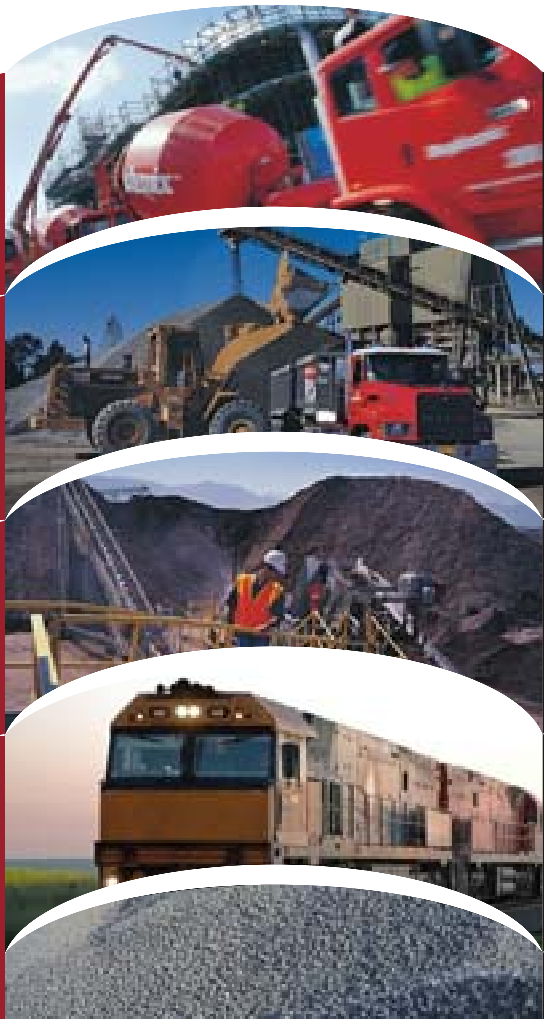
Environmental Impact Statement

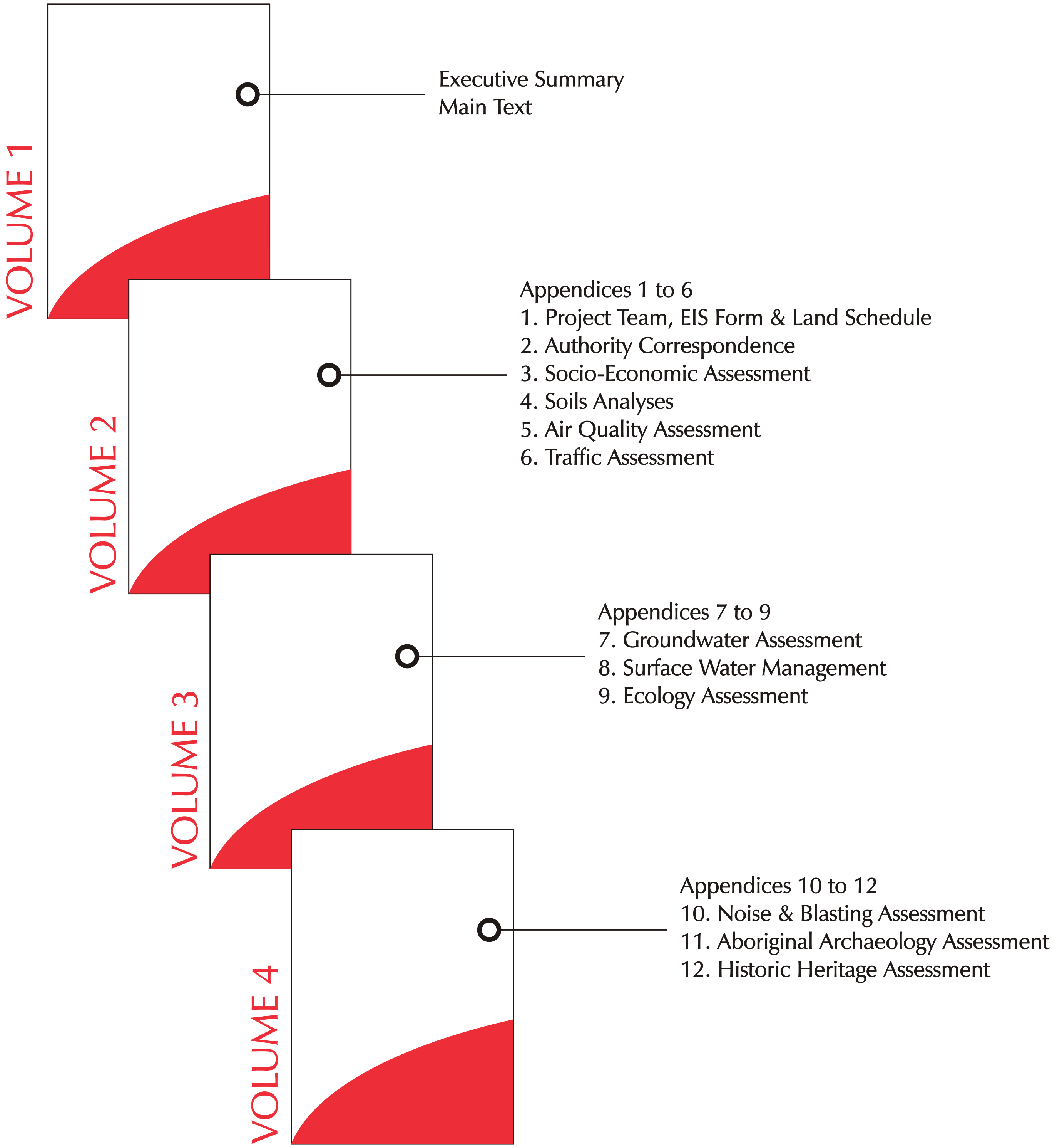
Readymix Holdings Pty Ltd
Proposed Lynwood Quarry, Marulan



VOLUME 3
APPENDICES 7 TO 9

MAY 2005

Umwelt
Environmental Consultants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APPENDIX 7

Groundwater Assessment

UMWELT (AUSTRALIA) PTY LIMITED

PROPOSED LYNWOOD QUARRY, MARULAN

GROUNDWATER IMPACT ASSESSMENT

PETER DUNDON AND ASSOCIATES PTY LTD

13TH MAY 2005

REPORT 04-0142_R01C

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1 INTRODUCTION

Readymix Holdings Pty Limited (Readymix) is proposing to establish a hard rock quarry to the west of Marulan in the Southern Tablelands region of NSW. The proposed quarry will be located approximately 160 km southwest of Sydney and approximately 27 km northeast of Goulburn. The Readymix land holding totals approximately 1000 ha, the majority of which is a grazing property known as ‘Lynwood’ (hereafter referred to as the “Project Area”).

The proposed Lynwood Quarry is intended to provide a long-term supply of high quality construction material into the Sydney, regional and local markets. It is proposed that the Lynwood Quarry will produce up to 5 Mt of hard rock aggregate per annum (Mtpa) with an expected life of in excess of 90 years. Initial approval is being sought for a 30 year quarry period. The quarry is proposed to operate on a 24 hour per day, seven day per week basis.

Construction Phase

Lynwood Quarry is a greenfields project and substantial construction works will be required prior to the quarry becoming operational. The construction phase is expected to last approximately two years and will include the following key activities:

- construction of initial site access road and set-up of construction compounds including supply of services (e.g. electricity, water etc.);
- setup of mobile concrete and crushing plants;
- construction of the Hume Highway interchange and site access road;
- construction of the rail overpass;
- extraction of material from the primary crusher area;
- excavations for the rail loop and reclaim tunnel;
- construction of the crushing plant, rail facility, truck loading facility and other infrastructure;
- construction of rail lines and connection onto the Main Southern Railway;
- construction of remaining facilities including workshops, site offices, amenities, laboratory, weighbridge, stores, parking areas, site access roads, safety bunds, etc;
- construction of water management structures and installation of pumps, pipelines, etc; and

- installation of security fencing and gates to ensure public safety and security for the quarry operations.

Operational Phase

Over the initial 30 year operation period, the Lynwood Quarry will produce up to 5 Mtpa of quarry product. Some of the material extracted as part of the quarrying process will not be suitable for sale and consequently emplacement areas will be required. This material consists of both overburden, which will be excavated and taken directly to emplacement areas without passing through the crushing and screening plant, as well as material generated at various phases of the crushing and screening process. Due to the depth of the resource and the number of years which will be required in order to reach a terminal face, in-pit dumping will not be possible during the initial 30 year quarry period without sterilising future resources and therefore, all emplacement areas are planned to be out-of-pit.

The footprint of the conceptual quarry plan and associated infrastructure for the initial 30 years are shown on **Figure 1**.

The quarrying process will involve the following broad steps:

- clearing and topsoil stripping – likely equipment will include a dozer, excavator, loaders and dump trucks;

- drill and blast – percussion drill drilling holes to a bench height of approximately 15 metres. Approximately one blast will be required each week in order to meet production requirements; and

- the resultant material from the blast will be loaded by front-end loaders into dump trucks and transported to the crushing and screening plant. Any pieces of rock that are too large to be transported or loaded into the primary crusher will be broken into smaller pieces by a hydraulic rock breaker.

Approval is sought to transport all of the 5 Mtpa quarry product from the site via the dedicated rail loading facility, with approval also sought to transport up to 1.5 Mtpa of the total of 5 Mtpa by road transport via a direct link onto the Hume Highway.

Various specialist studies have been undertaken to assess the potential impacts of the proposal, in support of an Environmental Impact Statement prepared by Umwelt (Australia) Pty Limited (Umwelt, 2005). This report presents the results of groundwater investigations and impact assessment studies undertaken by Peter Dundon and Associates Pty Ltd for Umwelt.

2 GROUNDWATER INVESTIGATIONS

2.1 Summary

A series of piezometers were installed to enable sampling, testing and monitoring of the groundwater beneath the Project Area. Piezometers were installed in selected open exploration drill-holes. An initial round of water quality sampling was undertaken in February 2004 immediately after piezometer installation, in conjunction with hydraulic testing to determine aquifer hydraulic properties.

Hydraulic testing was undertaken by monitoring water level response during pumping to purge the bores in preparation for sampling. The testing comprised either slug tests or short duration pumping tests, to determine aquifer permeabilities.

