverstone suggest permeabilities in the Ferricrete of the order of 0.02m/d (see Appendix D).

5.4 Groundwater Throughflow

Hydraulic gradients can be inferred along strike at both M1 and Silverstone, based on standing water levels measured in the vertical water bores (see Appendix E, Table E1).

At Silverstone, groundwater levels fall from south to north some 0.7m over 646m between vertical water bores at either end of the pit (hydraulic gradient i = 1.1×10^{-3}). There is a further 6m fall in groundwater levels between Silverstone and M1 (eight kilometres to the north). At M1, groundwater levels continued to fall from south to north some 2.6m over a distance of 326m between the vertical water bores at either end of the pit (hydraulic gradient i = 8×10^{-3}).

Adopting an ore zone cross sectional area and typical permeability as discussed in Section 6.1 of this report and illustrated in Figure 4, then indicative natural groundwater throughflow along the ore zones at both pits is as set out below:

Silverstone:	Throughflow	60kL/day
M1:	Throughflow	80kL/day

5.5 Groundwater Quality

The water quality pumped at M1 and at Silverstone was monitored during the course of pumping, using a field conductivity meter. Water quality at M1 remained comparatively consistent at 1.67mS (about 1200mg/L TDS). This is comparatively fresh.

Some 14 samples were also collected at M1 during the programme of airlifting of exploratory boreholes (see Table 1). These show salinity varying from 0.76mS to 2.57mS (about 500mg/L to 1800mg/L TDS). The lower salinity bores may provide an indication of a recharge path (rainfall recharge) to the aquifer zone. The results show a possible trend of increasing salinity from west to east, possibly suggesting some recharge off the ridge line west of M1.

Water quality at Silverstone during the pumping test showed a progressive decline from 8.54mS at the beginning of the test, to 9.54mS at the termination of the test (about 6000mg/L TDS to 6700mg/L TDS). Silverstone water is saline, and may deteriorate in quality further, as pumping continues.

TABLE 1 GROUNDWATER QUALITY – FIELD CONDUCTIVITY TESTING

Bore	Electric Conductivity	Comments
M1 RB 068	1.54	
M1 RB 070	2.57	
M1 RB 074	1.11	
M1 RB 078	0.92	
M1 RB 080	2.30	
M1 RB 082	1.13	
M1 RB 083	2.21	
M1 RB 086	2.34	
M1 RB 088	2.47	
M1 RB 089	2.35	

TABLE 1 GROUNDWATER QUALITY (CONT)

Bore	Electric Conductivity	Comments
M1 RB 102	1.02	
M1 RB 104	0.76	
M1 RB 115	1.07	
M1 RB 176	1.41	
M1 MB02	1.67	M1 Pump Test
MJWB01	8.54 to 9.54	Silverstone Pump Test

The results of analyses of major ions and other selected parameters from samples collected prior to the termination of each pump test, are presented in Appendix F.

The laboratory test results show M1 as comparatively fresh water (total dissolved salts less than 1000mg/L). It is an alkaline, high carbonate hardness water and would require pre-treatment to reduce hardness if used for domestic purposes. Nitrate nitrogen levels are elevated (this is an issue if the water is to be drunk over a prolonged period by infants or expectant mothers).

Silverstone pump test water is brackish to saline (total dissolved salts over 6,000 mg/L). It differs in salt balance (and therefore geological origin) from M1 water in that carbonate content is comparatively low. The water is predominantly sodium chloride. Silverstone water is not suitable for salt sensitive vegetation. It is a suitable water for dust suppression and mine process water requirements.

6. HYDROGEOLOGICAL MODEL

6.1 Conceptual Model

Figure 4 illustrates a conceptual hydrogeological "model" for both the Silverstone and the M1 pits. Two major water yielding zones have been identified:

- the ore zone itself, dipping to the west;
- a zone extending across footwall and hangingwall sequences, near the base of the rock weathering profile.

A third "perching" water zone (groundwater perching on the top of the oxide bedrock and at the base of the ferricrete) has previously been noted, but is unlikely to significantly affect dewatering yields for the two pits.

Permeabilities associated with the ore zone are judged to be significantly greater than permeabilities associated with the base of weathering, and other lesser bedrock discontinuities based on inspection of core, a comparison of airlift results from those bores that intersect the ore zone (compared to those that do not), and the drawdown responses observed during pumping testing for significant distances along strike. An indication of upper limit aquifer parameters for the ore zone can be assessed by assuming they dominate the overall performance of the aquifer system, and therefore the influence of the zone at the base of the weathering profile can be "ignored".

In order to make this assessment, it is necessary to "adopt" a cross sectional area (typical width times typical depth below the water table through which most of the groundwater flows). The cross sectional area adopted for both pit water yielding ore zones, is 1000m^2 (15 to 20m width; 60m saturated vertical thickness).

At Silverstone South bore, a constant yield of 960kL/day was maintained for about 14 hours. Setting aside initial "well loss" for the pumping bore, it is judged that the pumping induced a typical hydraulic gradient along strike of about 0.004, with drawdown at the pumping bore about 2.8m above well loss. A permeability of the order of 100m/day (rounded up to one significant figure) can be inferred from Darcy's Law. A specific yield of the order of 3% (to one significant figure) can also be inferred, using a similar logic.

At M1, a constant yield of 300kL/day was maintained for 1 day (yields were subsequently allowed to increase during a second day of pumping). Using the same approach as Silverstone, a typical hydraulic gradient along strike of about 0.01 was inferred, for a drawdown at the pumping site over and above well loss of about 3m. A permeability of the order of 20m/day (rounded upwards to one significant figure) and a specific yield of the order of 2% (to one significant figure) were inferred.

The above figures are likely to be upper bound, because they would be reduced as the contribution from the base of weathering water yielding zone increased. Sensitivity analyses using preliminary numerical models, suggest that the levels of drawdowns observed would not have occurred if permeabilities were less than one fifth of the upper bound figures. Therefore the adopted range of permeabilities for the ore zone is:

- Silverstone: 20 <k(m/d) <100
- M1: 4 <k(m/d) <20

It is not possible from the data available, to attempt to predict a range of specific yields for the ore zones at the two pits.

Packer permeability testing and also airlift testing for the footwall and hangingwall sequences, suggest generally low permeabilities (less than 0.01m/day) and specific yields (less than 0.5%). However water yielding zones other than the ore zone do exist in association with such rock discontinuities as fractured quartz veins, or simply zones of rock stress release (ie within the bedrock weathering profile). Such zones are generally near the base of the rock weathering profile, where the rock has not weathered to a clayey fabric.

These zones are not uniform in permeability, thickness, or depth. Nor is it certain how continuous such zones may be. For modelling studies, it is assumed that a zone 10m thick, subcropping 25m below the water table with a range of permeabilities from 0.1m/day to 0.5m/day occurs.

Figure 4 illustrates the conceptual model as described above. Table 2 presents a summary of the aquifer parameters assigned to each component of the model.

TABLE 2 CONCEPTUAL HYDROGEOLOGICAL MODEL

Rock Unit	K(m/d)	Sy	Comment
1	$20 < k_1 < 100$ (Silverstone)	3%	Width (20m) and depth (60m) of water yielding zone assumed
	$4 < k_1 < 20$ (M1)	2%	
2	0.1 <k <0.5	1%	Depth (25m) and thickness (10m) assumed
3	k <0.01	<0.5%	

K – Permeability (m/d)

Sy – Specific Yield (%)

Rock Unit – as illustrated on Figure 4

In undertaking assessment of the model, it is also necessary to understand the possible "boundary" conditions which control the extent of the zone of influence of pumping.

Boundary conditions could comprise "barrier" or no flow boundaries. For instance, a fault line displacing the ore zone 10's of metres out of alignment could be sufficient to prevent continuous flow (through the fault) along the ore zone. On the other hand, "constant head" boundaries provide a permanent source of water to the rock formations, and are not affected by pumping. An example of a "constant head" boundary would be a nearby permanent lake. At M1, the comparatively close proximity to the Moogoudera Shear to the east of the pit and other subparallel water yielding zones, may act like a "constant head" boundary.

Finally, the model responses will be influenced by direct rainfall recharge within the zone of influence of pumping. This is assumed to be very small for both M1 and Silverstone, given the low permeability of the clayey oxide rocks, and the low rainfall and high evaporation of the region.

The model as described above is highly complex. None of the aquifer zones would be expected to be homogenous or isotropic. There is uncertainty as to geometry, the magnitude of aquifer parameters, boundary conditions and possible extent of rainfall recharge.

Nevertheless, the dominant characteristic is its apparent linearity. The affect of this linearity is that as the main water yielding zone (the ore zone) is dewatered, water levels decline for a considerable distance along strike comparatively uniformly. Groundwater flow from encompassing rocks does not occur radially towards the pumping bores, but laterally towards the ore zone.

In the short term (days and weeks), the pumping yields may be determined by the storage and permeability of the ore zone. However in the longer term, the ore zone is only a conduit, and pumping yields will be determined by what are typically low permeability encompassing rock formations. In the longer term, the dewatering yields will be determined by the length of uninterrupted flow along the conduit, the water yielding properties of the base of weathering zone, and the distance laterally, to water zones that provide a "constant head" boundary.

The conduit does however provide a mechanism for lowering water levels around a proposed pit, and as a result, the primary pit dewatering approach is to intersect the conduit at either end of the pit with a pumping bore screened below the pit floor, and use the pumping bores:

- to cut off flow from outside the pit, along the conduit;
- to drain the conduit and the pit, as the conduit itself dewaters footwall and hangingwall sequences.

6.2 Numerical Modelling

Not with standing the difficulties in attempting to assign geometry and parameters to the water yielding zones, and overall boundary conditions to a pumping regime, a finite difference model has been prepared based on the conceptual model outlined in Section 6.1

The model is based on the US Geological Survey "MODFLOW" seepage modelling package. Analyses have been concerned with the magnitude of groundwater yields required to dewater the pit some 30m below current groundwater levels within 6 months of pumping (ie dewatering for proposed starter pits). Model boundaries have been assigned as follows:

- constant head conditions at 500m distance laterally, from the centre of the pit. Based on possibility of a number of subparallel water yielding structures which, in combination, will act as a constant head boundary;
- barrier boundary conditions at 1000m along strike from the centre of the pit, to represent faulting, cross cutting dolerite dyke or other possible low yield geological features.

The model has been prepared as a three layer model, with the second layer representing the base of weathering water yielding zone, and the main ore body water yielding zone (in a vertical structure) intersecting all three layers. Analysis for M1 based on the geometry and parameters presented in the conceptual model at Table 2, adopting k_2 = 0.2m/d and k_1 = 10m/d, and assuming a combined 400kL/day is pumped from the 2 bores (one located at each end of the pit), shows similar drawdown profiles to the M1 pumping test (300kL/day over 2 days) and suggests that the water table will be lowered some 20m in the pit, within about 6 months of commencement of pumping. Drawdown profiles plotted against time, and the logarithm of time, for the centre of the pit, and against distance along the ore zone from the centre of the pit for selected pumping times, are presented in Appendix G.

A similar analysis for Silverstone (but assuming k_1 = 50m/day, s_1 = 0.03) suggests yields may be 50% greater over the 6 month period.

7. DISCUSSION

7.1 Dewatering

Based on the results of the hydrogeological testing programme, dewatering of the M1 and Silverstone pits can be substantially achieved by pumping from dewatering bores located to intersect the main water yielding zone below the pit floor, at either end of each pit.

The initial dewatering bores should be targeted at lowering the water table over the depths required for the initial 6 months of mining. Existing production bores at the south end of Silverstone, and at the north end of M1 are adequate for this purpose. Production bores will now be required to be constructed at the north end of Silverstone, and the south end of M1. Bores targeted to hit the ore zone well below the initial 6 months of mining depths, may not be as effective in the initial lowering of water tables, and are not proposed at this time.

Indicative yields for M1 and Silverstone pits for this initial period, are 400kL/day and 600kL/day respectively. However given the variability in the water yielding conditions in the base of weathering horizon zone, and the unknown influences of various boundary conditions, the range of possible yields could extend beyond half to double the above figures.

New production bores should be cased with 155mm NB class 9 UPVC, with 1mm aperture slots, and with gravel pack.

It is not anticipated that dewatering bores will be required to intersect the base of weathering water yielding zone at locations other than the ore zone bores, because dewatering from the ore zone is expected to depressurise such zones, and yields are expected to be small. Nevertheless, provision may need to be made to collect seepage flows from areas identified as the pit is deepened, and also to install horizontal drains in pit walls to assist in draining localised water pockets.

7.2 Water Supply

Dewatering yields from M1 and Siverstone are judged to be of the order of 1000kL/day (combined) during the first 6 months of operations. Higher yields are achievable from the pits during initial months of pumping, but this would be expected to result in more rapid drawdowns. As water levels fall below the base of the weathering water yielding zone, yields are expected to decline significantly.

If Silverstone water is not pumped to the M1 treatment plant, then it would be reasonable to assume:

- haul road dust suppression could be substantially met by Silverstone;
- a pumping yield of 500kL/day could be sustained from M1 during a 3 to 4 month start up period;
- therefore water required from other sources to meet mine demand during start up, will be say 1800kL/day (see Section 2).

Assuming water is pumped from Golden Grove at a distance of 8 to 9km, to the plant site, then a Poliplex PE100, PN8 pipeline, 180mm diameter would be anticipated to have a pressure loss of 40m to 45m due to pipe friction, and presents a suitable pipe for this purpose, allowing for other pipe losses, and possible head differences between source and delivery. Detailed design studies will be required to accurately size the proposed pipe.

If Silverstone water, or other local sources of water can be added to the supply at the plant site, it would be possible to reduce the size of pipe required to deliver water from Golden Grove to a Poliplex PE100, PN10 pipeline, 160mm diameter.

Once the tailings dams are fully operational, water returns from tailings operations are anticipated to range between 200kL/day and 1500kL/day depending on seasonal conditions.

The additional pipeline capacity released as a result of tailings waters recovery, provides a buffer should the plant throughput be increased above 500,000 dry tonnes/year, but does not allow for a major increase in plant throughput.

Consideration will need to be given to the final size of pipeline, and its pressure rating, taking into account start up demand, seasonal demand ranges, whether Silverstone water is to be piped to the plant site or not, the possibility of plant upgrades, and the pipe route (changes in elevation, length).

It is anticipated that a separate water supply will be provided for village water supply purposes, by intersecting fractured chert rocks below the water table, immediately west of the proposed village site. Gold room water supplies are expected to come from the comparatively fresh M1 dewatering water.