A baseline monitoring program has been maintained subsequently, involving monthly measurement of piezometer water levels and 3-monthly collection of water samples for comprehensive laboratory analysis.

An assessment of the likely dewatering requirements of the proposed quarry was carried out with the aid of a numerical groundwater flow model.

2.2 Piezometer Installation

Eleven (11) piezometers have been installed (MP-1 to MP-11) at the sites shown on **Figure 1**.

All piezometers were constructed by installing 50mm PVC casing in open drillholes from earlier resource exploration drilling. The piezometers were located to give a broad geographic spread across the Project Area, and wherever possible drillholes that had reported water inflows or fracture intersections were selected. A drilling rig was used to flush out the selected drillholes prior to installing the casing. A 6m length of slotted casing was installed adjacent to the reported or interpreted main water inflow zone. The annulus was back-filled with a graded gravel pack, and a bentonite seal placed above the gravel, approximately 2m above the top of the screen interval. The top of the annulus was sealed with a cement plug, and a lockable steel monument installed above the ground surface. Thus the piezometers have been constructed to allow monitoring, testing and sampling from a 6-10m interval believed to be the major aquifer zone in the hole, and to prevent the ingress of surface contamination or direct infiltration of rainfall down the hole. Piezometer MP-1 has two separate 3m screened intervals.

Completion details of all piezometers and production bores are listed in **Table 1**.

Bore logs for the piezometers are presented in **Figures 2** to **12**.

Table 1: Piezometer Completion Details – Lynwood Quarry Project

Piezometer	Drillhole Number	Easting	Northing	Drilled Diameter (mm)	Drilled Depth (m)	Piezometer Depth (m)	Screen Intervals (m depth)	Aquifer Screened	Surface RL (mAHD)	Datum above Ground Level (m)	Water Level (2 July 2004)	
											(m depth)	(mAHD)
MP-1	P083	772286	6153749	100	36	26	8-11 23-26	Fractured porphyry, water inflow 9.5m	664.00	0.60	2.7	671.9
MP-2	P099	770914	6154024	100	40	38	30-36	Porphyry, damp from 30m	688.91	0.80	16.6	673.2
MP-3	P213	771089	6155416	100	40	31	25-31	Contact zone 25m	668.48	0.70	5.4	663.8
MP-4	P038	772335	6155989	100	33	33	27-33	Fractured porphyry, water inflow 31m	686.00	0.65	18.4	668.3
MP-5	D-07	772131	6156026	150	126	102	96-102	Porphyry, mod fractured 100-103m	690.44	0.70	28.9	662.2
MP-6	D-09	771956	6156674	150	110	103	97-103	Porphyry, unfractured	691.34	0.60	16.0	675.9
MP-7	P031	771858	6156691	100	40	40	34-40	Fractured porphyry, water inflow 27m	683.50	0.65	7.6	676.5
MP-8	P013	771542	6156142	100	40	37	31-37	Porphyry, damp from 37m	671.55	0.60	9.2	662.9
MP-9	D-13	771627	6155920	150	102	96	90-96	Porphyry, unfractured	682.40	0.70	23.5	659.5
MP-10	P196	772070	6155220	100	40	35	29-35	Fractured porphyry, water inflow 23m	656.00	0.50	6.2	650.3
MP-11	P124	773076	6155618	100	40	36	30-36	Porphyry, damp from 27m	655.00	0.60	26.4	629.3

2.3 Groundwater Levels

Groundwater levels have been monitored in all piezometers approximately monthly since February 2004. Hydrographs of the bore water levels are shown on **Figure 13**.

Most bores have shown a fluctuation in water level over a 1-2 m range through the more than one year of baseline monitoring. They show a modest but clear response to rainfalls in July 2004, October 2004 and January-February 2005.

However, three bores have shown a much larger fluctuation in water levels – MP-5, MP-9 and MP-11. All three bores showed an initial marked fall in water level between February and July 2004 (around 8m at MP-5, 3m at MP-9 and 16m at MP-11) before rising sharply by similar magnitudes following rainfall in July. Similar declines in water level are observed between September and October, before another sharp rise following rainfall in October. Further falls in level are then observed between late November 2004 and early January 2005, and between March and April 2005.

These three piezometers display the same general pattern of fluctuation as the other piezometers, but with a much larger magnitude. These are the least permeable sites (see Section 2.4 below), and the greater magnitude of fluctuation is interpreted to be due to the lower horizontal permeability acting to retard the lateral spread of groundwater following infiltration from the larger rainfall events in July-August and October-November 2004. It is also likely to be indicating lower aquifer storage potential in the areas of lowest permeability.

Contours of groundwater levels measured in the piezometers on 2 July 2004 are shown on **Figure 14**. The contours show a broad sympathy with the surface topography, with the lowest groundwater levels coinciding approximately with the central creek line which drains eastwards from the Project Area (Joarimin Creek). The groundwater flow pattern is thus expected to be broadly similar to the pattern of surface water flow.

2.4 Hydraulic Testing

None of the piezometers was capable of sustained pumping, due to the generally low to very low formation permeability, however short pumping tests were conducted on the piezometers while being purged in preparation for collection of water samples. This was achieved by installing a pressure transducer into the bore to monitor water levels while purging was taking place. In some cases, purging required repeated pumping, as the bores were quickly pumped dry. A slug test was also performed on MP-4.

Details of the pumping tests and the slug test on MP-4 are provided in **Table 2**.

Table 2: Details of Hydraulic Testing

Bore	Screened Interval	Hydrogeological Unit	Date of Test	Pumping Rate	Duration of Pumping	Transmissivity (m^2/d)	Average Hydraulic Conductivity m/day	Average Hydraulic Conductivity m/sec	Comments
MP-1	8-11m 23-26m	Fractured porphyry, water inflow at 9.5m	13 February 2004	7 m^3/day	65 min	4.3	0.72	8.3×10^{-6}	Early time data
						2.3	0.38	4.4×10^{-6}	Late time data
MP-2	30-36m	Porphyry, damp from 30m	21 February 2004	6.5 m^3/day	15 min	0.4	0.07	7.7×10^{-7}	Early time data
						0.03	0.005	5.7×10^{-8}	Late time data
MP-3	25-31m	Contact zone – 25m	17 February 2004	2.2 m^3/day	30 min	0.11	0.018	2.2×10^{-7}	
			21 February 2004	7 m^3/day	8 min	0.04	0.007	7.7×10^{-8}	
MP-4	27-33m	Fractured porphyry, water inflow at 31m	21 February 2004	Slug Test	-	-	0.028	3.2×10^{-7}	Early time data
							0.017	1.9×10^{-7}	Late time data
			21 February 2004	7 m^3/day	6 min	0.23	0.038	4.4×10^{-7}	
MP-6	97-103m	Unfractured porphyry	20 February 2004	10 m^3/day 14 m^3/day 16 m^3/day	0-30 min 30-60 min 60-70 min	0.60	0.10	1.2×10^{-6}	Analysis based on data from first 30 minutes pumping
MP-7	34-40m	Fractured porphyry, water inflow at 27m	18 February 2004	3.6 m^3/day	90 min	0.53	0.088	1.0×10^{-6}	Early time data
						0.19	0.031	3.6×10^{-7}	Late time data
			20 February 2004	15 m^3/day	8 min	0.10	0.017	1.9×10^{-7}	
MP-8	31-37m	Porphyry, damp from 37m	18 February 2004	1.1 m^3/day	15 min	0.10	0.017	1.9×10^{-7}	
			20 February 2004	5.8 m^3/day	18 min	0.06	0.0097	1.1×10^{-7}	Pumping phase
						0.21	0.035	4.1×10^{-7}	Recovery phase
MP-9	90-96m	Unfractured porphyry	22 February 2004	9 m^3/day	20 min	0.086	0.014	1.7×10^{-7}	Early time data
						0.030	0.005	5.7×10^{-8}	Late time data
MP-10	29-35m	Fractured porphyry, water inflow at 23m	22 February 2004	12 m^3/day	7 min	0.16	0.027	3.1×10^{-7}	
MP-11	30-36m	Porphyry, damp from 27m	22 February 2004	7 m^3/day	3 min	0.04	0.007	7.7×10^{-8}	

2.5 Water Sampling and Analysis

Water samples were initially collected in February 2004 from all piezometers, after first purging the bores of water to remove any residual drilling fluids, and to ensure that the samples collected were truly representative of the groundwater and not potentially contaminated by rainwater or surface runoff.

The samples were submitted to Australian Laboratory Services (ALS) for analysis of the main physical properties (conductivity, TDS and pH), concentrations of the major dissolved cations and anions, nutrients, and a screening analysis for dissolved metals and organics.

Follow-up sampling and laboratory testing was carried out in July 2004, October 2004, January 2005 and April 2005, as part of the ongoing baseline monitoring program. Again, each bore was purged of water prior to sampling to ensure that truly representative groundwater samples were collected. These samples were analysed by Ecowise Environmental in their Canberra laboratory.

Sampling, transport and laboratory analysis were carried out in accordance with industry standard quality assurance protocols. All samples were transported to the laboratory in sample containers provided by the laboratory, acidified where required to preserve specific analytes, and stored at below 4^0C in sealed eskies. Rigorous chain of custody documentation was maintained during the transport to protect the integrity of the samples. All analyses were performed within the laboratory-notified sample holding times. Sufficient field and laboratory duplicate samples were analysed to meet quality assurance objectives and to ensure the reliability of the sample results.

All laboratory analysis results from the groundwater baseline monitoring program are presented in **Table 3**.

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Parameter	Units	LOR	Drinking Water Guidelines (ANZECC, 1996)		Fresh Water Ecosystem Protection Guideline (ANZECC, 2000)	MP1					MP2					MP3				
			Health	Aesthetic		19/02/04	2/07/04	8/10/04	7/01/05	8/04/05	21/02/04	2/07/04	8/10/04	7/01/05	8/04/05	21/02/04	2/07/04	8/10/04	7/01/05	8/04/05
pH Value		0.01	ID	6.5 - 8.5		7.20	6.70	6.60	6.60	6.60	6.46	6.10	6.30	6.20	6.20	7.22	6.70	6.70	6.50	6.50
Conductivity @ 25'C	uS/cm	1				1070	1105	1103	1094	1090	1340	1269	1165	1146	1093	11500	11400	11521	10712	10669
Total Dissolved Solids (TDS)	mg/L	1		500		584	610	620	650	610	816	740	760	770	670	7500	6300	7100	7600	6400
Hardness as CaCO3	mg/L			200		211	221	232	228	222	222	227	216	210	201	3210	3169	3491	3210	2954
Calcium - Filtered	mg/L	1				30	34	37	37	36	23	25	24	23	23	298	280	310	280	260
Magnesium - Filtered	mg/L	1				33	33	34	33	32	40	40	38	37	35	599	600	660	610	560
Sodium - Filtered	mg/L	1		180		167	120	120	120	110	189	110	110	110	93	1330	1200	1200	1100	970
Potassium - Filtered	mg/L	1				2	3.3	2.6	3.1	3.7	7	7.3	5.5	6.3	6.6	18	28	17	19	25
Carbonate as CaCO3	mg/L	1				<1	0	0	0	0	<1	0	0	0	0	<1	0	0	0	0
Bicarbonate as CaCO3	mg/L	1				219	171	163	165	171	71	73	81	81	77	298	250	255	216	213
Sulphate - Filtered	mg/L	1	500	250		22	22	23	23	23	40	14	12	11	16	110	89	99	89	89
Chloride	mg/L	1		250		246	230	230	220	230	385	330	300	290	280	4000	3700	3700	3700	3700
Iron - Filtered	µg/L	100	ID	300	ID	1820	1100	5300	90	2600	10400	1100	26000	1600	17000	130	3800	2600	3500	340
Silver - Filtered	µg/L	1	100			<1	<1	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Aluminium - Filtered	µg/L	10/5	ID	200	55	<10	<5	<5	<5	<5	<10	7.7	<5	<5	<5	<10	13	<5	<5	<5
Antimony - Filtered	µg/L	3					<3	<3	<3	<3		<3	<3	<3	<3		5	<3	<3	<3
Arsenic - Filtered	µg/L	1	7		13	<1	<2	3	<1	2	<1	2	1	<1	1	<1	9	10	<1	<1
Barium - Filtered	µg/L						180	220	200	200		180	170	150	140		280	360	350	310
Beryllium -Filtered	µg/L						<0.1	<0.1	<0.1	0.2		0.5	0.2	<0.1	0.4		<0.1	<0.1	<0.1	<0.1
Boron - Filtered	µg/L	10	300			<10	<10	<10	<10	10	<10	20	<10	<10	0.03	<10	10	<10	<10	10
Cadmium - Filtered	µg/L	1/0.05	2		0.2	<0.1	<0.05	<0.05	<0.05	0.24	0.4	<0.05	<0.05	<0.05	<0.05	1	<0.05	<0.05	0.48	0.75
Chromium - Filtered	µg/L	1/2	50 as CrVI		1	<1	<5	<2	8	<2	<1	5	<2	5	<2	<1	6	3	22	5
Cobalt - Filtered	µg/L						0.8	<0.2	0.2	0.4		11	5.7	7.4	9.1		15	10	11	11
Copper - Filtered	µg/L	1	2000	1000	1.4	<1	<0.5	<0.5	<0.5	3.6	<1	<0.5	<0.5	<0.5	0.7	4	2.8	1.1	1.7	3.4
Manganese - Filtered	µg/L	1	500	100	1900	908	880	490	570	640	2140	3400	2200	2900	3200	2860	3800	3500	3100	3500
Molybdenum - Filtered	µg/L	0.5					0.7	<0.5	<0.5	<0.5		<0.5	<0.5	<0.5	<0.5		12	2.3	3.2	1.9
Nickel - Filtered	µg/L	1	20		11	1	2	<1	<1	3	20	9	2	<1	5	21	35	12	8	14
Lead - Filtered	µg/L	1/0.1/0.05	10		3.4	<1	0.39	<0.05	<0.05	0.11	<1	0.32	0.28	<0.05	0.28	<1	0.78	0.21	<0.05	0.19
Selenium - Filtered	µg/L	10/2/1	10		5	<10	<2	<2	<1	<1	<10	<2	<2	<1	<1	<10	<2	<2	<2	<1
Zinc - Filtered	µg/L	1	ID	3000	8	<5	53	<5	<5	50	100	<5	<5	<5	21	57	7	8	35	85
Mercury - Filtered	µg/L	0.1	1		0.06	<0.1					<0.1					<0.1				
WAD Cyanide	µg/L	5	80 total CN		10	<5					<5					<5				
Ammonia as N	mg/L	0.01	ID	0.41	0.9	<0.01	<0.01	<0.01	0.02	0.03	0.06	<0.01	<0.01	0.09	0.03	<0.01	<0.01	0.03	0.05	0.06
Nitrate as N	mg/L	0.01/0.2	11.3		0.70	<0.01	<0.2	<0.2	<0.2	<0.2	<0.01	<0.2	<0.2		<0.2	<0.01	<0.2	<0.2		<0.2
Total Kjeldahl Nitrogen as N	mg/L	0.1				<0.1					<0.1					0.4				
Total Phosphorus as P	mg/L	0.01				0.07	0.08	0.13	0.11	0.09	0.33	0.04	0.05	0.06	0.08	0.08	0.03	0.02	0.03	0.03
Reactive Phosphorus as P	mg/L	0.01				<0.01	0.01	0.03	0.02	0.01	0.03	0.02	0.05	0.02	0.02	<0.01	<0.01	0.02	0.01	0.01
Total Cations	me/L	0.01				11.6					13.4					122.0				
Total Anions	me/L	0.01				11.8					13.1					121.0				
Actual (Anion / Cation) Difference	me/L	0.01				0.16					0.28					1.19				
Allowed (Anion / Cation) Differen	me/L	0.01				0.59					0.66					6.05				
TOTAL PETROLEUM HYDROCARBONS																				
C6 - C9 Fraction	ug/L	20			ID	<20	<25	<25	<25	<25	26	<25	<25	<25	<25	21	<25	<25	<25	<25
C10 - C14 Fraction	ug/L	50			ID	<50	<25	<25	<25	<25	<50	<25	<25	<25	<25	140	<25	<25	<25	<25
C15 - C28 Fraction	ug/L	100			ID	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	452	<100	<100	110	<100
C29 - C36 Fraction	ug/L	50			ID	<50	<100	<100	<100	<100	<50	<100	<100	<100	<100	<50	<100	<100	<100	<100
Total C10 - C36					ID	0	0	0	0	0	0	0	0	0	0	592	0	0	110	0
BTEX																				
Benzene	ug/L	1	1		950	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Toluene	ug/L	2	800	25	ID	<2	<1	<1	<1	<1	12	<1	<1	<1	<1	11	<1	<1	<1	<1
Chlorobenzene	ug/L	2	300	10		<2					<2					<2				
Ethylbenzene	ug/L	2	300	3	ID	<2	<1	<1	<1	<1	<2	<1	<1	<1	<1	<2	<1	<1	<1	<1
meta- & para-Xylene	ug/L	2	600	20	200	<2					<2					<2				
ortho-Xylene	ug/L	2	600	20	350	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2