The possibility of locating additional groundwater supplies for process water in the region (over and above water from M1 and Silverstone) is judged to be good. Targets include the Moogoudera Shear east of M1, and thick chert/BIF beds evident in the ridge line west of M1.

7.3 Disposal of Silverstone Dewatering Water

Dewatering analyses indicate that in the long term (6 months) dewatering yields from Silverstone are likely to be of the order of 600kL/day.

If most of the water required for mine site dust suppression can be taken from Silverstone (say 300kL/day of the 400kL/day nominated in Section 2), then a further 300kL/day will need to be disposed of either by piping to the plant site, or by evaporation.

Assuming 1500mm/year can be lost from a large pond as a result of net evaporation (taking into account annual average evaporation from Paynes Find and Yalgoo are 2480 and 2140mm respectively, adopting a pond factor of about 0.7, and allowing for rainfall), then an area of approximately 2.5 hectares would be required for each 100kL/day to be disposed of by evaporation.

An alternative option is to construct a water holding dam of sufficient capacity to hold the excess water for the duration of mining of Silverstone, after which it could be allowed to drain back into the (mined) Silverstone pit and disperse into the water yielding zones, or allowed to evaporate over a prolonged period, with no water inflow to it.

Either evaporation ponds or water holding dam may need to be sized to accommodate a significantly larger yield from Silverstone, should the estimates presented from the numerical analyses, underestimate the dewatering rates required.

If water other than required for dust suppression from Silverstone was to be piped to M1, then a PE100, PN10 Poliplex pipe 110mm NB, would be expected to deliver in excess of 500kL/day. If yields have been underestimated, it may be necessary to increase the pipe size to 125mm NB.

It is recommended that feasibility design studies be based on the 110mm NB pipe option, with alternative options considered during detailed design studies.

7.4 Further Investigations

The drawdown versus time graph prepared for M1 in Appendix G, shows that the rate of drawdown when plotted against the logarithm of time, continues to increase beyond 20 days of pumping. Any field testing to adequately test the numerical model would need to be of a duration for constant rate of drawdown to be achieved (say 30 days). Given that all M1 water can be used by the mine as process, dust suppression, and/or domestic (gold room) water, then refining M1 yield estimates is not critical. Therefore further testing can be restricted to the construction of the southern dewatering bore, and pumping tests for 1 day on that bore (such a duration is not sufficient to test the model).

Silverstone faces a different problem, in that infrastructure has to be developed to "use" the pumped water:

- a pipeline to M1 plant site (where the water can be used in the process, as well as for dust suppression); or
- evaporation ponds/holding dam at Silverstone.

It is recommended that a long term constant rate pumping test be undertaken using the existing Silverstone South bore, with pumping rate of 900kL/day for a minimum 20 days. The water will need to be piped to sumps/holding dams of sufficient capacity (almost 20,000kL) to retain the water until it can either seep back into the ground, or evaporate. The test should be designed to monitor drawdowns across the full length of the pit, and to monitor for boundary conditions. It is envisaged that this test could be conducted by Gindalbie field personnel after purchase of an adequate pump, fittings, discharge pipeline, and hire of generator. Detailed specifications for this test could be prepared by Coffey.

Other testing proposed at Silverstone includes the construction of the new northern dewatering bore, and bore testing (1 day).

Based on analyses of the long term pumping test, a decision can be made whether to design and install a pipeline to M1 (the case to be adopted in project costing for the feasibility study), or whether the yields can be managed by on site storage and evaporation.

It is recommended that drilling be carried out to construct a water bore to supply domestic water to the proposed mine village. The bore should be located to intersect BIF/chert water yielding zones west of the mine camp. A 1 day pumping test should be undertaken on the successfully constructed bore.

For and on behalf of

COFFEY GEOSCIENCES PTY LTD

Information

Important information about your **Coffey** Report

As a client of Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Coffey to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Coffey and applies only to the site investigated. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of the subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Coffey to be advised how time may have impacted on the project.

Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

Important information about your **Coffey** Report

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Coffey to work with other project design professionals who are affected by the report. Have Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they have incorporated the report findings.

Data should not be separated from the report*

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way.

Logs, figures, drawings etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment. Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Coffey for information relating to geoenvironmental issues.

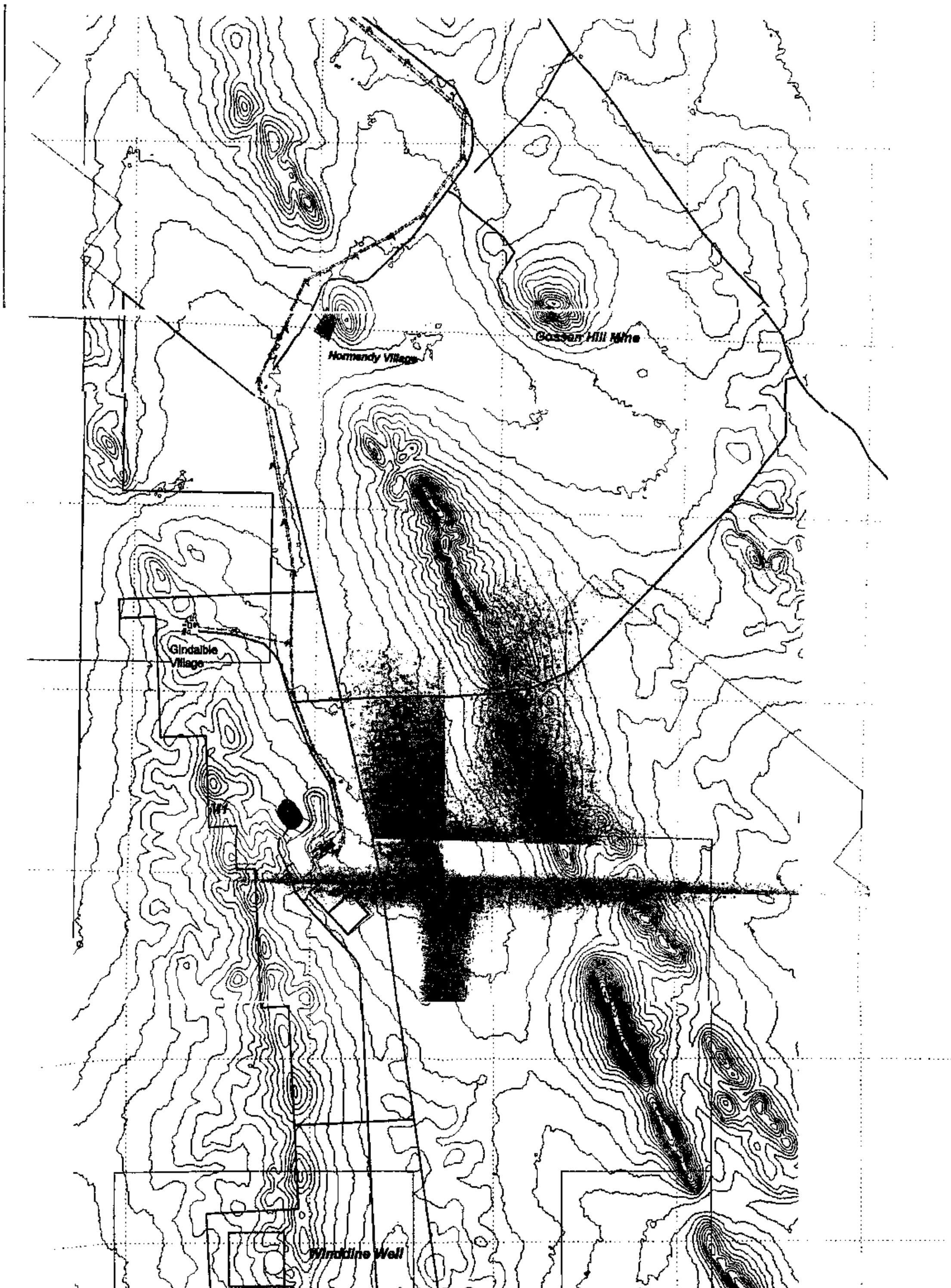
Rely on Coffey for additional assistance

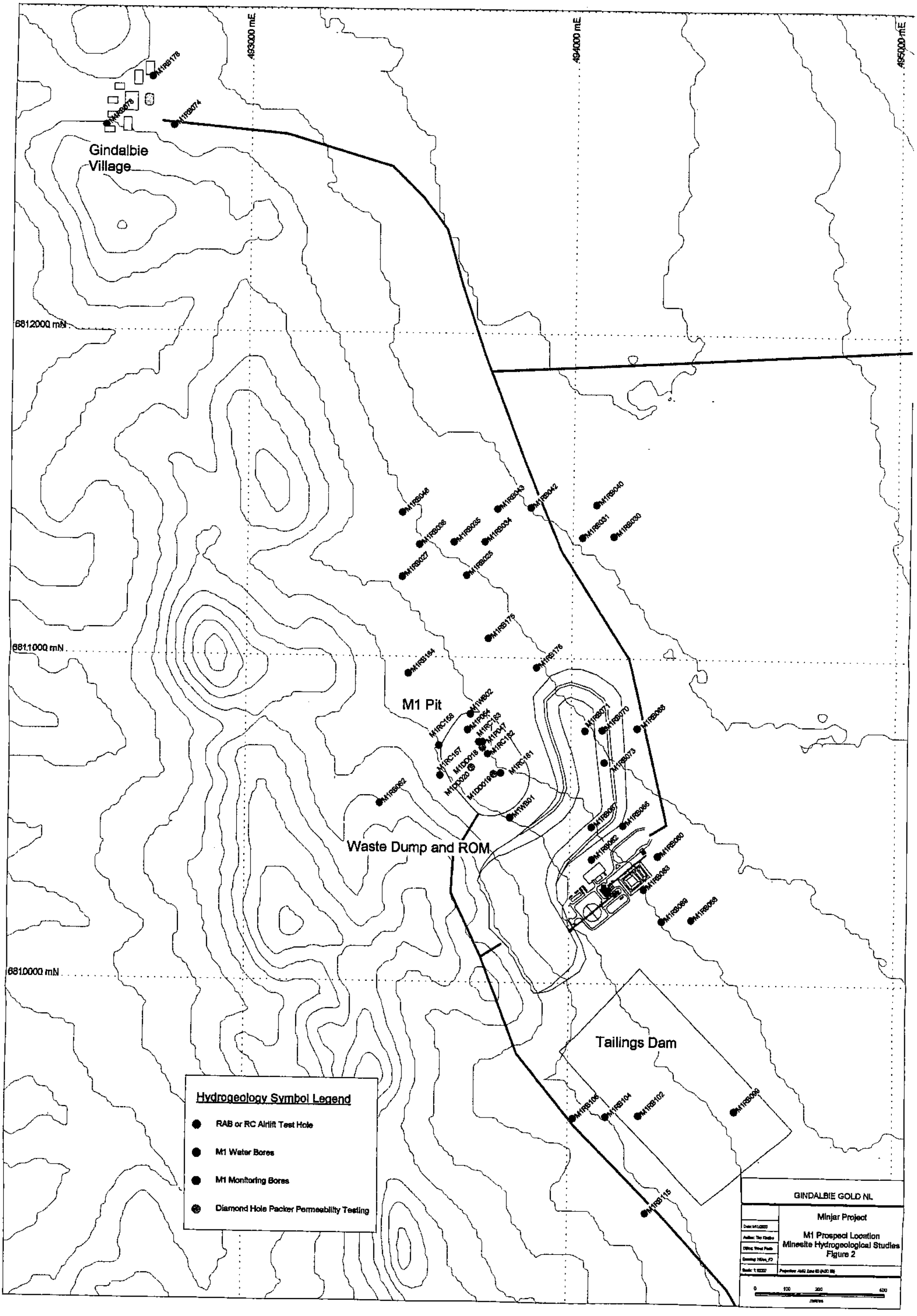
Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design toward construction, speak with Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

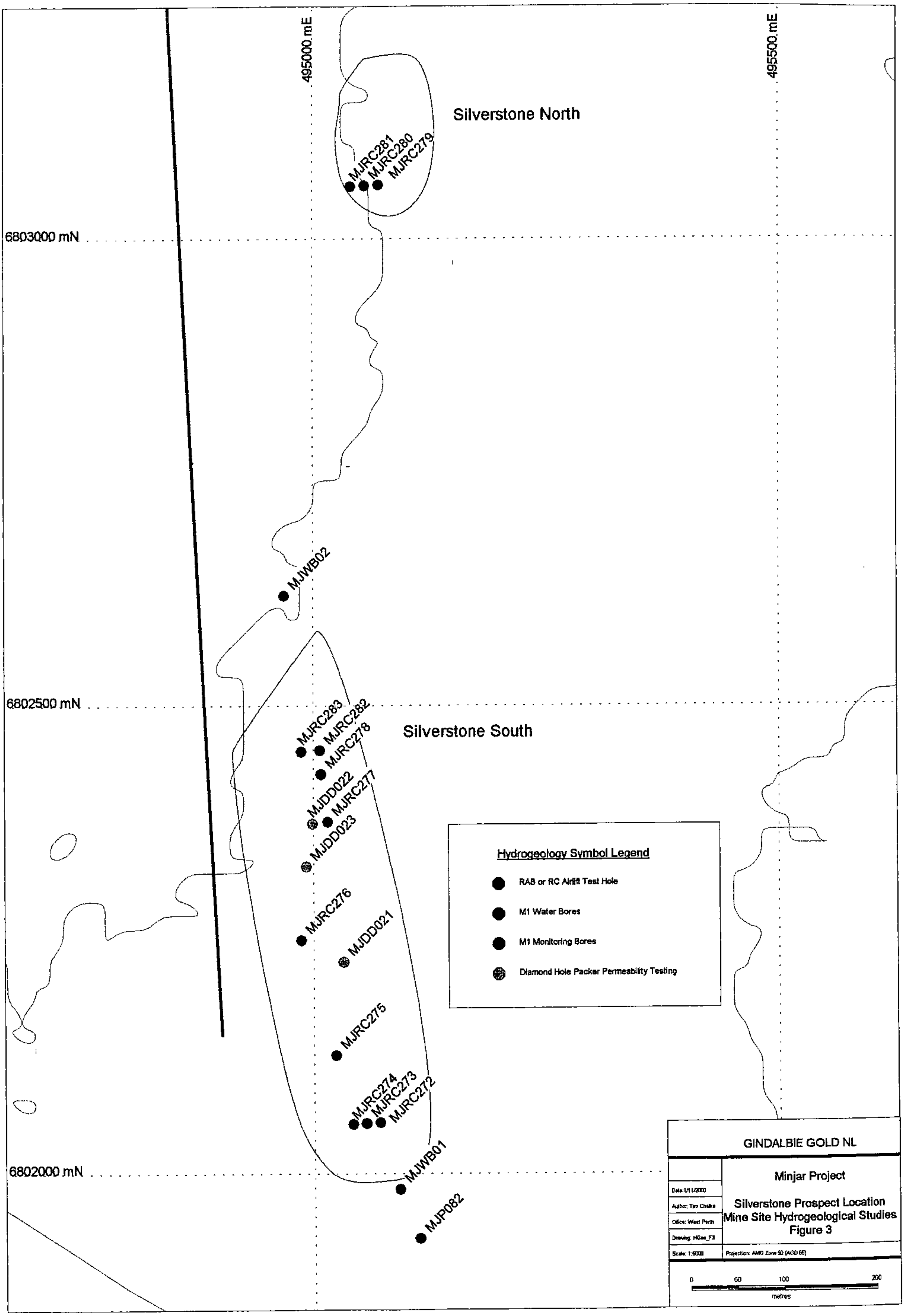
Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Coffey to other parties but are included to identify where Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Coffey closely and do not hesitate to ask any questions you may have.

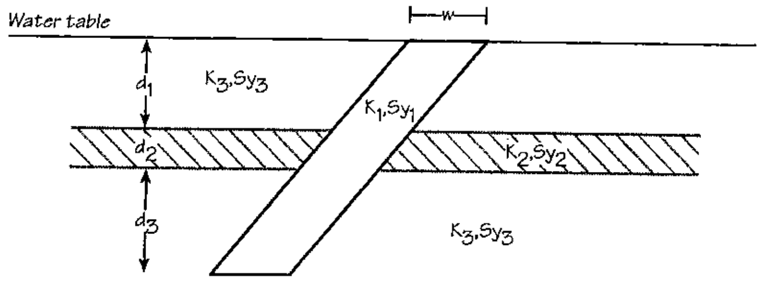
** For further information on this aspect reference should be made to "Guidelines for the Provision of Geotechnical Information in Construction Contracts" published by the Institution of Engineers Australia, National Headquarters, Canberra, 1987.*


Normandy Village
Gossan Hill Mine
Gindalbie Village


493000 mE
494000 mE
495000 mE
6812000 mN
6811000 mN
6810000 mN
Gindalbie Village
M1 Pit
Waste Dump and ROM
Tailings Dam
Hydrogeology Symbol Legend
RAB or RC Airlift Test Hole
M1 Water Bores
M1 Monitoring Bores
Diamond Hole Packer Permeability Testing
GINDALBIE GOLD NL
Minjar Project
M1 Prospect Location
Minesite Hydrogeological Studies
Figure 2
0
100
200
400

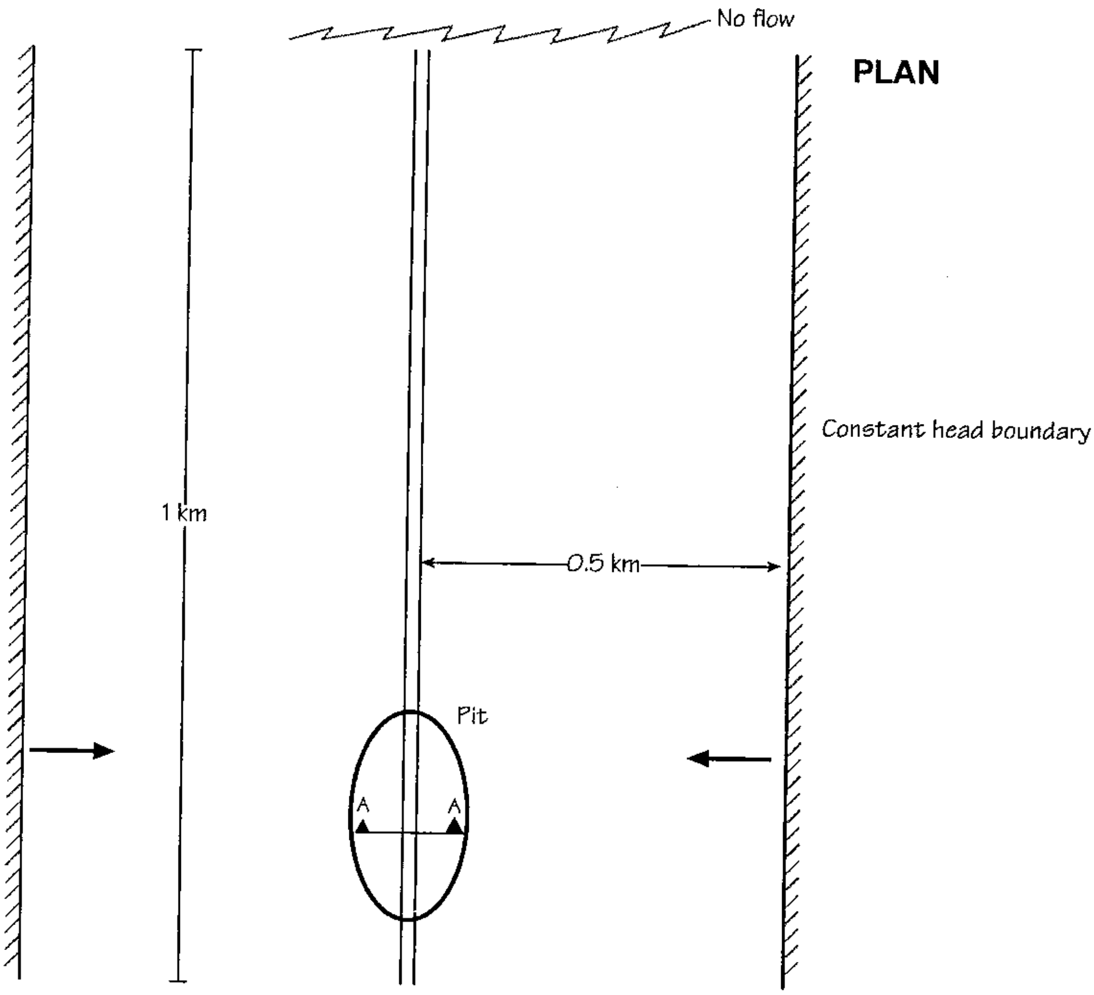

495000 mE
495500 mE
Silverstone North
MJRC281
MJRC280
MJRC279
6803000 mN
MJWB02
6802500 mN
Silverstone South
MJRC283
MJRC282
MJRC278
MJDD022
MJRC277
MJDD023
MJRC276
MJDD021
MJRC275
MJRC274
MJRC273
MJRC272
MJWB01
6802000 mN
MJP082
Hydrogeology Symbol Legend
RAB or RC Airlift Test Hole
M1 Water Bores
M1 Monitoring Bores
Diamond Hole Packer Permeability Testing
GINDALBIE GOLD NL
Minjar Project
Silverstone Prospect Location
Mine Site Hydrogeological Studies
Figure 3
Date:1/11/2000
Author: Tim Chalke
Office: West Perth
Drawing: HGeo_F3
Scale: 1:5000
Projection: AMG Zone 50 (AGD 66)
0
50
100
200
metres

SECTION A-A



w = 15 to 20m	K_1 = (Silverstone)	20<	K_1	<100	(m/d)
d_1 = 25m	K_1 = (M1)	4<	K_1	<20	(m/d)
d_2 = 10m	Sy_1 = (Silverstone)		3%		
d_3 = 25m	Sy_1 = (M1)		2%		
	K_2	0.1<	K_2	<0.5	(m/d)
	Sy_2		1%		
	K_3		<0.01%		(m/d)
	Sy_3		<0.5%		

PLAN



Coffey GeoServices Pty Ltd
Report P2167/2-BB
Appendix C

CONCEPTUAL HYDROGEOLOGICAL MODEL

GIN0025, 1/11/00

Figure 4

APPENDIX A

TAILINGS WATER BALANCE

TAILINGS DAM WATERBALANCE WORK SHEET

PROGRAM: ***TAILS***

PURPOSE: TO CALCULATE MONTHLY REMOTE BOREFIELD DEMAND OR MONTHLY EXCESS WATER GENERATED BY THE TAILINGS LIQUOR CIRCUIT.

JOB NUMBER	P2167/2
DATE:	29 SEPT. 00
CLIENT NAME:	GINDALBIE GOLD NL
PRINCIPAL NAME:	GINDALBIE GOLD NL
PROJECT LOCATION:	YALGOO
PROJECT DESCRIPTION:	TAILINGS STORAGE FACILITY
SPREADSHEET AUTHOR:	M.O.HILLMAN 12 February 1996
SPREADSHEET USER:	M.O.HILLMAN
JOB TITLE:	WATER BALANCE
RUN TITLE:	LONG TERM AVERAGE RAINFALL/ EVAPORATION CONDITION

PLANT THROUGHPUT (DRY TONNE / DAY)	1370
ORE MOISTURE CONTENT (% BY WEIGHT)	3
TAILINGS SOLIDS CONTENT (%)	40
SOLIDS SPECIFIC GRAVITY	2.8
DRY DENSITY AT TIME OF SPIGOTTING (T/CU.M)	1.35
RAINFALL RUNOFF CATCHMENT (SQ.M)	180000

MONTH:	January	February	March	April	May	June	July	August	Septemb.	October	November	December	TOTAL
DAYS:	31	28	31	30	31	30	31	31	30	31	31	31	365
RAINFALL (mm)	15	23	26	21	32	43	36	26	11	8	8	10	259
RAINFALL SCALING FACTOR:	1	1	1	1	1	1	1	1	1	1	1	1	
ADJUSTED RAINFALL (mm):	15	23	26	21	32	43	36	26	11	8	8	10	
RAINFALL RUNOFF FACTOR:	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	
PAN EVAPORATION (mm):	381	308	270	165	105	66	74	90	150	229	288	353	2479
PAN FACTOR (drying tails):	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	
PAN FACTOR (outflow+pond):	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	
AREA UNDER TAILS (SQ.M):	180000	180000	180000	180000	180000	180000	180000	180000	180000	180000	180000	180000	
WETTED SUB AREA (SQ.M):	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	
SEEPAGE RATE (kL):	100	100	100	100	100	100	100	100	100	100	100	100	
WATER INPUT TO TAILS DAM(kL)													
INTERSTITIAL:	63705	57540	63705	61650	63705	61650	63705	63705	61650	63705	63705	63705	
SURFACE RUNOFF:	2673	4099	4633	3742	5702	7663	6415	4633	1960	1426	1426	1782	
TOTAL:	66378	61639	68338	65392	69407	69313	70120	68338	63610	65131	65131	65487	798284
WATER OUTPUT FROM TAILS DAM (kL):													
INTERSTITIAL:	16291	14715	16291	15766	16291	15766	16291	16291	15766	16291	16291	16291	
EVAPORATION:	41148	33264	29160	17820	11340	7128	7992	9720	16200	24732	31104	38124	
SEEPAGE:	3100	2800	3100	3000	3100	3000	3100	3100	3000	3100	3100	3100	
TOTAL:	60539	50779	48551	36586	30731	25894	27383	29111	34966	44123	50495	57515	496676
WATER THROUGH PROCESS CIRCUIT (kL):													
IN FEED ORE:	1274.1	1150.8	1274.1	1233	1274.1	1233	1274.1	1274.1	1233	1274.1	1274.1	1274.1	
MILLWATER DEMAND	63705	57540	63705	61650	63705	61650	63705	63705	61650	63705	63705	63705	
WATER ADDED TO PROCESS	62431	56389	62431	60417	62431	60417	62431	62431	60417	62431	62431	62431	
RECOVERABLE FROM DAM	**5839**	**10860**	**19787**	**28806**	**38676**	**43419**	**42737**	**39227**	**28644**	**21007**	**14635**	**7972**	301608
REQUIRED BOREFIELD MAKEUP	56592	45529	42644	31611	23755	16998	19694	23204	31773	41424	47796	54459	435479

APPENDIX B

AIRLIFT TEST RESULTS

APPENDIX B

AIRLIFT TEST RESULTS

Gindalbie Gold carried out a program of airlift testing on exploration boreholes drilled during their August to September 2000 exploration drilling campaign. A selection of older exploration holes were also re-entered and airlifted to provide additional airlift data.

Not all boreholes drilled were airlift tested because:

- the airlift programme did not commence until part way into the exploratory drilling programme;
- collar blow outs prevented a number of sites from being set up to conduct V notch flow measurements.

The attached table presents V notch flow results for those bores where an airlift result was recorded.