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Parameter	Units	LOR	Drinking Water Guidelines (ANZECC, 1996)		MP4					MP5					MP6				
			Health	Aesthetic	21/02/04	2/07/04	8/10/04	7/01/05	8/04/05	22/02/04	2/07/04	8/10/04	7/01/05	8/04/05	20/02/04	2/07/04	8/10/04	7/01/05	8/04/05
pH Value		0.01	ID	6.5 - 8.5	7.20	6.60	6.70	6.50	6.60	7.55	7.00	7.20	7.10	7.30	7.59	7.20	7.30	7.20	7.30
Conductivity @ 25'C	uS/cm	1			496	527	550	550	552	601	633	655	666	720	3940	2499	2909	3319	3993
Total Dissolved Solids (TDS)	mg/L	1		500	284	340	360	340	310	398	410	420	440	440	2680	1500	1800	2100	2400
Hardness as CaCO3	mg/L			200	87	94	94	97	103	140	133	139	149	172	1149	623	789	893	1059
Calcium - Filtered	mg/L	1			15	18	18	19	20	28	30	31	35	49	376	200	250	290	340
Magnesium - Filtered	mg/L	1			12	12	12	12	13	17	14	15	15	12	51	30	40	41	51
Sodium - Filtered	mg/L	1		180	72	66	69	71	69	56	47	52	55	61	452	380	270	280	330
Potassium - Filtered	mg/L	1			1	2.2	2	2.2	2.4	43	45	43	42	30	5	13	10	11	11
Carbonate as CaCO3	mg/L	1			<1	0	0	0	0	<1	0	0	0	0	<1	0	0	0	0
Bicarbonate as CaCO3	mg/L	1			143	141	140	142	141	208	211	214	218	232	291	198	212	230	253
Sulphate - Filtered	mg/L	1	500	250	9	14	9.9	10	8.3	4	<1	<1	<1	<1	22	<1	<1	<1	1.6
Chloride	mg/L	1		250	70	78	80	78	84	80	63	87	70	88	1270	570	760	910	1100
Iron - Filtered	µg/L	100	ID	300	230	800	1100	770	1000	650	3700	3400	3100	3300	2450	730	710	770	830
Silver - Filtered	µg/L	1	100		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Aluminium - Filtered	µg/L	10/5	ID	200	<10	9	7	<5	5	20	90	85	82	46	<10	120	79	77	31
Antimony - Filtered	µg/L	3				<3	<3	<3	<3		<3	<3	<3	<3		<3	<3	<3	<3
Arsenic - Filtered	µg/L	1	7		2	3	3	<1	2	4	3	2	<1	<1	5	4	4	<1	<1
Barium - Filtered	µg/L					130	130	120	120		73	68	67	110		51	59	45	52
Beryllium -Filtered	µg/L					0.6	0.6	0.1	0.6		<0.1	<0.1	<0.1	<0.1		0.1	<0.1	<0.1	<0.1
Boron - Filtered	µg/L	10	300		<10	10	<10	<10	10	60	50	50	40	50	40	40	<10	40	50
Cadmium - Filtered	µg/L	1/0.05	2		0.2	<0.05	<0.05	<0.05	<0.05	5	<0.05	<0.05	<0.05	<0.05	<0.1	<0.05	0.08	0.1	<0.05
Chromium - Filtered	µg/L	1/2	50 as CrVI		<1	5	<2	10	3	2	6	4	7	3	<1	10	6	24	5
Cobalt - Filtered	µg/L					0.8	0.5	1.1	0.7		1.3	1.1	1.3	1		0.7	0.6	1.1	0.9
Copper - Filtered	µg/L	1	2000	1000	1	<0.5	<0.5	<0.5	<0.5	<1	0.9	1	0.6	0.9	<1	3.7	3	3.7	2.1
Manganese - Filtered	µg/L	1	500	100	243	420	310	460	460	470	570	490	480	860	586	520	480	560	720
Molybdenum - Filtered	µg/L	0.5				4.8	2	2.2	2.5		37	36	44	89		14	8.4	8.1	5.2
Nickel - Filtered	µg/L	1	20		3	3	1	<1	2	10	2	2	1	3	<1	4	4	3	7
Lead - Filtered	µg/L	1/0.1/0.05	10		<1	0.89	1.1	<0.05	0.74	11	8.9	11	9.8	6.8	<1	13	11	9.6	5
Selenium - Filtered	µg/L	10/2/1	10		<10	<2	<2	<1	<1	<10	<2	<2	<1	<1	<10	<2	<2	<1	<1
Zinc - Filtered	µg/L	1	ID	3000	21	9	16	<5	20	56	12	15	13	18	7	31	28	31	27
Mercury - Filtered	µg/L	0.1	1		<0.1					<0.1					<0.1				
WAD Cyanide	µg/L	5	80 total CN		<5					<5					<5				
Ammonia as N	mg/L	0.01	ID	0.41	<0.01	<0.01	<0.01	0.03	<0.01	0.21	1.8	2.3	2.5	2.2	<0.01	0.25	0.42	0.32	0.42
Nitrate as N	mg/L	0.01/0.2	11.3		<0.01	<0.2	<0.2		<0.2	<0.01	<0.2	<0.2		<0.2	<0.01	<0.2	<0.2		<0.2
Total Kjeldahl Nitrogen as N	mg/L	0.1			<0.1					6.7					0.5				
Total Phosphorus as P	mg/L	0.01			0.17	0.05	0.04	0.07	0.05	0.66	0.52	0.46	0.42	0.37	0.04	0.11	0.1	0.07	0.06
Reactive Phosphorus as P	mg/L	0.01			<0.01	0.01	0.03	0.02	0.02	0.07	0.09	0.14	0.07	0.04	0.04	0.02	0.03	0.01	0.01
Total Cations	me/L	0.01			4.9					6.4					42.9				
Total Anions	me/L	0.01			5.0					6.5					42.1				
Actual (Anion / Cation) Difference…	me/L	0.01			0.13					0.11					0.75				
Allowed (Anion / Cation) Differen…	me/L	0.01			0.20					0.20					2.11				
TOTAL PETROLEUM HYDROCARBONS																			
C6 - C9 Fraction	ug/L	20			25	<25	<25	<25	<25	70	<25	<25	<25	<25	<20	31	60	<25	<26
C10 - C14 Fraction	ug/L	50			<50	<25	<25	<25	<25	174	<25	<25	<25	<25	568	260	180	58	<25
C15 - C28 Fraction	ug/L	100			<100	<100	<100	<100	<100	1550	<100	160	160	120	1020	570	1300	400	170
C29 - C36 Fraction	ug/L	50			<50	<100	<100	<100	<100	978	<100	<100	<100	<100	294	290	<100	<100	<100
Total C10 - C36					0	0	0	0	0	2,702	0	160	160	120	1,882	1,120	1,480	458	170
BTEX																			
Benzene	ug/L	1	1		2	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Toluene	ug/L	2	800	25	10	<1	<1	<1	<1	45	<1	<1	<1	<1	3	<1	<1	<1	<1
Chlorobenzene	ug/L	2	300	10	<2					<2					<2				
Ethylbenzene	ug/L	2	300	3	<2	<1	<1	<1	<1	<2	<1	<1	<1	<1	<2	<1	<1	<1	<1
meta- & para-Xylene	ug/L	2	600	20	<2					<2					<2				
ortho-Xylene	ug/L	2	600	20	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2

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Parameter	Units	LOR	Drinking Water Guidelines (ANZECC, 1996)		MP7					MP8					MP9				
			Health	Aesthetic	20/02/04	2/07/04	8/10/04	7/01/05	8/04/05	20/02/04	2/07/04	8/10/04	7/01/05	8/04/05	22/02/04	2/07/04	8/10/04	7/01/05	8/04/05
pH Value		0.01	ID	6.5 - 8.5	7.14	6.80	6.80	6.70	6.80	7.00	6.70	6.80	6.50	6.50	7.82	7.60	7.80	7.70	7.60
Conductivity @ 25'C	uS/cm	1			5560	6311	6320	6156	6169	2900	3080	2603	4075	4471	742	801	828	826	862
Total Dissolved Solids (TDS)	mg/L	1		500	5070	3600	4100	4200	3800	2050	1600	2200	2800	2800	770	550	600	620	590
Hardness as CaCO3	mg/L			200	1756	2047	2080	1865	1964	826	850	1164	1221	1411	103	110	115	119	137
Calcium - Filtered	mg/L	1			446	490	520	450	490	85	93	120	110	120	18	21	23	23	27
Magnesium - Filtered	mg/L	1			156	200	190	180	180	149	150	210	230	270	14	14	14	15	17
Sodium - Filtered	mg/L	1		180	460	610	470	430	430	293	200	300	290	310	106	95	98	88	100
Potassium - Filtered	mg/L	1			3	7.1	5	5.7	7.6	7	8.3	7.6	8.6	11	36	40	38	39	39
Carbonate as CaCO3	mg/L	1			<1	0	0	0	0	<1	0	0	0	0	<1	0	0	0	0
Bicarbonate as CaCO3	mg/L	1			361	322	316	316	319	190	167	166	159	160	178	204	205	205	209
Sulphate - Filtered	mg/L	1	500	250	22	25	25	26	23	21	14	22	26	29	10	<1	<1	<1	<1
Chloride	mg/L	1		250	1640	1900	1800	1800	1900	910	860	1000	1100	1300	140	130	130	130	150
Iron - Filtered	µg/L	100	ID	300	11000	1700	4100	830	3000	11200	770	11000	10000	7600	270	360	1800	2100	2300
Silver - Filtered	µg/L	1	100		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Aluminium - Filtered	µg/L	10/5	ID	200	<10	15	9	<5	6	<10	9	<5	<5	<5	90	960	290	640	1200
Antimony - Filtered	µg/L	3				<3	<3	<3	<3		<3	<3	<3	<3		<3	<3	<3	<3
Arsenic - Filtered	µg/L	1	7		1	6	7	<1	<1	3	3	4	<1	3	2	3	3	<1	<1
Barium - Filtered	µg/L					350	410	430	400		280	380	430	400		5.8	46	56	46
Beryllium -Filtered	µg/L					0.2	0.3	<0.1	0.3		<0.1	<0.1	<0.1	0.1		<0.1	<0.1	<0.1	<0.1
Boron - Filtered	µg/L	10	300		<10	20	<10	<10	20	<10	10	<10	<10	20	50	50	50	40	50
Cadmium - Filtered	µg/L	1/0.05	2		<0.1	<0.05	<0.05	<0.05	<0.05	<0.1	<0.05	<0.05	<0.05	<0.05	<0.1	<0.05	0.29	0.32	<0.05
Chromium - Filtered	µg/L	1/2	50 as CrVI		<1	3	5	31	5	<1	<2	<2	16	<2	7	14	11	22	10
Cobalt - Filtered	µg/L					2.9	2.1	2.8	2.7		0.8	1	2.3	2.5		0.4	0.3	0.3	0.4
Copper - Filtered	µg/L	1	2000	1000	32	1.3	0.8	1.4	2.2	<1	0.7	0.6	0.6	0.9	1	11	7.1	8.4	8.2
Manganese - Filtered	µg/L	1	500	100	3360	3500	2800	3000	3400	1230	1400	1300	1600	1600	155	410	390	380	480
Molybdenum - Filtered	µg/L	0.5				2.4	1.2	1.3	1.9		1.2	0.6	0.7	3.5		770	760	770	810
Nickel - Filtered	µg/L	1	20		2	14	9	5	11	5	3	3	2	8	8	3	2	<1	3
Lead - Filtered	µg/L	1/0.1/0.05	10		<1	0.1	0.23	<0.05	0.49	<1	<0.05	0.13	<0.05	0.08	2	5.4	6.1	7.1	8.5
Selenium - Filtered	µg/L	10/2/1	10		<10	<2	<2	<1	<1	<10	<2	<2	<1	<1	<10	<2	<2	<1	<1
Zinc - Filtered	µg/L	1	ID	3000	8	<5	6	6	12	30	<5	7	<5	8	20	14	20	16	31
Mercury - Filtered	µg/L	0.1	1		<0.1					<0.1					<0.1				
WAD Cyanide	µg/L	5	80 total CN		<5					<5					<5				
Ammonia as N	mg/L	0.01	ID	0.41	<0.01	0.02	0.07	0.13	0.15	<0.01	<0.01	0.11	0.08	0.07	0.19	0.4	0.51	0.58	0.54
Nitrate as N	mg/L	0.01/0.2	11.3		<0.01	<0.2	<0.2		<0.2	<0.01	<0.2	<0.2		<0.2	<0.01	<0.2	<0.2		<0.2
Total Kjeldahl Nitrogen as N	mg/L	0.1			0.3					0.7					6.3				
Total Phosphorus as P	mg/L	0.01			0.07	0.04	0.03	0.03	0.03	0.03	0.05	0.04	0.04	0.04	0.31	0.49	0.43	0.38	0.36
Reactive Phosphorus as P	mg/L	0.01			<0.01	<0.01	0.03	0.01	0.01	<0.01	<0.01	0.03	0.01	0.01	0.03	0.1	0.1	0.11	0.09
Total Cations	me/L	0.01			55.7					30.0					7.6				
Total Anions	me/L	0.01			54.0					29.9					7.7				
Actual (Anion / Cation) Difference	me/L	0.01			1.78					0.09					0.12				
Allowed (Anion / Cation) Difference	me/L	0.01			2.70					1.50					0.20				
TOTAL PETROLEUM HYDROCARBONS																			
C6 - C9 Fraction	ug/L	20			<20	<25	<25	<25	<25	<20	<25	<25	<25	<25	90	52	25	32	<25
C10 - C14 Fraction	ug/L	50			<50	<25	<25	<25	<25	<50	<25	<25	<25	<25	5,870	290	150	160	49
C15 - C28 Fraction	ug/L	100			<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	6450	550	380	610	<100
C29 - C36 Fraction	ug/L	50			<50	<100	<100	<100	<100	<50	<100	<100	<100	<100	3220	<100	<100	<100	<100
Total C10 - C36					0	0	0	0	0	0	0	0	0	0	15,540	840	530	770	49
BTEX																			
Benzene	ug/L	1	1		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Toluene	ug/L	2	800	25	<2	<1	<1	<1	<1	4	<1	<1	<1	<1	52	<1	<1	3.6	<1
Chlorobenzene	ug/L	2	300	10	<2					<2					<2				
Ethylbenzene	ug/L	2	300	3	<2	<1	<1	<1	<1	<2	<1	<1	<1	<1	<2	<1	1.8	<1	<1
meta- & para-Xylene	ug/L	2	600	20	<2					<2					<2				
ortho-Xylene	ug/L	2	600	20	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	2.4	2.2	<2