Minjar Water Flow Tests August, September 2000

HOLE	NORTH_LOCAL	EAST_LOCAL	PROSPECT	TYPE	HOLE DEPTH	AQUIFER FROM	AQUIFER TO	AIRLIFT DEPTH (m)	V-NOTCH HEIGHT (mm)	V-NOTCH YIELD (l/s)	COMMENT
MJRC272	15425	12565	Silverstone	RC	40						no test
MJRC273	15425	12550	Silverstone	RC	55	45	48				no test
MJRC274	15425	12535	Silverstone	RC	65	55	57	59	42	0.5	
MJRC275	15500	12520	Silverstone	RC	68			41	35	0.3	
MJRC275						51	55	62	40	0.4	
MJRC276	15625	12490	Silverstone	RC	89	69	74				
						81	84				
						85	87	83	38	0.4	
MJRC277	15750	12490	Silverstone	RC	45			39	37	0.4	
MJRC278	15800	12525	Silverstone	RC	40			39	28	0.2	
MJRC279	16425	12520	Silverstone	RC	50	34	44	41	45	0.6	
MJRC280	16425	12600	Silverstone	RC	59	31	43				
						46	50	47	45	0.6	
MJRC281	15825	12585	Silverstone	RC	77	24	35				
						37	39				
						42	46				
						51	62				
						66	73	74	55	1.0	
MJRC282	15825	12520	Silverstone	RC	36						no test
MJRC283	15825	12500	Silverstone	RC	53	32	37	47	40	0.4	
MJWB01	15360	12585	Silverstone	RC	83	31	32				
						59	70	77	75	2.2	155dia. Cased to 70m. Yield 9.4l/s
M1WB01	23940	11745	M1	RC	83	47	49	47	36	0.3	80dia. Cased to 42m.Stuck in clay.
M1WB02	24265	11635	M1	RC	80	31	32	77	58	1.1	155dia. Cased to 72m. Yield 2.9l/s
M1RC158	24165	11539	M1	RC	62				128	8.2	Air Lift Exceded storage
M1RC157	24073	11540	M1	RC	62				98	4.2	
M1RC181	24072	11727	M1	RC	62				8	0.0	
M1RC182	24134	11689	M1	RC	59				50	0.8	
M1RC183	24172	11663	M1	RC	57				53	0.9	
M1P047	24172	11675	M1	RC	62				45	0.6	
M1DD020	24070	11705	M1	CORE	100				25	0.1	
M1RB025	24700	11650	M1	RC	75					1.1	
M1RB027	24700	11450	M1	RC	75					0.7	
M1RB030	24800	12100	M1	RC	75					0.4	
M1RB031	24800	12000	M1	RC	69					0.6	
M1RB034	24800	11700	M1	RC	75					0.6	
M1RB035	24800	11600	M1	RC	75					1.1	
M1RB036	24800	11500	M1	RC	75					0.5	
M1RB040	24900	11950	M1	RC	75					0.9	
M1RB042	24886	11853	M1	RC	75					1.3	
M1RB043	24887	11750	M1	RC	75					0.7	
M1RB046	24888	11456	M1	RC	75					1.2	
M1RB062	23994	11350	M1	RC	75					0.7	FRESH
M1RB068	24192	12152	M1	RC	75					0.8	Conductivity 1.54mS
M1RB070	24191	12045	M1	RC	70				53	0.9	Conductivity 2.57mS
M1RB071	24192	11992	M1	RC	75					1.0	
M1RB073	24092	12047	M1	RC	75					1.0	
M1RB074	26114	10803	M1	RC	75					1.2	Conductivity 1.11mS
M1RB078	26124	10595	M1	RC	75					1.0	Conductivity 0.916mS
M1RB080	23795	12199	M1	RC	75					1.1	Conductivity 2.30mS
M1RB082	23794	11995	M1	RC	75					0.6	Conductivity 1.126mS
M1RB083	23695	12151	M1	RC	75					0.6	Conductivity 2.21mS
M1RB086	23894	12095	M1	RC	75					0.6	Conductivity 2.34mS
M1RB087	23894	11999	M1	RC	75					0.2	
M1RB088	23595	12294	M1	RC	75					1.6	Conductivity 2.47mS
M1RB089	23594	12203	M1	RC	75					1.3	Conductivity 2.35mS
M1RB099	23000	12400	M1	RC	75					0.3	
M1RB0102	22998	12105	M1	RC	61					0.7	Conductivity 1.019mS
M1RB0104	22999	12004	M1	RC	69					0.4	Conductivity 0.763mS
M1RB0106	22999	11904	M1	RC	75					0.2	
M1RB0115	22697	12112	M1	RC	73					0.4	Conductivity 1.069mS
M1RB0164	24391	11455	M1	RC	75					0.5	FRESH
M1RB0175	24489	11706	M1	RC	76					1.2	
M1RB0176	24397	11850	M1	RC	75					0.9	Conductivity 1.409mS
M1RB0178	26267	10742	M1	RC	54					1.0	

APPENDIX C

PACKER PERMEABILITY TEST RESULTS

APPENDIX C

PACKER PERMEABILITY TEST RESULTS

Gindalbie Gold carried out a programme of Packer Permeability testing concurrently with the drilling of HQ and PQ cored boreholes, during metallurgical/geotechnical/exploration drilling of the Silverstone and M1 pits in August 2000.

The attached table presents an interpretation of the permeabilities (to one significant figure) calculated by Coffey for the data presented.

Packer Permeability Test Work - Silverstone, Minjar

Hole ID	Hole Size	Depth	Pump Pressure	Fluid Vol (L) read 1	read2	Total	Time (min)	Test Length-m	ZONE	PERMEAB. (m/d)	Comments
MJDD021	HQ	61.7m	120	560	691	131	5	1	Ore zone/ Footwall	>5	Shale, highly to moderately weathered, limonite stained breaks 0.15m width. Joint parallel to cor exis 60.1m to 60.5m
MJDD021		61.7m	500	-	-	-	5				
MJDD021		61.7m	750	-	-	-	5				
MJDD021		61.7m	500	-	-	-	5				
MJDD021		61.7m	250	-	-	-	5				
MJDD021	HQ	75m	280	167	196.8	29.8	5	1	Footwall	0.07	Shale, slightly weathered, limonite stained breaks 0.2m spacing
MJDD021		75m	560	203	242.8	39.8	5				
MJDD021		75m	840	248	297.8	49.8	5				
MJDD021		75m	560	303	336	33	5				
MJDD021		75m	240	338.4	358	19.6	5				
MJDD022	HQ	55.6m	250	597	755	158	5	1	Ore zone/ Footwall	>5	Shale, highly to moderately weathered, limonite stained breaks 0.1m spacing
MJDD022		55.6m	500	-	-	-	5				
MJDD022		55.6m	750	-	-	-	5				
MJDD022		55.6m	500	-	-	-	5				
MJDD022		55.6m	250	-	-	-	5				
MJDD022	HQ	67.6m	270	889	955	66	5	1	Footwall	0.03	Shale, highly to moderately weathered, limonite stained breaks 0.1m spacing
MJDD022		67.6m	540	964	1071	107	5				pressure dropped to 610kpa after 1 min - and it was not possible to obtain 810 kpa again
MJDD022		67.6m	810	79	245	166	5				
MJDD022		67.6m	540	254	403	149	5				
MJDD022		67.6m	270	410	506	96	5				
MJDD023	PQ	35m	200	523	527	4	5	2	Hanging wall	0.01	Clay, white, with fractured chert band (Extremely weathered oxide)
MJDD023		35m	400	527.2	538.6	11.4	5				
MJDD023		35m	600	541.8	564.4	22.6	5				
MJDD023		35m	400	565.8	583.6	17.8	5				
MJDD023		35m	200	584.4	596	11.6	5				
MJDD023	PQ	45m	220	723.2	728	4.8	5	2	Hanging wall	0.005	Clay, white, with fractured chert band (Extremely weathered oxide)
MJDD023		45m	440	729	737.4	8.4	5				
MJDD023		45m	660	738.6	748.8	10.2	5				
MJDD023		45m	440	749.6	757	7.4	5				
MJDD023		45m	220	757.2	762.4	5.2	5				
											Note: tests were also attempted at depths 50 - 60 amd 60 - 70, but the ground was too permeable and the packer would not stop water flow below the rods to generate any pressure at all. Inferred to be high permeability associated with the ore zone. K>5M/D

Packer Permeability Test Work - M1, Minjar

Hole ID	Hole Size	Depth	Pump Pressure	Fluid Vol (L) read 1	read2	Total	Time (min)	Test Length-m	ZONE	PERMEAB. (m/d)	Comments
M1dd018	HQ	43.2m	100	951	952.2	1.2	5	1	Footwall	0.01	Ultramafic Schist, moderately weathered,
M1dd018		43.2m	200	952.3	954.2	1.9	5				strongly foliated, weakly silicified, limonite
M1dd018		43.2m	300	954.6	957.2	2.6	5				stained joints at 0.2m spacing.
M1dd018		43.2m	200	957.6	959.5	1.9	5				
M1dd018		43.2m	100	959.6	960.7	1.1	5				
M1dd018	HQ	60m	250	19	22.4	3.4	5	1	Footwall	0.03	Dolerite, moderately weathered, limonite
M1dd018		60m	500	23.6	29.4	5.8	5				stained joints at 0.5m, strongly foliated
M1dd018		60m	750	33	44.8	11.8	5				
M1dd018		60m	500	45.4	54.2	8.8	5				
M1dd018		60m	250	55	60	5	5				
M1dd019	HQ	61.5m	250	158.6	169.5	10.9	5	1	Footwall	0.04	Ultramafic Schist, moderately weathered,
M1dd019		61.5m	500	171	186.6	15.6	5				strongly foliated, within shear zone/ fault
M1dd019		61.5m	750	188.8	210.4	21.6	5				zone
M1dd019		61.5m	500	212	228.7	16.7	5				
M1dd019		61.5m	250	229.8	241.3	11.5	5				
M1dd019	HQ	72m	280	343.2	347	3.8	5	1	Footwall	0.009	Ultramafic Schist, moderately weathered,
M1dd019		72m	560	347.8	353	5.2	5				strongly foliated, weakly silicified, limonite
M1dd019		72m	840	353.8	360.4	6.6	5				stained joints at 0.2m spacing.
M1dd019		72m	560	361	366.2	5.2	5				
M1dd019		72m	280	366.6	370.2	3.6	5				
M1DD020	PQ	45m	220	412.2	419.2	7	5	2	Hanging	0.04	Ultramafic Schist, with quartz stringers,
M1DD020		45m	440	421.4	453.6	32.2	5		Wall		moderately weathered, limonite stained
M1DD020		45m	660	456.6	536	79.4	5				joints
M1DD020		45m	440	540	605.8	65.8	5				
M1DD020		45m	220	610	657.6	47.6	5				
M1DD020	PQ	50 - 70	270			0	5	2	Hanging	>5	Ultramafic Schist, Mw to SW, cross cutting qtz
M1DD020		50 - 70	540			0	5		Wall (?)		veins
M1DD020	PQ	88.4m	300	929	936.4	7.4	5	2	Footwall	0.02	Dolerite, slightly weathered, limonite stained
M1DD020		88.4m	600	937	947.6	10.6	5				joints
M1DD020		88.4m	900	948	960.5	12.5	5				
M1DD020		88.4m	600	961	970	9	5				
M1DD020		88.4m	300	970.2	976.6	6.4	5				
M1DD020	PQ	100m	320	50	76	26	5	2	Footwall	0.01	Dolerite, slightly weathered, limonite stained
M1DD020		100m	640	78	114	36	5				joints
M1DD020		100m	960	116	159.5	43.5	5				
M1DD020		100m	640	161	190	29	5				
M1DD020		100m	320	192	208.5	16.5	5				

APPENDIX D

INFILTRATION MONITORING – SURFACE SUMPS

APPENDIX D

SUMP DISSIPATION

At Silverstone, a sump was established adjacent the pumping bore to collect pumped water. The base of the sump terminated in an indurated/ferruginised transported clay (a clayey ferricrete, medium rock strength (?)). Monitoring of rates of dissipation of water from the sump showed a comparatively consistent 20mm/day. Dissipation occurred:

- by vertical infiltration into the ferricrete;
- through the walls of the sump into uncemented soils and the ferricrete;
- through evaporation (up to 5mm/day).

Adopting a hydraulic gradient of 1 for vertical infiltration, it is judged that the permeability of the ferricrete bore is likely to be less than 0.02m/day.

At M1, a sump some 2m x 3.6m in area was constructed adjacent the pumping bore to enable rates of vertical dissipation to be monitored through the upper soil/ferricrete horizon. The ferricrete at this site was an indurated/ferruginsed transported sand/gravel. Under repeat refilling and monitoring a steady state flow was achieved whereby water levels in the sump fell from full capacity 100mm in 105 minutes. Dissipation is likely to have occurred as for the three bullet points for Silverstone. However losses laterally through the uncemented surficial soils were judged to dominate water losses. Permeabilities in the uncemented soils were assessed to be greater than 1m/d.

The testing was repeated for both M1 and Silverstone, with water levels below the uncemented soil horizon. A record of seepage losses from 28 September 2000 to 8 October 2000 from sumps is attached. Based on this record, the permeability of the ferricrete is judged to be about 0.02m/d.

M1 Sump Seepage rates

Date	Prospect	Width (m)	length(m)	Drop(m)	Level(beolow nominal point)	Days	Seepage m3	Seepage lsec	RL from	RL To	Comment
18-Sep						1					
19-Sep						2					
20-Sep						3					
21-Sep						4					
22-Sep						5					
23-Sep						6					
24-Sep						7					
25-Sep						8					
26-Sep						9					
27-Sep						10					
28-Sep	M1	7.5	1.25			11					
29-Sep	M1	6.5	1.1	0.035	65	12	0.25025	0.00000290			
30-Sep	M1	5	1.18	0.03	95	13	0.177	0.00000205			
1-Oct	M1	3.5	1.15	0.04	135	14	0.161	0.00000186			
2-Oct	M1	3.5	1.13	0.025	160	15	0.098875	0.00000114			
3-Oct	M1	3.4	1.12	0.02	185	16	0.07616	0.00000088			
4-Oct	M1			0.065	250	17					
5-Oct						18					
6-Oct						19					

Silverstone South Sump

Date	Prospect	Width	length	Drop	Level (mm below ground surface)	Days					
18-Sep				0.1	100	1					
19-Sep						2					
20-Sep						3					
21-Sep						4					
22-Sep						5					
23-Sep						6					
24-Sep						7					
25-Sep						8					
26-Sep						9					
27-Sep						10					
28-Sep	SS	12.3	23.5	0.03	230	11	8.6715	0.00010036	360.6	360.47	
29-Sep	SS	12.3	23.5	0.02	260	12	5.781	0.00006691	360.47	360.45	
30-Sep	SS	12.3	23.5	0.02	280	13	5.781	0.00006691	360.45	360.43	
1-Oct	SS	12.3	23.5	0.02	300	14	5.781	0.00006691	360.43	360.41	
2-Oct	SS	12.3	23.5	0.02	320	15	5.781	0.00006691	360.41	360.39	
3-Oct	SS	12.3	23.5	0.02	340	16	5.781	0.00006691	360.39	360.37	
4-Oct	SS	12.3	23.5	0.025	365	17	7.22625	0.00008364	360.37	360.345	windy and warm+35 degrees
5-Oct	SS	12.3	23.5	0.02	395	18	5.781	0.00006691	360.345	360.325	
6-Oct	SS	12.3	23.5	0.02	415	19	5.781	0.00006691	360.325	360.305	
7-Oct	SS	12.3	23.5	0.015	430	20	4.33575	0.00005018	360.305	360.29	overcast and cool
8-Oct	SS	12.3	23.5	0.02	450	21	5.781	0.00006691	360.29	360.27	
9-Oct						22					

APPENDIX E

PUMPING TEST RESULTS

APPENDIX E

PUMPING TESTS

Pumping tests were carried out by Western Irrigation on production bores constructed at Silverstone (MJWB01), and at M1 (M1WB02). A third test on drillers' water bore MJWB02 (Silverstone) was abandoned after 45 minutes, when the pump sanded up, and it was apparent the bore casing was cracked. Table E1 presents details of location and elevation of pumping bore and piezometers at both sites.

Water was pumped from Silverstone at a constant rate for 14 hours, of 11.2L/s (about 968kL/day). Water was pumped to a sump constructed to hold the pumped water. The test was terminated when the sump was full, because discharge of saline water overland could have lead to vegetation distress/death. The rate of vertical dissipation from the sump was small (see Appendix D).

Water was pumped from M1 at a constant rate of about 3.5L/s (300kL/day) for 24 hours, and increased gradually up to a maximum of about 5.4L/s (470kL/day) over the subsequent 24 hours. Water was pumped to a sump located a short distance from the pumping bore.

Groundwater quality was monitored by field conductivity meter throughout the tests, and by the collection of pumped samples at the commencement, and prior to termination of the tests. Recovery measurements were carried out following termination of both tests.

MINJAR PUMPING TEST PROGRAMME

Sep-00

Silverstone Pumping test collar coordinates

Hole_Id	AMG_East	AMG_North	AMG_RL	Local_East	Local_North	Working_RL	Max_Depth	Azim._Grid	Dip	SWL	DIST.	Comment
MJRC274	495041.134	6802052.91	360.47	12534.681	15424.031	360.47	65	90	-60		85m - N	Piezo1
MJP082	495112.34	6801930.79	360.982	12599.643	15298.469	360.982	40	90	-60		57m - S	Piezo2
MJWB01	495091.105	6801983.56	361.035	12581.097	15352.248	361.035	83	0	-90	341.2		PUMPING BORE south end of pit
MJWB02	494969.384	6802618.08	358.609	12491.482	15992.094	358.609	70	0	-90	340.5	646m - N	Drillers bore 100mm cracked casing north end of pit

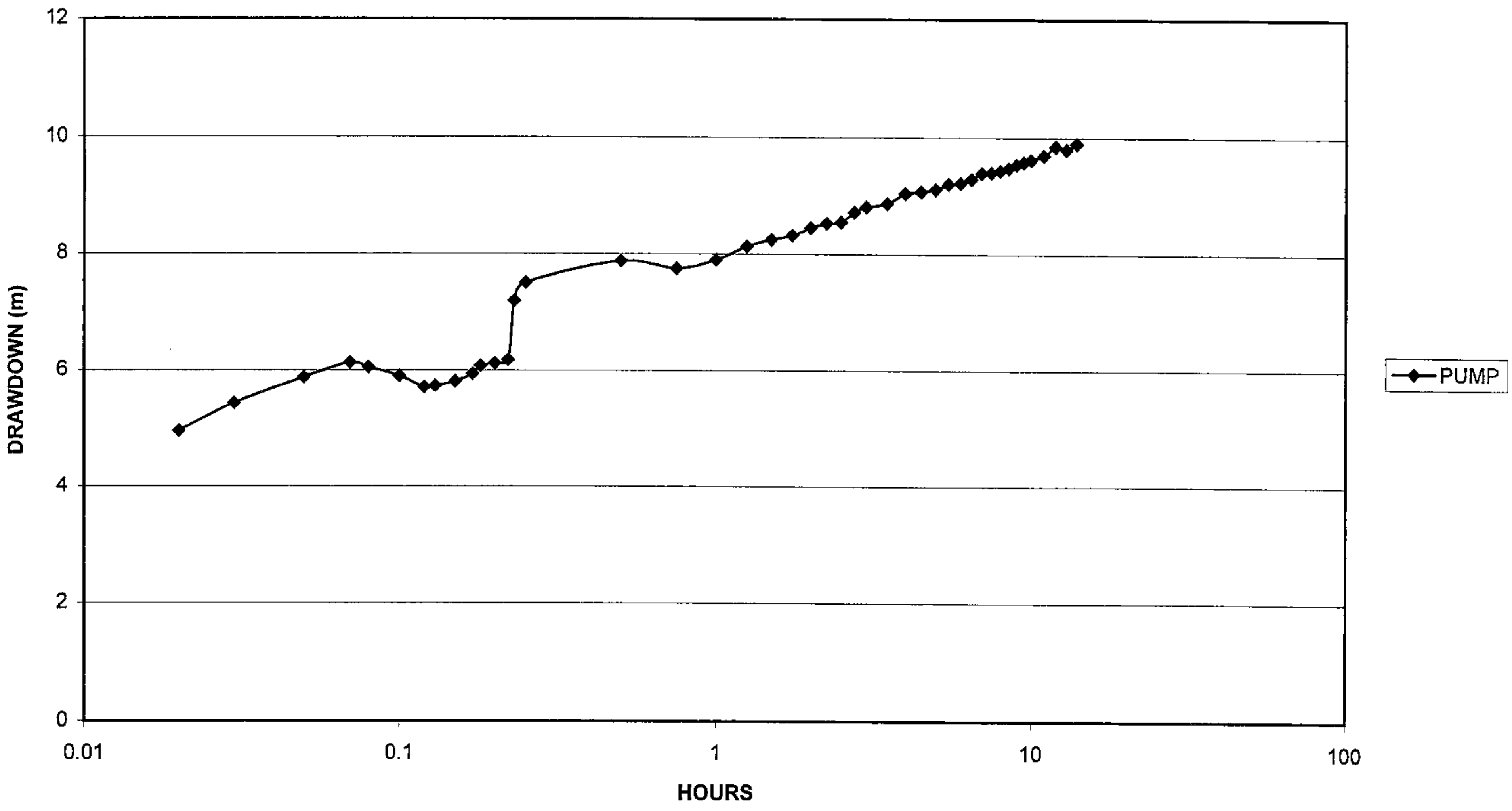
M1 Pumping Test Collar cordinates

Hole_Id	AMG_East	AMG_North	AMG_RL	Local_East	Local_North	Working_RL	Max_Depth	Azim._Grid	Dip	SWL	DIST.	Comment
M1WB01	493814.546	6810507.44	360.782	11749.014	23932.989	360.782	83	0	-90	337.7	326m - S	Monitoring Bore south end of pit
M1WB02	493689.294	6810826.64	357.097	11640.281	24258.349	357.097	80	0	-90	335.1		PUMPING BORE north end of pit
M1RC183	493716.81	6810741.3	356.49	11663.38	24171.7	356.49	58	90	-60		90m - S	Piezo 2
M1P054	493681.458	6810778.03	357.48	11629.9	24210.07	357.48	60	90	-60		49m - S	Piezo 1

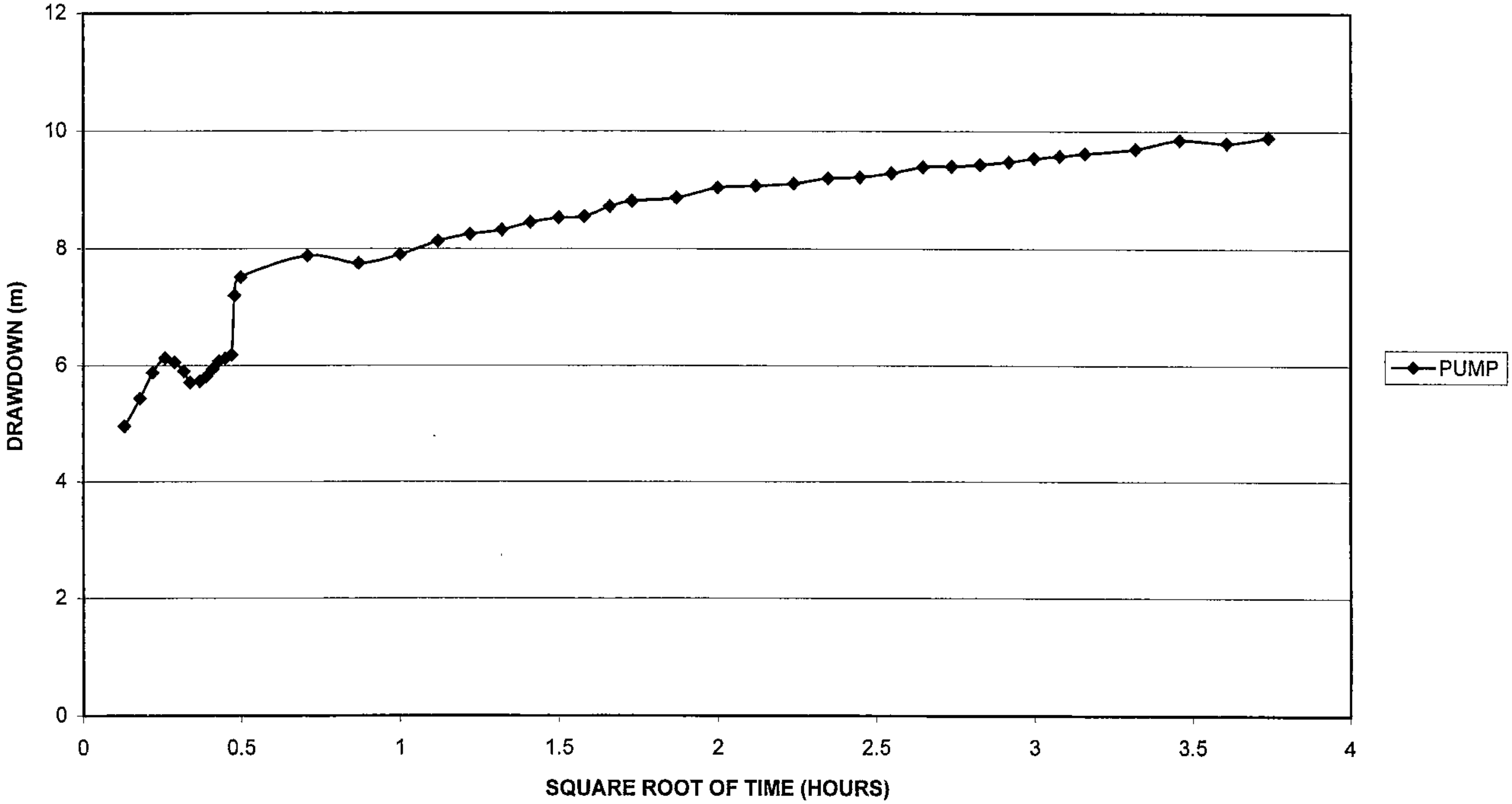
SWL - Standing water level, reduced to mine datum elevations