Table 5: Marulan Groundwater - Laboratory Analysis Results - page 4 of 4

Parameter	Units	LOR	Drinking Water Guidelines (ANZECC, 1996)		MP10					MP11				
			Health	Aesthetic	22/02/04	2/07/04	8/10/04	7/01/05	8/04/05	22/02/04	2/07/04	8/10/04	7/01/05	8/04/05
pH Value		0.01	ID	6.5 - 8.5	7.35	6.80	6.90	6.70	6.60	7.76	7.10	7.20	7.20	7.40
Conductivity @ 25'C	uS/cm	1			6120	6673	7152	7093	7093	610	645	766	703	747
Total Dissolved Solids (TDS)	mg/L	1		500	4760	3800	4500	4300	4400	364	380	470	440	450
Hardness as CaCO3	mg/L			200	1610	1903	2217	1878	1878	253	268	287	258	283
Calcium - Filtered	mg/L	1			302	350	410	340	340	83	89	97	87	97
Magnesium - Filtered	mg/L	1			208	250	290	250	250	11	11	11	9.8	9.8
Sodium - Filtered	mg/L	1		180	808	760	750	640	610	27	25	44	53	50
Potassium - Filtered	mg/L	1			11	12	13	12	12	3	3.7	3.3	2.6	2.9
Carbonate as CaCO3	mg/L	1			<1	0	0	0	0	<1	0	0	0	0
Bicarbonate as CaCO3	mg/L	1			378	300	330	307	289	246	309	331	309	325
Sulphate - Filtered	mg/L	1	500	250	68	47	24	30	27	4	1.2	30	31	29
Chloride	mg/L	1		250	1970	2000	2100	2200	2300	42	25	25	24	35
Iron - Filtered	µg/L	100	ID	300	40	22000	2400	1200	350	20	1000	2400	110	720
Silver - Filtered	µg/L	1	100		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Aluminium - Filtered	µg/L	10/5	ID	200	<10	14	7	<5	<5	10	13	7	<5	<5
Antimony - Filtered	µg/L	3				<3	<3	<3	<3		<3	<3	<3	<3
Arsenic - Filtered	µg/L	1	7		1	6	7	<1	<1	<1	<1	3	1	2
Barium - Filtered	µg/L					240	400	420	260		200	400	450	420
Beryllium -Filtered	µg/L					<0.1	<0.1	<0.1	<0.1		<0.1	<0.1	<0.1	<0.1
Boron - Filtered	µg/L	10	300		<10	70	<10	<10	<10	20	20	20	<10	20
Cadmium - Filtered	µg/L	1/0.05	2		5.1	<0.05	<0.05	<0.05	<0.05	0.2	<0.05	<0.05	<0.05	<0.05
Chromium - Filtered	µg/L	1/2	50 as CrVI		<1	<2	5	33	4	1	2	3	9	4
Cobalt - Filtered	µg/L					3.3	1.5	3.7	2.3		2.8	2.5	1.4	1.9
Copper - Filtered	µg/L	1	2000	1000	1	1.2	0.7	1.6	1.4	1	2.2	1.6	0.6	<0.5
Manganese - Filtered	µg/L	1	500	100	1350	1600	2300	2300	1400	390	740	2200	1700	1700
Molybdenum - Filtered	µg/L	0.5				6.6	8.1	2.3	4.9		17	15	6.9	12
Nickel - Filtered	µg/L	1	20		40	21	4	9	12	44	25	4	<1	6
Lead - Filtered	µg/L	1/0.1/0.05	10		<1	1.5	0.19	<0.05	0.15	2	2.1	0.88	<0.05	0.08
Selenium - Filtered	µg/L	10/2/1	10		<10	<2	<2	<1	<1	<10	<2	<2	<1	<1
Zinc - Filtered	µg/L	1	ID	3000	46	6	<5	<5	10	164	9	6	<5	7
Mercury - Filtered	µg/L	0.1	1		<0.1					<0.1				
WAD Cyanide	µg/L	5	80 total CN		<5					<5				
Ammonia as N	mg/L	0.01	ID	0.41	<0.01	<0.01	<0.01	<0.01	0.05	<0.01	0.01	0.07	0.1	0.09
Nitrate as N	mg/L	0.01/0.2	11.3		<0.01	<0.2	<0.2		<0.2	0.04	<0.2	<0.2		<0.2
Total Kjeldahl Nitrogen as N	mg/L	0.1			0.5					0.60				
Total Phosphorus as P	mg/L	0.01			1.23	0.02	0.03	0.03	0.02	0.13	0.04	0.08	0.06	0.05
Reactive Phosphorus as P	mg/L	0.01			0.03	0.01	0.02	0.02	0.01	0.01	0.01	0.03	0.02	0.01
Total Cations	me/L	0.01			67.6					6.3				
Total Anions	me/L	0.01			64.5					6.2				
Actual (Anion / Cation) Difference	me/L	0.01			3.09					0.11				
Allowed (Anion / Cation) Differen	me/L	0.01			3.23					0.20				
TOTAL PETROLEUM HYDROCARBONS														
C6 - C9 Fraction	ug/L	20			51	<25	<25	<25	<25	26	33	<25	<25	<26
C10 - C14 Fraction	ug/L	50			114	<25	<25	<25	<25	280	<25	<25	39	<25
C15 - C28 Fraction	ug/L	100			532	<100	<100	120	<100	1430	<100	<100	410	<100
C29 - C36 Fraction	ug/L	50			206	<100	<100	<100	<100	398	<100	<100	<100	<100
Total C10 - C36					852	0	0	120	0	2,108	0	0	449	0
BTEX														
Benzene	ug/L	1	1		<1	<1	<1	<1	<1	<1	<1	<2	<1	<1
Toluene	ug/L	2	800	25	28	<1	<1	<1	<1	12	22	23	<1	<1
Chlorobenzene	ug/L	2	300	10	<2					<2				
Ethylbenzene	ug/L	2	300	3	<2	<1	<1	<1	<1	<2	<1	<1	<1	<1
meta- & para-Xylene	ug/L	2	600	20	<2					<2				
ortho-Xylene	ug/L	2	600	20	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2

2.5.1 Salinity

Groundwater salinity ranged from sub-potable to saline, with reported values from the lab analysis ranging from 284 mg/L (MP-4) to 7600 mg/L (MP-3) total dissolved solids (TDS). MP-1, MP-2, MP-4, MP-5, MP-9 and MP-11 had salinities of less than 1000 mg/L.

No significant changes in salinity at any piezometer were noted through the period of baseline monitoring.

2.5.2 pH

pH was generally close to neutral, with most samples reporting pH in the range 6.5 to 8.0 (**Table 3**). Samples collected from MP-2 were slightly more acidic, with pH reported in the range 6.1 to 6.5.

2.5.3 Dissolved Metals

Samples were analysed for dissolved trace metals and the concentrations compared with ANZECC guideline values for freshwater ecosystem protection. Some elevated concentrations were reported, as listed in **Table 4**.

Table 4: Dissolved Metals – Exceedences of ANZECC Guideline Values for Fresh Water Ecosystem Protection

	Al	Cd	Cr	Cu	Mn	Ni	Pb	Zn
ANZECC (2000) Freshwater Ecosystem Protection Guideline	**55 µg/L**	**0.2 µg/L**	**1 µg/L**	**1.4 µg/L**	**1900 µg/L**	**11 µg/L**	**3.4 µg/L**	**8 µg/L**
Piezometer	**Range of Reported Concentrations (µg/L)**							
MP-1			<1 - 8					<5 - 53
MP-2		<0.05 - 0.4	<1 - 5		2140 - 3400	<1 - 20		<5 - 100
MP-3		<0.05 - 1.0	<1 - 22	1.1 - 2.8	2860 - 3800	8 - 35		7 - 57
MP-4			<1 - 10					<5 - 21
MP-5	20 - 90	<0.05 - 5	2 - 7				8.9 - 11	12 - 56
MP-6	<10 - 120		<1 - 24	<1 - 3.7			<1 - 13	7 - 31
MP-7			<1 - 31	0.8 - 32	2800 - 3500	2 - 14		
MP-8			<1 - 16					<5 - 30
MP-9	90 - 960	<0.05 - 0.32	7 - 22	1 - 11			2 - 7.1	14 - 20
MP-10		<0.05 - 5.1	<1 - 33	0.7 - 1.6	1350 - 2300	4 - 40		<5 - 46
MP-11			1 - 9	1 - 2.2	390 - 2200	<1 - 44		<5 - 164

No arsenic, selenium or mercury was detected at concentrations in excess of ANZECC (2000) freshwater ecosystem protection guidelines.

Both iron and manganese were recorded at levels in excess of NHMRC (1996) drinking water guideline concentrations in every piezometer. Occasional samples also reported aluminium, arsenic, cadmium, lead and nickel at levels above NHMRC drinking water guidelines.

2.5.4 Cyanide

No cyanide was detected at any piezometer.

2.5.5 Nutrients

Ammonia and nitrate concentrations were generally low. One piezometer (MP-5) reported ammonia at up to 2.5 mg/L (as N), which exceeds the ANZECC freshwater ecosystem protection guideline value of 0.9 mg/L. MP-5, MP-6 and MP-9 all had ammonia in excess of the NHMRC drinking water guideline value of 0.41 mg/L.

2.5.6 Total Petroleum Hydrocarbons

TPHs were detected in MP-3, MP-5, MP-6, MP-9, MP-10 and MP-11 in the initial sampling in February 2004, at up to 15,540 µg/L (MP-9). In some cases, low levels of toluene were also detected in conjunction with the elevated TPHs. It is likely that these elevated levels were the result of residual grease and organic drilling additives, as there are no known or likely sources of contamination which could contribute to such a result. Elevated TPHs have persisted in subsequent sampling, especially at MP-6 and MP-9, and occasionally at other bores as well, although this persistence is considered to be largely explained by the low aquifer yields at these locations and with limited ‘flushing’ occurring. The TPH concentrations continue to decline, and in the latest sampling in April 2005, the only TPHs recorded were 120 µg/L at MP-5, 170 µg/L at MP-6 and 49 µg/L at MP-9. It is expected that the TPHs will continue to diminish with time.

2.5.7 Potability

The groundwater beneath the Project Area is not suitable for potable use. Although salinities below 500 mg/L TDS occur at some piezometers, the high concentrations of dissolved iron and manganese in all samples, and occasional other dissolved metals at concentrations above the NHMRC (1996) drinking water guideline values (**Table 3**), renders the water unsuitable for drinking purposes.

The groundwater is marginally suitable for stock use, however in some samples the molybdenum concentration exceeds the recommended maximum concentration of 10 µg/L for livestock drinking water (ANZECC, 1992). The tolerable salinity for stock drinking water varies according to the type of stock, but generally water with TDS above 3000 mg/L is considered unsuitable as a stock water supply. In any event, the volumes of water likely to be available from the fractured hard rock aquifer are very low, and this aquifer is unlikely to be of interest as a source of stock water supply.

2.6 Groundwater – Major Ion Composition

The hydrochemistry of the Lynwood groundwater has been evaluated with the aid of Schoeller and Piper Trilinear water quality diagrams, which allow a visual comparison of the relative concentrations of the major ions in solution, ie the cations calcium, magnesium, sodium and potassium, and the anions chloride, bicarbonate and sulphate.

The Schoeller diagram (**Figures 15** to **17**) is a plot of the major ion concentrations in milli-equivalents per litre. The relative concentrations give an indication of the groundwater samples in relation to the recharge and discharge points in the hydrological cycle. The Piper Trilinear diagram (**Figure 18**) comprises two triangular fields on which the relative concentrations of the cations and anions respectively are plotted, as percentage equivalents. The plotted positions of each sample in the cation and anion fields are projected onto a diamond field, allowing each sample to be represented by a single point. The plotted positions of the samples in the diamond field enable them to be assessed in relation to their proximity to the sources of recharge, and they can also allow the identification of different sources of water, and mixing of those different water sources in the flow field.

Figure 18 shows the most recent sample result for each of the piezometers. The size of the data point for each sample in the diamond field is scaled according to the TDS of the sample. The higher salinity samples are all clustered near the upper right side of the diamond field, due to the increasing proportion of chloride among the anions at higher salinities. The Piper Diagram suggests that the MP-5 water chemistry may be typical of recently recharged groundwater, with MP-3, MP-7, MP-8 and MP-10 being more representative of the chemistry of groundwater near the discharge end of the cycle.

2.7 Surface Water Quality

Surface water quality has been monitored at seven sites on and around the Project Area, as discussed in the main text of the EIS. SW3, SW4, SW5 and SW6 are sites on Joarimin Creek (**Figure 1**), of which only the two downstream sites (SW5 and SW6) consistently contained visible flow.

The salinity at SW5 and SW6 varied through the monitoring period, with noticeably lower salinities after September 2004 (**Figure 19**). The surface flow at site SW6 had an initial TDS of 1200 mg/L on 1 July 2004, but increased markedly to a maximum of 2200 mg/L in September 2004. Since October 2004, the TDS has been consistently below 450 mg/L. The TDS at SW5, where Joarimin Creek leaves the Project Area (**Figure 1**), reached a maximum of 490 mg/L in September 2004, but since November 2004 has been in the range 170 to 240 mg/L.

The surface water is generally of lower salinity than the groundwater. However, the increase in salinity at SW6 prior to the major rainfall in September-October 2004, and the very much lower salinity since that time, suggests that streamflow late in the dry period was being maintained by groundwater discharge.

3 DESCRIPTION OF EXISTING ENVIRONMENT

3.1 Climate

3.1.1 Rainfall

The nearest long-term Bureau of Meteorology rain gauging stations to the Lynwood Quarry Project are those listed in **Table 5**.

Table 5: Bureau of Meteorology Stations in Project Vicinity

Station No.	Location	Distance from Proposed Quarry	Latitude	Longitude
070063	Marulan (George St)	1.6 km	34.714 S	150.003 E
070269	Marulan (Johnniefields)	4.0 km	34.665 S	149.990 E
568083	Shelleys Flat	4.7 km	34.740 S	149.983 E
070143	Brayton (Longreach)	8.0 km	34.639 S	149.954 E
568084	Bumbulla	12.9 km	34.734 S	150.135 E
070037	Goulburn	13.4 km	34.750 S	149.867 E
070263	Goulburn (Progress St)	13.6 km	34.723 S	149.740 E
070119	Big Hill (Glen Dusk)	14.7 km	34.568 S	149.997 E

Analysis of the long term daily rainfall data from 1857 to 1967 (ie. 110 years) from Goulburn, 13.4 km west of the proposed quarry, provides the following key characteristics shown in **Table 6**.

Table 6: Long Term Rainfall Data for Goulburn Station 070037[1]

Rainfall	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Mean (mm)	64.8	60.6	55.6	48.5	51.5	56.3	47.8	49.1	50.0	62.5	56.1	62.9	665.7
Median (mm)	61.4	46.4	41.7	40.3	31.0	44.2	35.3	42.5	43.3	57.8	45.2	48.7	625.8
Highest Monthly (mm)	254.7	224.0	251.2	163.3	299.5	318.2	243.4	169.5	175.4	236.8	221.0	217.4	
Lowest Monthly (mm)	0.6	0.3	0.0	1.3	2.1	5.1	5.8	2.6	4.8	5.3	0.3	1.8	
Highest Recorded Daily	121.4	95.3	105.7	94.7	122.7	68.8	136.1	52.1	64.8	125.7	93.2	122.2	
Mean No of Raindays	7.5	7.2	7.4	7.7	9.0	11.0	10.9	10.2	9.5	9.2	7.9	7.9	105.3

The annual rainfall at Goulburn exhibits a very slight seasonal pattern with the average rainfalls between October and February being about 20 percent higher than between March and September.

3.1.2 Evapotranspiration

The nearest meteorological station for which evaporation records are available is Goulburn (Progress St – Station 70263), 13.6 km west of the proposed quarry. Average annual pan evaporation at Station 70263 is 1643 mm[1]. The evaporation records from this station are available for the period 1973 to 2000 (ie 27 years of full record). The average annual rainfall for this period was 631 mm[1], slightly higher than the average for the same period at Goulburn Station 70037 (613 mm).

[1] From Bureau of Meteorology records.

It appears that rainfall between 1973 and 2000 was below the longer-term average (shown as 666 mm in **Table 6** above).

It is not known whether the average evaporation between 1973 and 2000 has been higher or lower than the long term average. Nonetheless, it is clear that average evaporation greatly exceeds average annual precipitation. Based on the rainfall records from Station 70037, it is likely that average daily evaporation exceeds average daily precipitation in all months of the year except June and July.

3.2 Groundwater

3.2.1 Geology

The Goulburn 1:250,000 Geological Map Sheet indicates that the Project Area is substantially underlain by rocks of the Devonian age Bindook Porphyry Complex, described as *"… quartz porphyry, hypersthene porphyry, felsite, dacite, tuff, minor conglomerate, sandstone and limestone"* (DMR, 1969).

There is limited alluvium developed in the vicinity of Joarimin Creek, which drains from west to east across the central part of the Project Area. This is believed to be no more than 5m or so in thickness. The porphyritic bedrock is typically weathered to a depth of between 1 and 10 m, however, weathering extends to as much as 30 m in some areas.

3.2.2 Groundwater Occurrence

Groundwater is generally present throughout the area, although the porphyry bedrock is poorly to very poorly permeable. Most exploration holes drilled on the site yielded no water during drilling, although all holes still open to sufficient depth were found to contain groundwater when inspected.

Sporadic localised fracture zones provide discontinuous regions of moderate permeability.

3.2.3 Current Groundwater Use

A search of the Department of Infrastructure, Planning and Natural Resources (DIPNR) database of registered groundwater bores carried out in February 2004 identified fifteen (15) registered bores within 5km of the proposed quarry location; and a further twenty-six (26) between 5 and 10 km from the project.

The identified registered bores/wells within 5km of the proposed quarry site are listed in **Table 7**. Locations are shown on **Figure 20**. The reported yields of the 15 registered bores within 5km of the Project Area range up to a maximum of 2.9 L/sec. Salinity is variable, from fresh to saline. The highest yielding bore GW018809 (located on the eastern side of Marulan township) is recorded as being for general commercial use. Bore GW068878 (located on the southern side of the Hume Highway to the south of the Project Area) is listed as being used for industrial purposes, but it has a reported very low yield (**Table 7**). Bores

GW101320 and GW101321 are described as monitoring bores. The remainder are for domestic and/or stock use.

A similar range in yields (up to 1.25 L/s) and salinities (fresh to saline) are reported for the registered bores between 5 and 10 km from the Project Area.

It is acknowledged that other bores may exist within the project vicinity that are currently in use, but are either not registered or are not yet listed in the DIPNR database.