DIST. - Distance of observation site from pumping bore

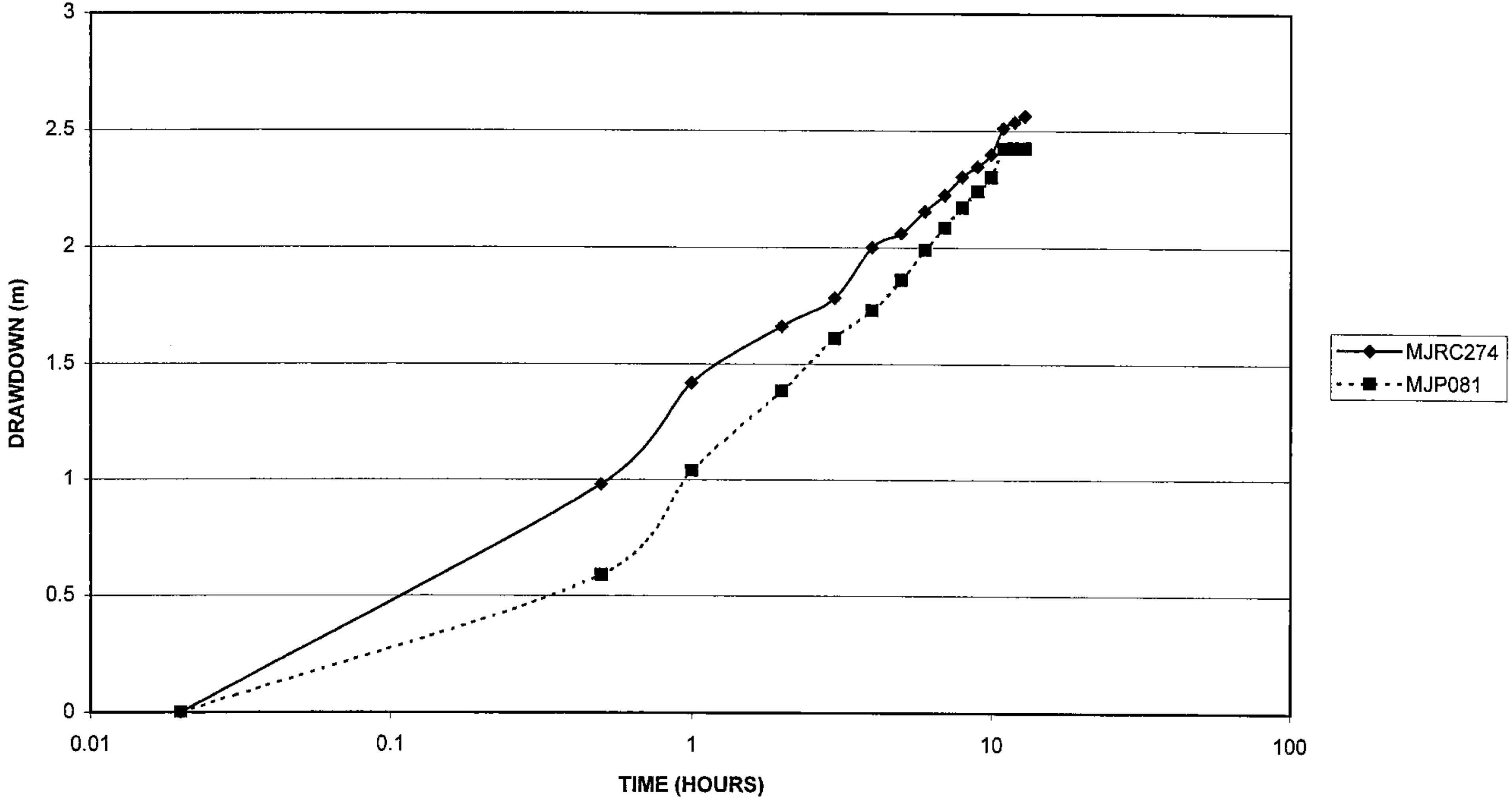
SILVERSTONE SOUTH BORE - PUMPING BORE DRAWDOWN



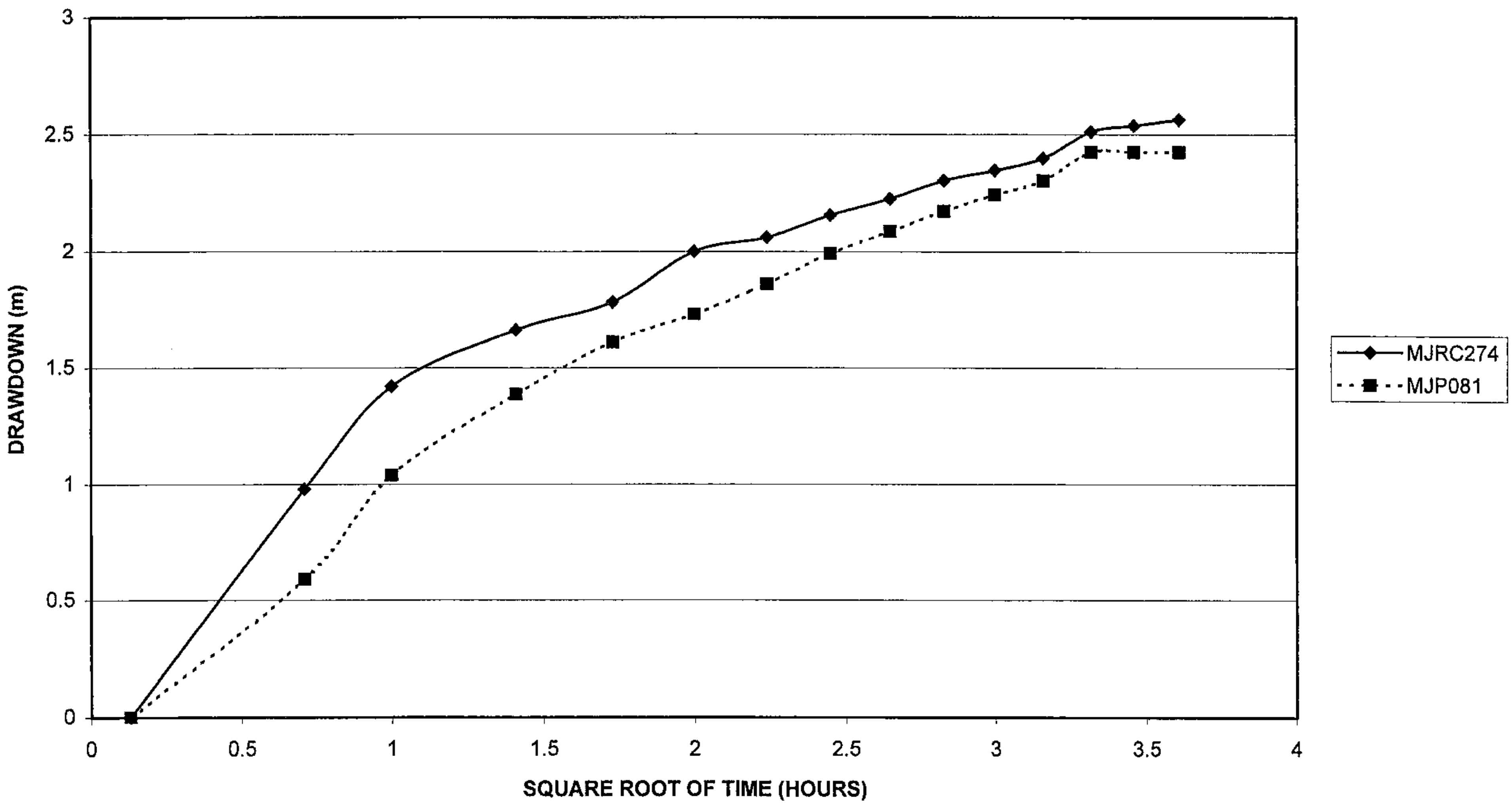
SILVERSTONE SOUTH BORE - PUMPING BORE DRAWDOWN



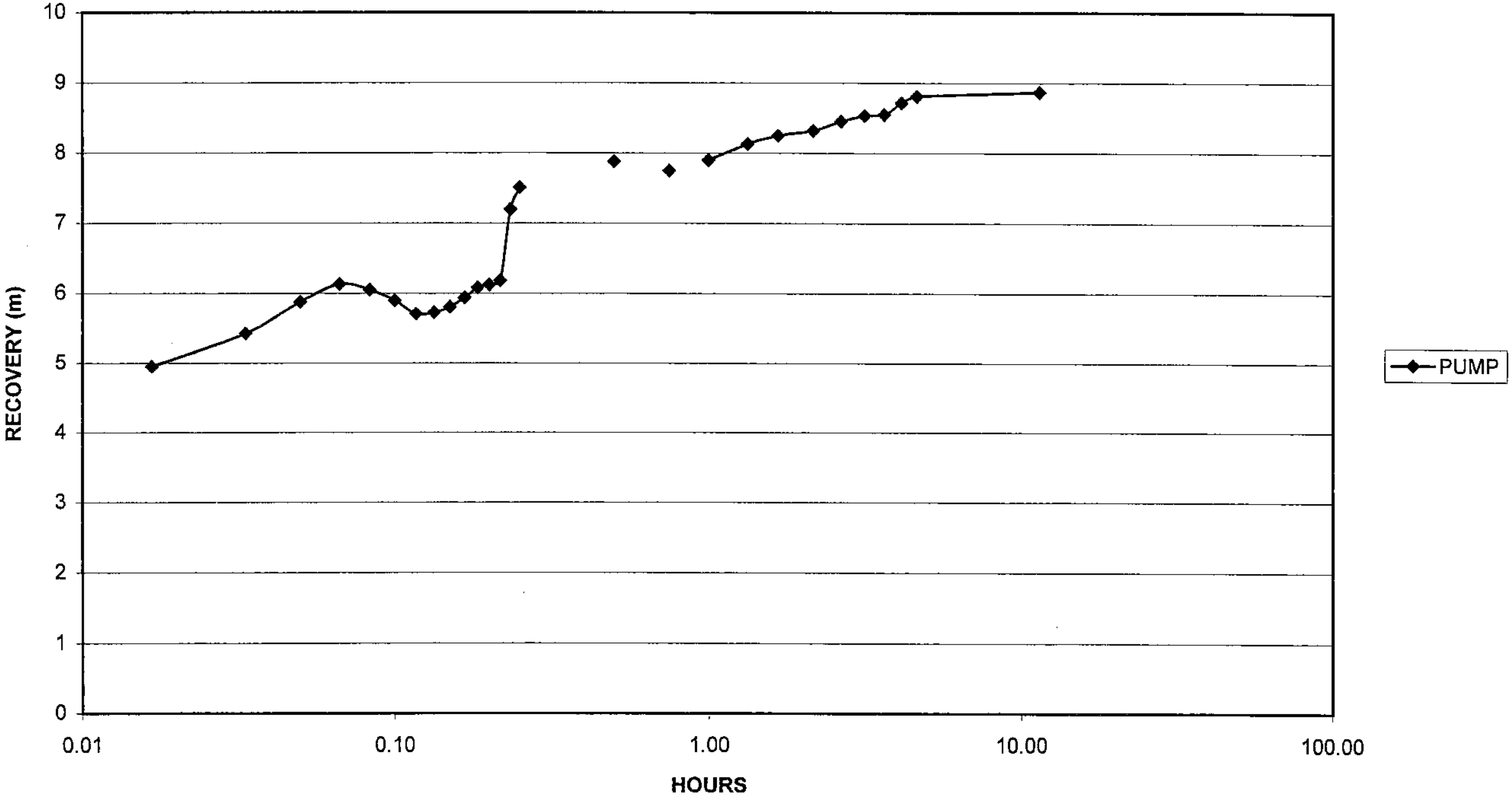
SILVERSTONE SOUTH BORE PIEZOMETER RESULTS



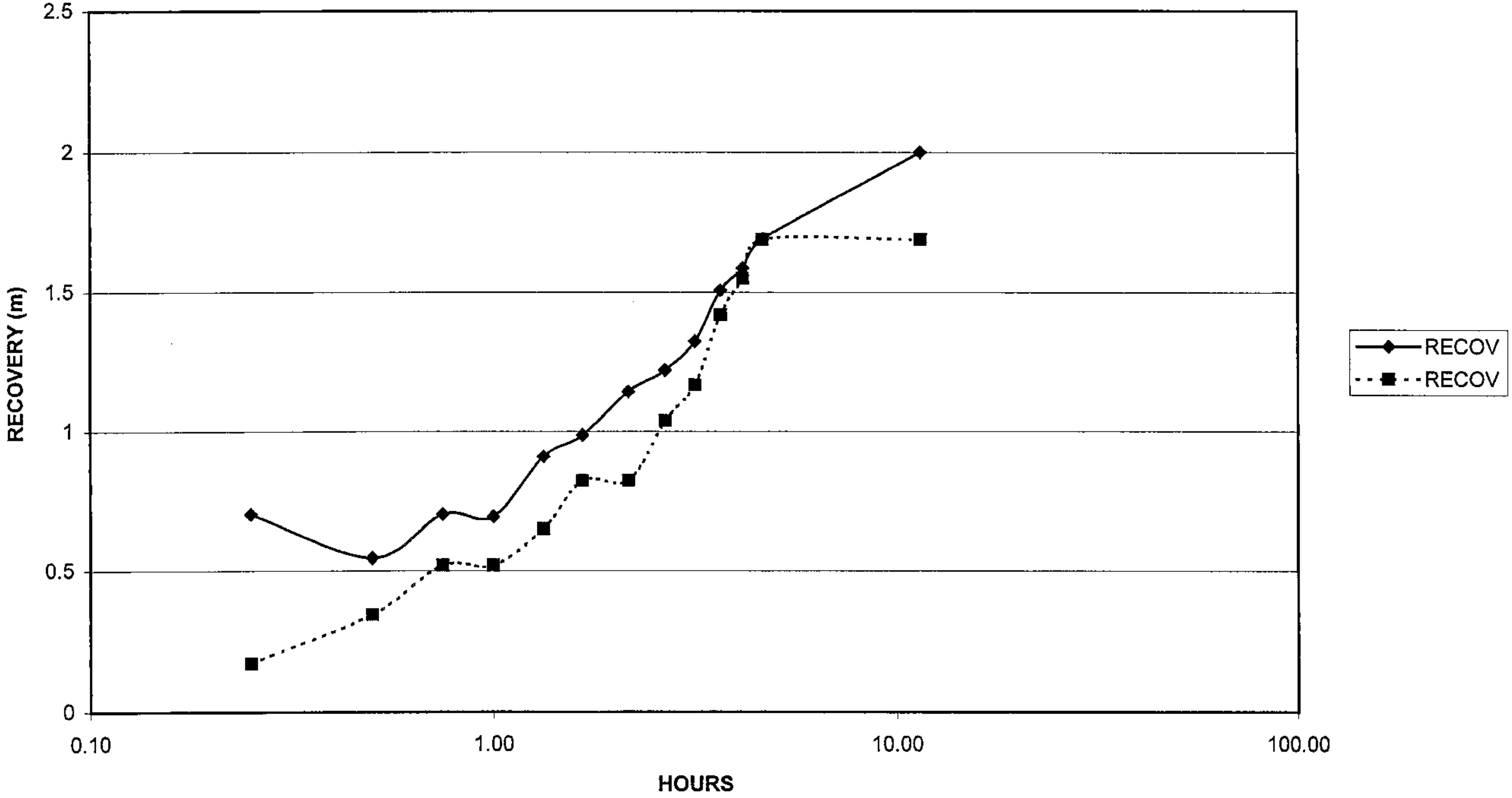
SILVERSTONE SOUTH BORE - PIEZOMETER RESULTS