Table 7: Registered Bores Located within 5 km of the Proposed Quarry

DIPNR Registered No.	Latitude	Longitude	Depth (m)	Intended Use	Yield	Salinity
GW010600	34°40'7"	149°56'20"	92.7 m	Stock	0.8 L/s	Good/salty
GW018809	34°42'39"	150°0'28"	24.5 m	General use - commercial	1.1 L/s	960 mg/L
GW019646	34°42'49"	150°0'16"	48.7 m	Domestic – waste disposal	0.2 L/s	Unknown
GW022357	34°42'58"	150°0'4"	26.5 m	Domestic – waste disposal	0.3 L/s	Unknown
GW023891	34°42'54"	150°0'16"	61.0 m	Domestic – waste disposal	?	Unknown
GW051574	34°43'36"	149°59'6"	61.0 m	Domestic	0.2 L/s	Fair
GW054057	34°44'15"	149°59'21"	60.0 m	Domestic, stock	2.9 L/s	Fair
GW055436	34°41'36"	149°55'49"	76.2 m	Domestic, stock	0.4 L/s	Good
GW056376	34°40'58"	149°58'54"	51.0 m	Stock	0.15 L/s	Unknown
GW068878	34°44'27"	149°57'57"	46.0 m	Industrial	0.2 L/s	Good
GW072404	34°44'29"	149°59'16"	48.8 m	Domestic, stock	0.25 L/s	Brackish
GW101320	34°43'31"	149°59'48"	15.8 m	Monitoring bore	0.1 L/s	Salty
GW101321	34°43'29"	149°59'54"	15.7 m	Monitoring bore	0.1 L/s	350 mg/L
GW104791	34°44'24"	149°57'6"	72. 0m	Domestic, stock	0.1 L/s	Unknown
GW105505	34°44'19"	149°59'2"	49.0 m	Domestic, stock	1.7 L/s	600 mg/L

3.2.4 Groundwater Flow Pattern

The groundwater contours on **Figure 14** are based on groundwater levels measured in all bores on 2 July 2004. The groundwater contours are generally sympathetic to the topography, with the highest water table elevations being recorded in the elevated regions near the northern and southern boundaries of the Project Area, and the lowest in the central zone close to Joarimin Creek. Groundwater would flow southwards or northwards towards the vicinity of Joarimin Creek, then flow eastwards in the same general direction as surface flow.

Measured groundwater elevations ranged from around 630m AHD (at MP-11) to around 675m AHD (at MP-6 and MP-7 near the northern boundary and at MP-1 and MP-2 near the southern boundary). The water table is generally well below ground surface, even in the vicinity of Joarimin Creek, eg at MP-10 (**Figure 14**) the water table is approximately 6m below surface.

In the vicinity of the proposed quarry, the water table is expected to be encountered at depths of between 10 and 30m below the current ground surface.

3.2.5 Recharge and Discharge

It is interpreted from the groundwater contours that groundwater recharge occurs by direct infiltration of incident rainfall and local sheetflow following rainfall events. Discharge would occur by down-gradient flow towards seepage zones in low-lying areas close to or within the major creek lines, together with evapotranspiration or direct evaporation from such areas when the water table is sufficiently shallow. This is consistent with the groundwater quality distribution, where the highest salinities are found in piezometers in the valley areas and lowest salinities in upland areas.

Recharge rates are expected to be generally quite low and variable, with the most ready recharge occurring in areas where there is fractured bedrock exposed at the ground surface, or where the bedrock is covered by highly permeable sandy soil. The northern elevated part of the Project Area, where the initial quarry is proposed, is typically covered by sandy soils derived from weathering of the underlying bedrock, and is expected to be favoured by higher rates of recharge than the lower slopes and valley areas.

It is estimated by comparing the measured chloride concentrations of the groundwater samples with the likely chloride content of rainfall that net recharge rates vary from less than 0.1 percent of rainfall to perhaps more than 5 percent in favoured areas, with net recharge over the full project area probably between 0.1 and 0.2 percent of total rainfall.

3.2.6 Groundwater Quality

The groundwater quality is quite variable across the Project Area. Measured TDS (total dissolved solids) ranges from less than 400 mg/L to more than 7500 mg/L. This high degree of variability in salinity is believed to indicate a generally low hydraulic conductivity and poor lateral continuity within the bedrock formation.

The lowest salinities were generally reported from bores in areas of higher elevation, where there is abundant rock outcrop or a shallow cover of permeable sandy soil derived from weathering of the bedrock, and where it is interpreted that recharge by infiltration of rainfall occurs more readily. The higher salinities reported from piezometers located in less elevated sites or closer to the drainage lines probably results from a combination of poorer recharge and progressive salinity increase due to evapotranspiration.

The groundwater has near neutral pH.

Due to the variable salinity, and the presence of some dissolved metals at elevated concentrations (as discussed in **Section 2.5.7**), the groundwater is generally not suitable for potable use.

A number of the dissolved metals are also present at concentrations in excess of ANZECC (2000) guidelines for freshwater ecosystem protection. Aluminium, cadmium, chromium, copper, lead, iron, manganese, nickel and zinc concentrations were all greater than ANZECC freshwater ecosystem protection guidelines in some or all of the piezometers on the Project Area (as discussed in **Section 2.5.3**).

3.2.7 Groundwater – Surface Water Interaction

The groundwater surface is generally more than 5m below ground surface, and there is no direct interconnection with the surface water environment within the Project Area. Groundwater was found to be somewhat closer to the surface at MP-1, the southernmost piezometer in the Project Area, at about 2m below the surface. However, there is no visible evidence of any springs or seepage in that area.

Downstream from (ie to the east of) the Project Area within the Joarimin Creek drainage, there is some evidence in the surface water quality monitoring data that during extended periods without runoff-generating rainfall, stream baseflow is probably maintained by small volumes of groundwater discharge. This is reflected in a marked increase in salinity of the streamflow as observed at site SW6 (**Figure 1**) during the period up to October 2004. The TDS of streamflow at SW6 increased from an initial 1200 mg/L in July 2004 to 2200 mg/L by September 2004, then fell to 360 mg/L in October 2004 and has since fluctuated between 210 and 410 mg/L (**Figure 19**).

Therefore, although there is no evidence for a direct interconnection between groundwater and surface water within the Project Area, it is interpreted that regionally, one mechanism for groundwater discharge will be by seepage into the surface drainage system at low elevations within the main creek valleys.

The presence of green patches on the aerial photograph near Marulan Creek to the south of the Project Area is a possible indication of the presence of localised perched groundwater in that area. The main regional water table is too deep to be the cause of this near-surface dampness.

4 QUARRY PROPOSAL

4.1 The Proposal

It is proposed to commence quarrying to the north of the Main Southern Railway, and all quarrying within the first 30 years would occur in the northern half of the project area, north of the Main Southern Railway (**Figure 1**).

It is proposed to extract up to 5 Mt of material per year, for on-site crushing, screening and blending. Some of the processing operations and stockpile areas are to be located to the south of the Main Southern Railway.

The proposal will see the quarry progressively deepened over time, with the planned lowest pit level at various stages of the project life as detailed in **Table 8** below.

Table 8: Planned Progressive Pit Floor Levels

Year	Lowest Pit Elevation (m AHD)
1	660 m AHD
2	645 m AHD
5	630 m AHD
10	630 m AHD
15	630 m AHD
20	615 m AHD
25	615 m AHD
30	570 m AHD

4.2 Groundwater Issues

The proposed quarry will not extend below the water table during the first year, but thereafter, some part of the pit will be below the water table. By the end of Year 30, the pit floor will be more than 100m below the pre-project water table level at the northern end of the pit.

Accordingly, it will be necessary to control groundwater inflows during most of the quarry operation, and there is potential for the project to impact on the groundwater system, at least locally. It has been necessary therefore to undertake an assessment of the potential impact of the proposal on groundwater levels and groundwater quality. This assessment is discussed in the next section of this report, **Section 5**.

4.3 Dewatering

Dewatering of the pit will be necessary from the second year of the proposed project, by which time the pit floor is scheduled to extend below the present water table level. Minor shallow perched groundwater may be intercepted during year 1, but any resultant inflows are expected to be minor and short-lived.

The likely dewatering requirements or groundwater inflow rates are discussed in **Section 5**.

4.4 Quality of Dewatering Abstraction

The quality of groundwater inflows is expected to be variable in the early stages, but over time is expected to gradually assume a quality that represents a mean of the water qualities sampled from the piezometers during the investigation program. The quality is also likely to gradually improve over time, as the dewatering or inflow to the pit will represent an interception of water much earlier in its natural flow regime, thus reducing the opportunity for salinity to increase by evapotranspiration and dissolution of rock minerals.

4.5 Water Supply

The water balance for the project is discussed in the main text of the Environmental Impact Statement (Umwelt, 2005). There is expected to be a significant shortfall between the volumes of groundwater inflow to the pit and the project’s water demand. Water sources other than groundwater inflow will therefore be required to supply process water.

The low permeability and storage potential of the aquifer system as revealed by the hydraulic testing of piezometers suggests that the potential for developing a make-up water supply from groundwater sources on the Project Area are minimal.

5 IMPACT ASSESSMENT

5.1 Groundwater Modelling

5.1.1 Model Description

A numerical finite difference groundwater flow model has been set up to evaluate the potential impacts of the quarry proposal.

The model is based on the industry standard MODFLOW code (McDonald and Harbaugh, 1988), used in conjunction with the Groundwater Vistas visualisation software (Environmental Simulations Inc, 2004).

The model comprises a rectangular grid of cells, in 28 columns and 32 rows, with cells varying in size from 100m x 100m around the proposed quarry area to 500m x 500m at the outer margins of the model area (**Figure 21**). The boundaries of the model flow area have been set as no flow boundaries coinciding with Chapman's Creek to the north, Lockyersleigh Creek to the west, Marulan Creek to the south, portion of Joarimin Creek to the north-east, and the catchment divide in the vicinity of Marulan township to the east (**Figure 21**). The boundaries are approximately 3km or more beyond the limits of the proposed quarry.

There are two model layers, a 20m thick upper layer to represent the weathered and fractured porphyry bedrock, and a thicker underlying layer of much lower permeability and storage potential to represent the unweathered and unfractured bedrock.