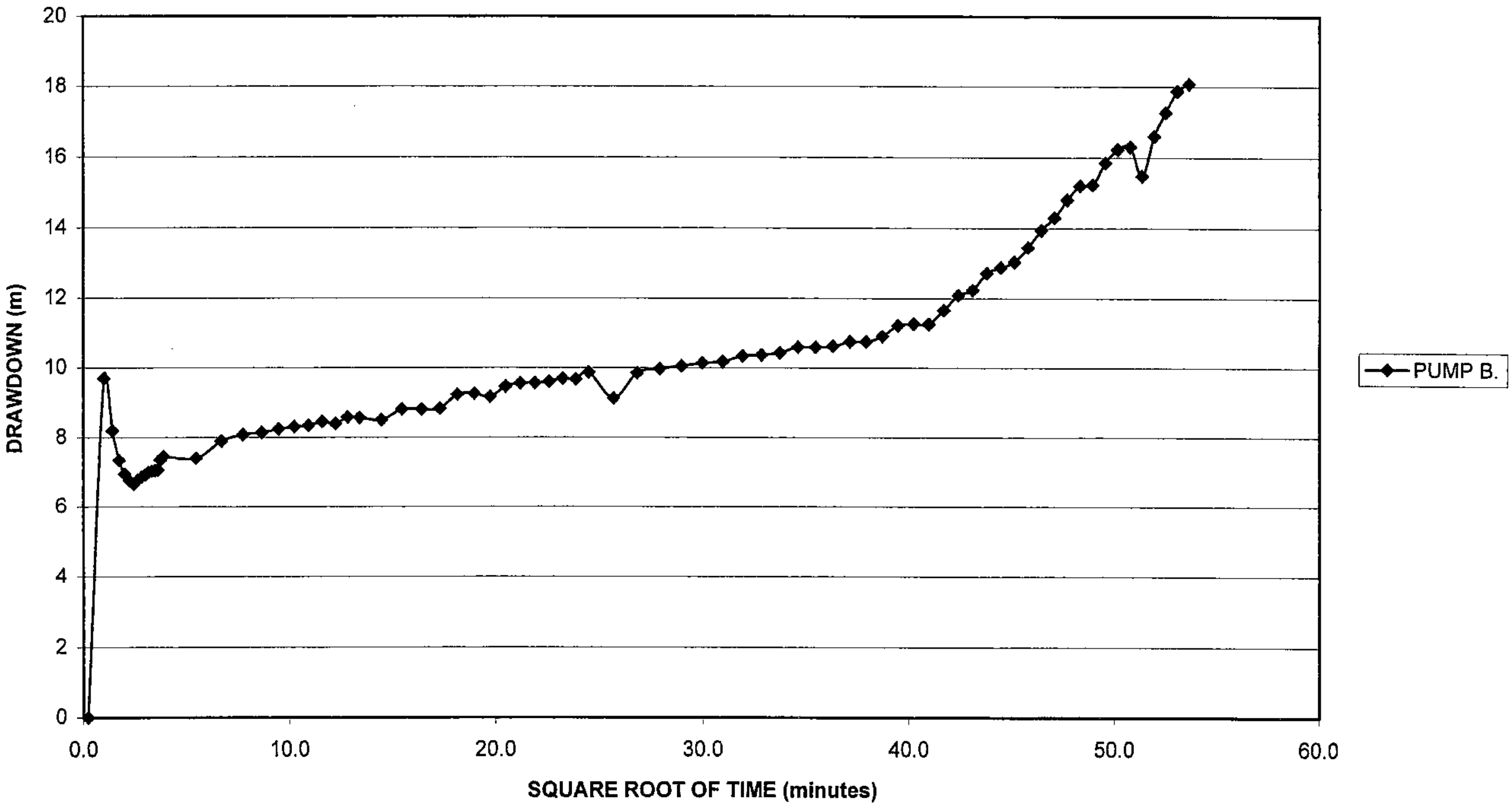
SILVERSTONE SOUTH BORE RECOVERY - PUMPING BORE

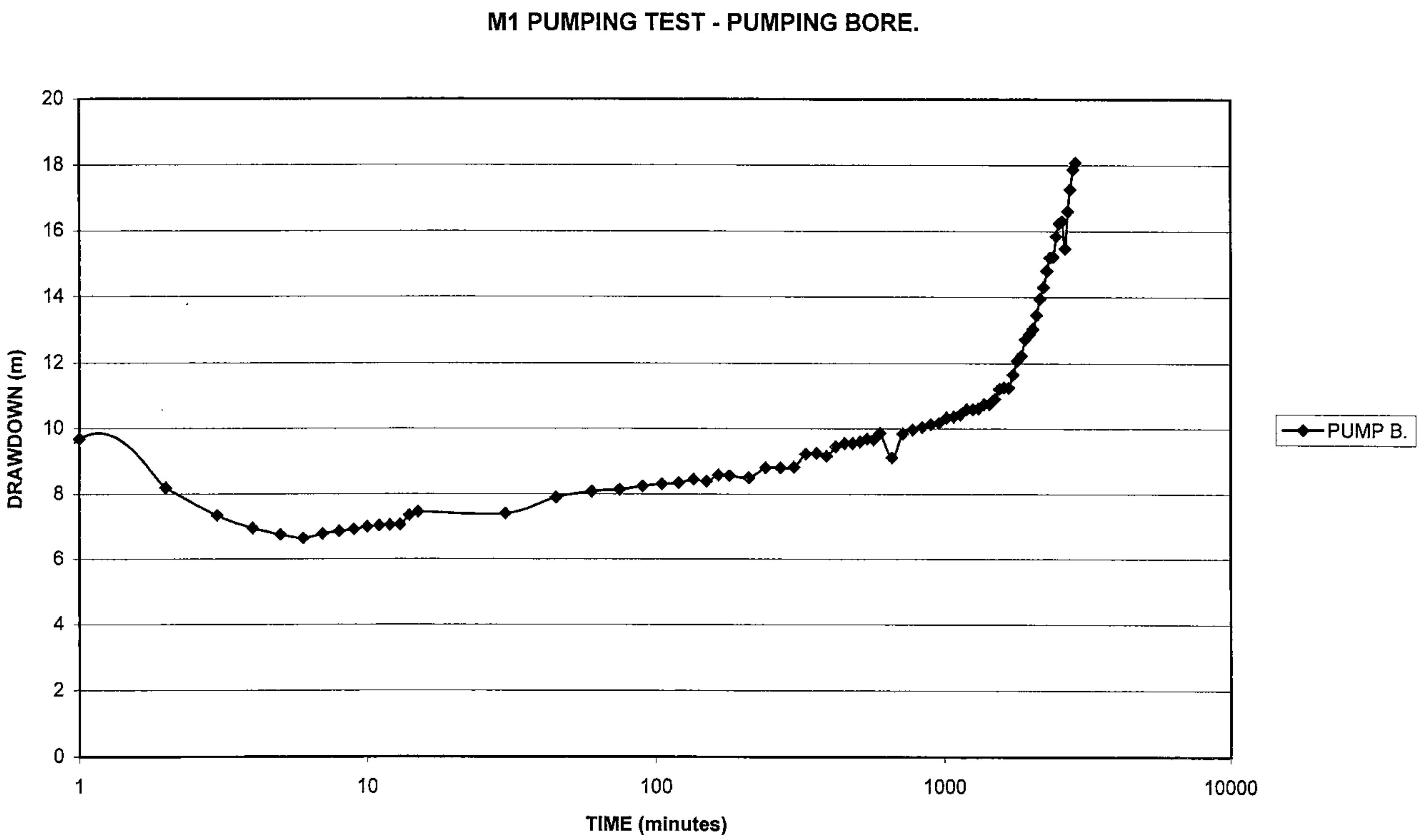


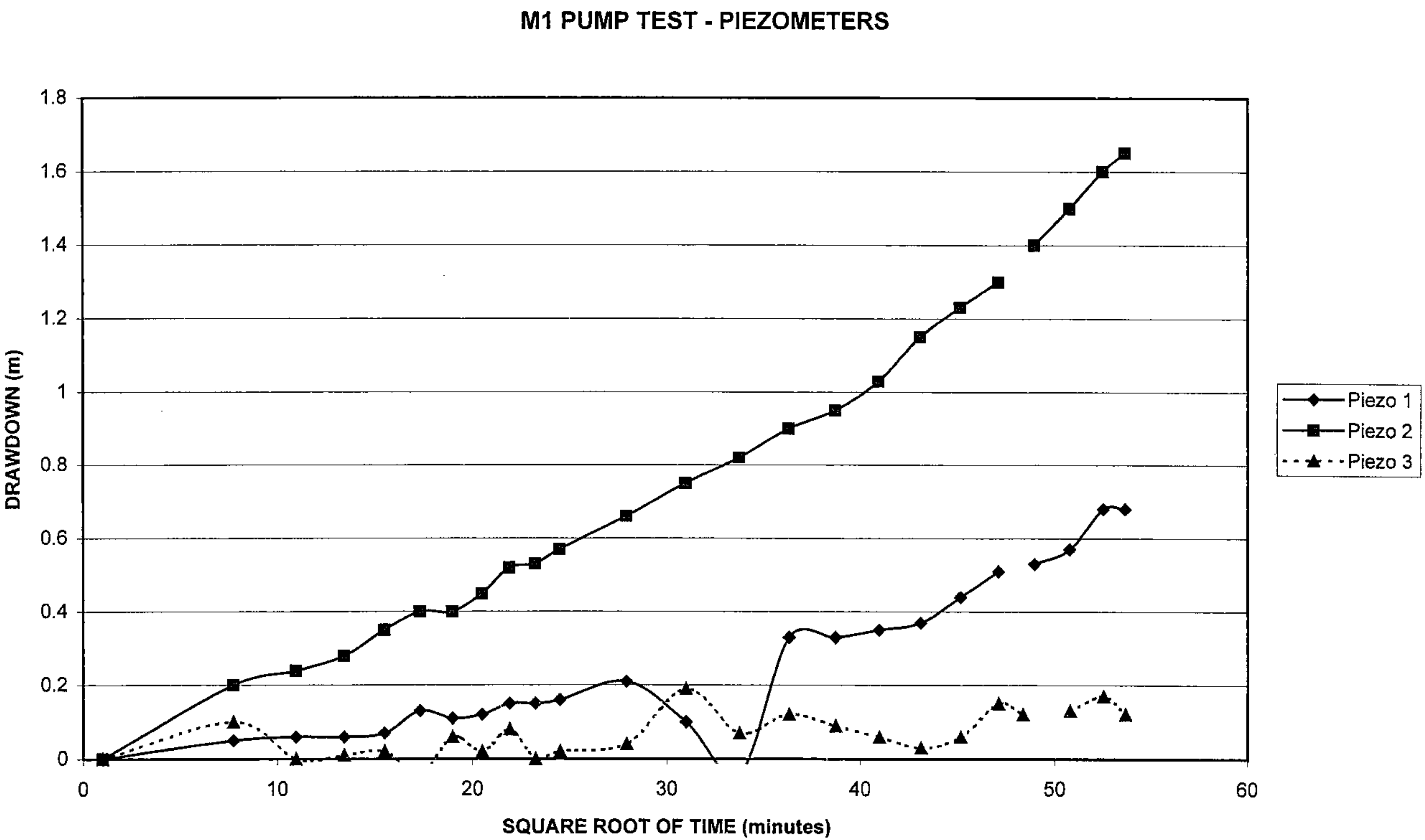
SILVERSTONE SOUTH BORE - PIEZOMETER RECOVERY

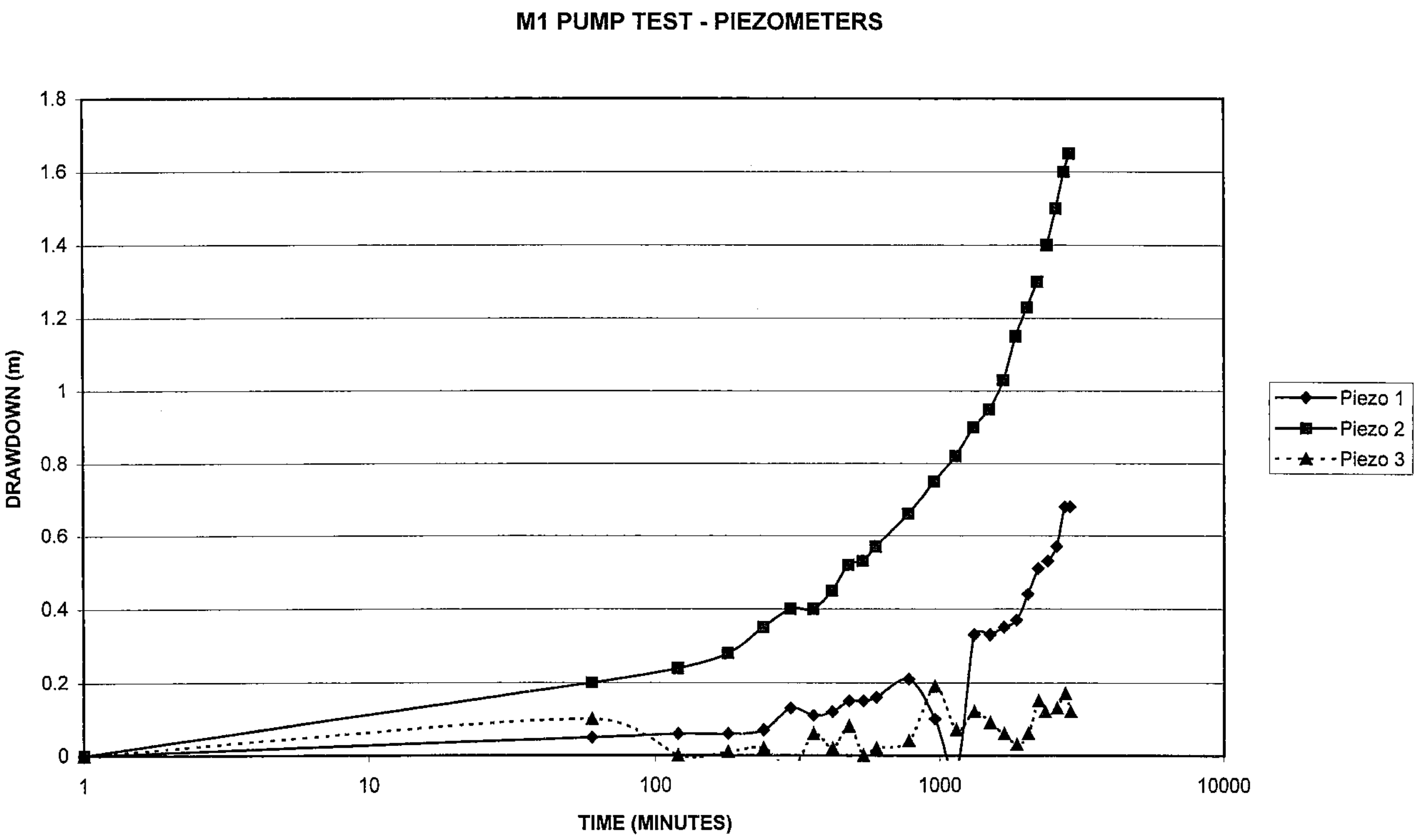


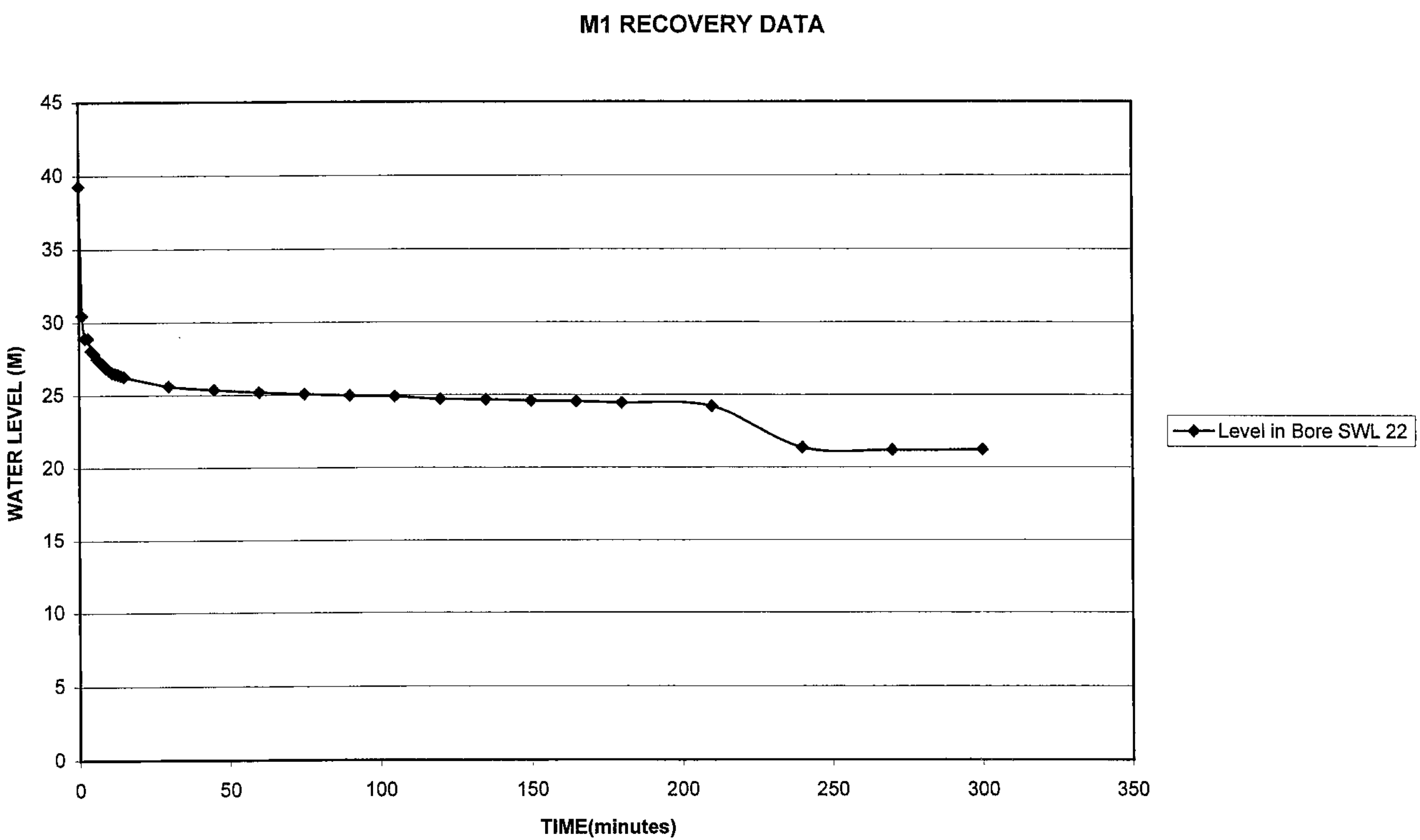
M1 PUMP TEST -PUMPING BORE




M1 PUMPING TEST - PUMPING BORE.
DRAWDOWN (m)
20
18
16
14
12
10
8
6
4
2
0
1
10
100
1000
10000
TIME (minutes)
PUMP B.


M1 PUMP TEST - PIEZOMETERS
DRAWDOWN (m)
SQUARE ROOT OF TIME (minutes)
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
10
20
30
40
50
60
Piezo 1
Piezo 2
Piezo 3


M1 PUMP TEST - PIEZOMETERS
DRAWDOWN (m)
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1
10
100
1000
10000
TIME (MINUTES)
Piezo 1
Piezo 2
Piezo 3


M1 RECOVERY DATA
WATER LEVEL (M)
45
40
35
30
25
20
15
10
5
0
0
50
100
150
200
250
300
350
TIME(minutes)
Level in Bore SWL 22

APPENDIX F

LABORATORY TEST RESULTS

Australian Environmental Laboratories

Quality System
Quality Endorsed Company
ISO 9002 Lic 7007
Standards Australia

LABORATORY REPORT COVERSHEET

DATE:	10 October 2000
TO:	Coffey Geosciences Pty Ltd
	PO Box 1530
	OSBORNE PARK B.C. WA 6916
ATTENTION:	Mr Mike Hillman
YOUR REFERENCE:	P2167/2
OUR REFERENCE:	54201
SAMPLES RECEIVED:	29/9/2000
SAMPLES/QUANTITY:	2 Waters

MN | MH.

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.

JANICE VENNING
Manager Operations

PETER BAMFORD
Manager Laboratory Services

This report supersedes our preliminary results that were reported by facsimile.
This report must not be reproduced except in full.

(Analabs Pty. Ltd.) ACN 004 591 664
52 Murray Road, Welshpool Western Australia 6106 Australia
Telephone: (61 8) 9458 7278 Facsimile: (61 8) 9451 3505

Australian Environmental Laboratories

CLIENT: Coffey Geosciences Pty Ltd **OUR REFERENCE:** 54201
PROJECT: P2167/2

LABORATORY REPORT

Your Reference Our Reference Type of sample	Units	M1WB02 54201-1 Water	MJWB01 54201-2 Water
pH	pH Units	7.9	8.5
Electrical Conductivity @ 25°C	µS/cm	1600	9600
Total Dissolved Solids (grav) @ 180°C	mg/L	930	6200
Iron, Fe (soluble)	mg/L	<0.05	<0.05
Sodium, Na	mg/L	280	1900
Potassium, K	mg/L	22	77
Calcium, Ca	mg/L	14	98
Magnesium, Mg	mg/L	39	240
Hardness (equivalent $CaCO_3$)	mg/L	200	1200
Chloride, Cl	mg/L	340	2900
Carbonate, CO_3	mg/L	<1	17
Bicarbonate, HCO_3	mg/L	260	390
Total Alkalinity as $CaCO_3$	mg/L	210	340
Sulphate, SO_4	mg/L	80	730
Nitrate, NO_3	mg/L	16	7.6
Total Nitrogen, N	mg/L	4.0	2.1
Sum of Ions (calc.)	mg/L	1055	6398
Cation/Anion balance	%	2.34	1.90

Australian Environmental Laboratories

CLIENT: Coffey Geosciences Pty Ltd **OUR REFERENCE:** 54201
PROJECT: P2167/2

LABORATORY REPORT

TEST PARAMETERS	UNITS	LOR	METHOD
Standard 2			
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
Hardness (equivalent $CaCO_3$)	mg/L	5	PEM-002
Chloride, Cl	mg/L	5	PEI-008
Carbonate, CO_3	mg/L	1	PEI-006
Bicarbonate, HCO_3	mg/L	5	PEI-006
Total Alkalinity as $CaCO_3$	mg/L	5	PEI-006
Sulphate, SO_4	mg/L	10	PEI-034
Nitrate, NO_3	mg/L	0.2	PEI-011
Total Nitrogen, N	mg/L	0.1	PEI-012/011
Sum of Ions (calc.)	mg/L		Calc.
Cation/Anion balance	%		Calc.

NOTES:
LOR - Limit of Reporting.

APPENDIX G

RESULTS OF NUMERICAL MODELLING

APPENDIX G

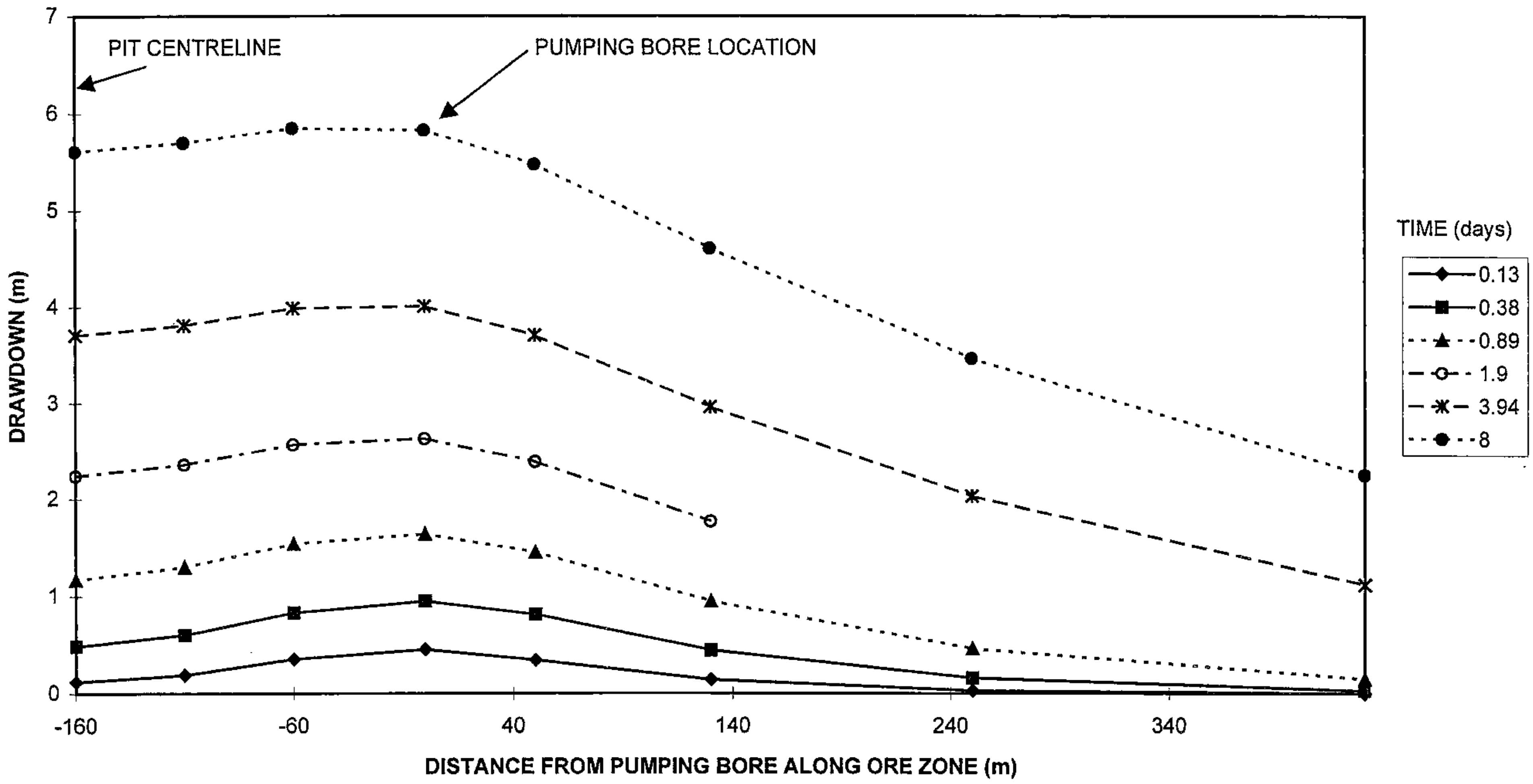
RESULTS OF MODELLING

The US Geological Survey "MODFLOW" seepage modelling programme has been used to assess the pit dewatering requirements for M1 and Silverstone pits, based on the conceptual model discussed in Section 6.1, 6.2 and illustrated in Figure 4. A three layer model was used in the analysis, with the second layer representing a base of weathering profile water yielding zone. The ore zone was assumed to be vertical for the purposes of the modelling.

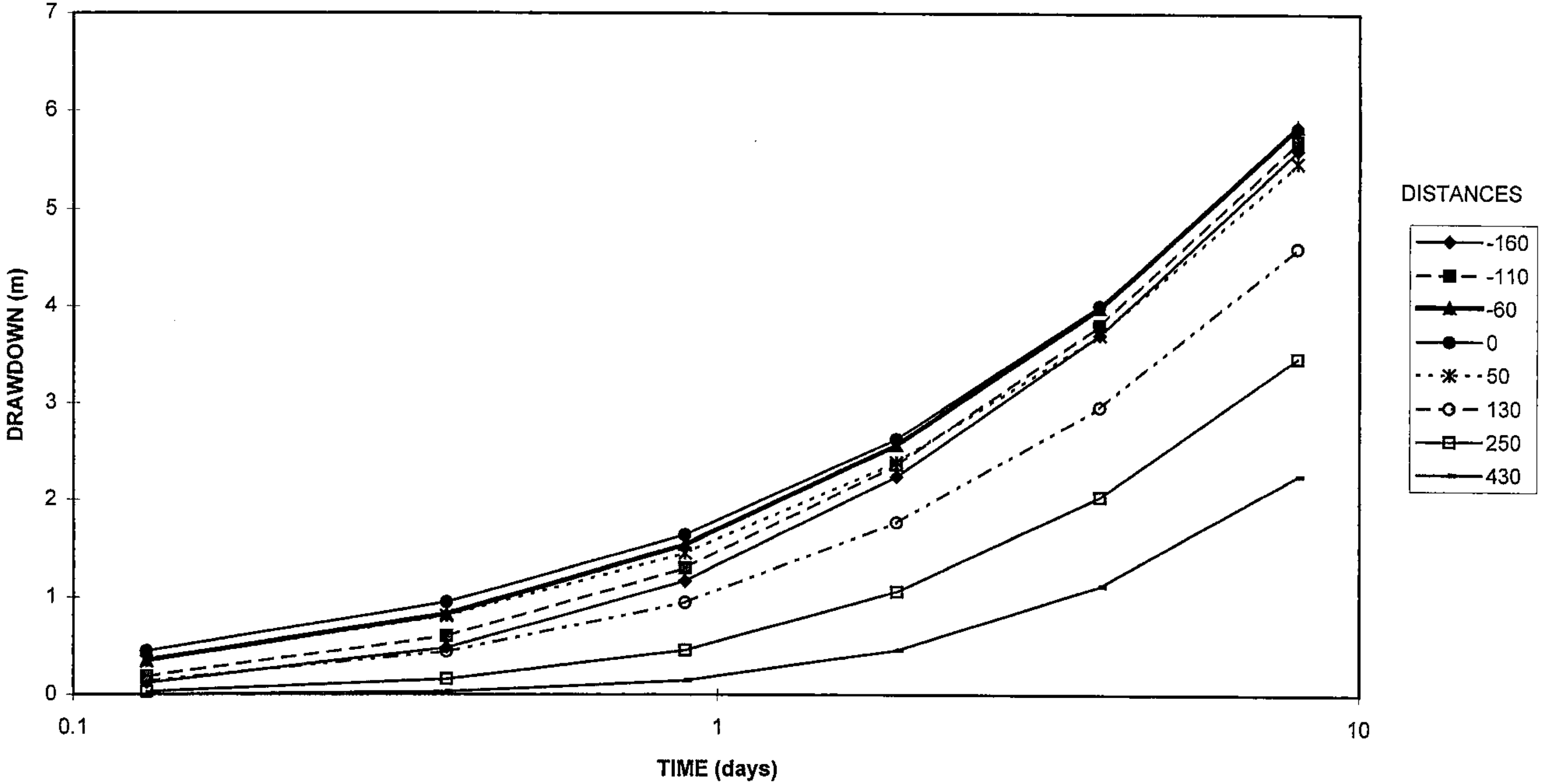
The model was symmetrical parallel to, and normal to the ore zone, from the centre of the pit. A dewatering stress was applied to the model at a distance from the centre along the ore zone, representing the edge of the pit. The natural water gradient was assumed to be zero for the modelling. Confined storage coefficients for all zones were assumed to be 0.00001

The attached Figures summarise results of modelling for M1 pit, based on a dewatering rate of 400kL/d (200kL/d from each bore/either end of the pit). Drawdowns along strike during the initial days of pumping (Figure G1), drawdown with time during the initial days of pumping at various distances from the pit centre (Figure G2) and drawdown versus time over the initial 6 months of dewatering (Figure G3) are illustrated.

GINDALBIE GOLD MODFLOW ANALYSIS, M1 MODEL: CHANGE IN DRAWDOWNPROFILE WITH TIME (days)



GINDALBIE MODFLOW ANALYSIS, M1 MODEL; DRAWDOWNS OVER TIME AT VARIOUS DISTANCES FROM FOCUS OF PUMPING



GINDALBIE GOLD, MODFLOW ANALYSIS, CENTRE OF PIT DRAWDOWN WITH TIME