The hydraulic properties assigned to the upper and lower layers are listed in **Table 9**.

Table 9: Hydraulic Parameters Adopted in the Groundwater Flow Model

Model Layer	Geological Description	Hydraulic Conductivity (m/d)		Storativity	Specific Yield
		Horizontal	Vertical		
1	Weathered porphyry	5	1	0.05	0.05
2	Unweathered, unfractured porphyry	0.001	0.0001	0.0001	0.01

A net recharge rate has been assumed in the model as 0.8 mm/d over most of the model area, with a higher rate of 2.4 mm/d assumed for the elevated area extending north from the railway line, and including the proposed quarry area. The higher rate of recharge for the elevated areas was based on the results of steady state modelling to derive pre-project groundwater levels, as discussed in **Section 5.1.2** below.

As the creeks in the area are almost all ephemeral, the model cells coinciding with a creek line were set in the model as drain cells, with the drain elevation in each drain cell set at the average creek-bed elevation within that cell.

5.1.2 Steady State Modelling – Pre-Project Conditions

The model was first run in steady-state mode, to simulate pre-project groundwater levels. These were compared to the known existing groundwater levels within the Project Area (**Figure 14**), and the model input parameters amended where appropriate to ensure an acceptable calibration between the model and the observed head distribution. Due to the very low permeability and limited thickness of the upper weathered bedrock (model layer 1) over an essentially impermeable layer 2, calibration of the model was difficult and it was not possible to very closely replicate the observed groundwater head distribution..

The optimum head distribution generated by the steady-state model is shown in **Figure 22**. It was achieved with the parameters listed in **Table 9** above.

5.1.3 Transient Modelling – Project Impact Simulations

A series of transient runs was then carried out, to simulate the progressive expansion and deepening of the quarry over the first 30 (thirty) years of the proposed quarry operation. Model runs were carried out for each of the stages listed in **Table 8**.

For the Year 1 simulation, the surface topography was amended in the model to match the proposed Year 1 quarry profile, and each model cell within the quarry area set as a drain cell, with the drain elevation set at the average floor elevation within that part of the quarry. The head distribution generated by the steady-state model was used as input heads for the Year 1 simulation.

The Year 1 simulation resulted in no groundwater inflow to the quarry, as the entire excavation is above the water table.

In the Year 2 simulation, the surface topography was again amended to match the proposed Year 2 quarry profile, and all cells within the quarry set as drain cells as described above. The final heads generated by the Year 1 simulation were used as starting heads.

The results of the Year 2 simulation are plotted on **Figure 23**. It shows a very slight westward displacement of the 645m AHD groundwater contour as the only noticeable impact.

Subsequent simulations were run for Years 5, 10, 15, 20, 25 and 30. For each successive simulation, the surface topography was amended to match the proposed quarry profile for that stage of the operation, and each quarry cell set as a drain cell in the model as described above, and the output heads from the preceding run used as starting heads for the new simulation.

The modelling results at Years 5, 10, 20 and 30 are presented as groundwater contours on **Figures 24** to **27**. They show a progressively deepening and expanding cone of depression around the quarry. However, the cone of depression remains very small, with drawdown impact limited to within about 1.5 km from the pit during the 30 year extraction period. This result is consistent with the low permeabilities determined from testing, and also with the highly variable groundwater quality in the area, which suggests a general low degree of lateral hydraulic continuity, and very slow groundwater flow rates.

Mass balance figures generated from each run were examined to determine the average rate of groundwater inflow to the quarry during each model simulation. The predicted average inflow rates are listed in **Table 10**.

Table 10: Average Groundwater Inflow Rates to Quarry

Year	Pit Floor Level (m AHD)	Average Inflow Rate	
		m^3/day	ML/year
1	660	0	0
2	645	2.0	0.7
5	630	11.1	4.0
10	630	16.0	5.5
15	630	22.8	8.3
20	615	38.2	13.9
25	615	47.8	17.6
30	570	72.8	26.6

These inflow rates are very modest, but are consistent with the very low hydraulic conductivity values derived from the piezometer testing program.

5.1.4 Steady State Modelling – Post-Project Conditions

The recovery of groundwater levels after completion of the quarry project have been simulated by a further transient run, for a period of 100 years. This model run assumes that the quarry is left with the profile at the end of the 30 year extraction period, and water is allowed to flow back into the pit over time. The quarry cells within the model are no longer retained as drain cells, but there is an evapotranspiration component introduced to the cells corresponding to the lowest cells within the pit area at completion of 30 years extraction, ie the 570 and 585m AHD levels. This was done to simulate the progressive inflow of groundwater into the pit, and the off-setting influence of direct evaporation from any seepage pond that may develop in the pit bottom.

The results of this simulation are presented in **Figure 28**. It shows a contour pattern largely unchanged from that predicted for the completion of 30 years extraction (**Figure 27**), except for the region due east (ie down-gradient) of the pit. At a distance of about 1km east of the pit, a further lowering of groundwater levels by between 5 and 10 m is predicted to have occurred during the 100 years after completion. In all other locations, no significant further change in groundwater levels is predicted to take place during the 100 year period following completion of extraction.

It is also seen on **Figure 28** that the groundwater levels remain below the pit floor, indicating that the groundwater inflow rate is less than the potential evaporation rate from even the lowermost bench level. The mass balance from the model indicates an evaporation loss from the pit floor of just 39 m^3/day, compared with a theoretical open water evaporation loss of 390 m^3/day from a pond covering the combined area of the 570 and 585m AHD benches in the mined out pit. The very low ongoing groundwater inflow rate is thus insufficient to allow a permanent pond to develop in the pit.

5.2 Impact of Extraction on Groundwater Levels

The results of the transient model simulations presented in **Figures 23** to **27** show that the impact of the proposal on groundwater levels during the life of the project will be limited to within about 1.5 km or less of the quarry itself. From the model outputs, a plot of total drawdowns after the end of 30 years extraction has been generated, and is plotted at **Figure 29**.

The maximum drawdown of 75 m would occur in the (deepest) eastern part of the pit, while the predicted 10m drawdown contour would extend only approximately 200m beyond the quarry limits.

No existing groundwater supply is predicted to be impacted by the quarry project.

5.3 Post-Quarrying Recovery of Groundwater Levels

As discussed above in **Section 5.1.4**, potential evaporation will greatly exceed the predicted ongoing rate of groundwater inflow to the pit, and will prevent a permanent water body developing within the pit if the pit remains open to the stage reached at the end of 30 years extraction. It is likely that temporary accumulations of water will develop within the pit following heavy rainfalls, but that evaporation and seepage through the floor will remove this water gradually once the rainfall event has passed. It is predicted that groundwater levels would remain below the pit floor into the long-term.

The pit would thus remain as a permanent groundwater sink, and groundwater would flow inwards towards the pit. Thus a groundwater depression would develop around the former quarry, which over time would lead to a reduction in downgradient areas to the east, as shown on **Figure 28**.

It should be noted that these predictions are based on the quarrying operation ceasing at the completion of 30 years extraction, and no backfilling of the pit. It is anticipated that Readymix would seek to continue quarrying operations beyond 30 years, and that at some stage it would be possible to commence emplacement of overburden and excess product material back into the pit. This would have an ameliorating effect on long-term groundwater impacts, by allowing partial recovery of groundwater levels within the emplaced rock, and thus reducing the magnitude of regional impacts on groundwater levels to the east.

5.4 Impacts on Groundwater Quality

As discussed above in **Section 4.4**, it is predicted that the quality of groundwater flowing into the pit during the quarry project will initially be quite variable, with probably lower salinity groundwater flowing in from the northern and eastern sides of the pit, and higher salinity from the south and west.

Over time, the average quality of pit inflows is expected to settle at a salinity intermediate between the highest and lowest salinities determined from the baseline sampling program, and may progressively trend towards lower salinity over time. This would be a consequence of the combined effects of a reduction in evapotranspiration losses as the water table is lowered, and the capture of a higher proportion of incident rainfall as groundwater recharge within the cone of depression created by dewatering of the pit.

Externally, a slight reduction in groundwater salinity may result in areas away from the pit, due to the potential reduction in evapotranspiration, but this would only occur in areas where the water table is lowered, ie within 1.5 km or less of the quarry.

After project completion, assuming that the pit remains open after the completion of 30 years extraction with no backfilling, the potential direct evaporation from any open water that might accumulate temporarily within the pit is predicted to be much greater than the potential groundwater inflows. If a permanent or semi-permanent water body were to accumulate, the effects of evaporation would result in a progressively increasing salinity in the pit water.

As there is not predicted to be a permanent pond within the pit, there will be an accumulation of salt on the pit bottom that would cause any temporary water ponding in the pit bottom after rain to become salty relatively quickly. However, as the pit is predicted to be a groundwater sink, with groundwater flowing inwards towards this pit, this internal gradient towards the pit will prevent the saline water in the pit from escaping. There would thus be no effect of this salinity increase on regional groundwater quality.

The project is likely to lead to a reduction in the already small component of groundwater baseflow to the surface water flow within Joarimin Creek within 1.5 km of the quarry pit. However, this groundwater baseflow currently leads to a marked increase in salinity once surface runoff ceases to contribute to streamflow, as discussed above in **Section 3.2.7**. Accordingly, any impact of the project in reducing this baseflow component would be beneficial.

6 RECOMMENDED MONITORING PROGRAM

It is recommended that the following monitoring program be implemented through the quarry project:

- Monitoring of pit water as part of the surface water monitoring program (refer to the main text of the EIS)
- Water levels in all piezometers, on a three-monthly basis
- Water sampling from all piezometers, and laboratory analysis for a broad suite of water quality parameters, in March and October each year.

It is also recommended that, where possible, arrangements be made with the owners of selected licensed bores on neighbouring properties to measure water levels and conduct field measurements of pH, conductivity and TDS annually through the life of the project. This would aim to establish trends in both regional groundwater levels and groundwater quality so that any changes experienced at those locations can be reviewed in light of regional trends and can be distinguished from any changes related to the project.

Additional piezometers should be constructed near the north-western and north-eastern corners of the Project Area, beyond the limits of the proposed quarry or emplacement areas, as existing piezometers MP-5, MP-6, MP-7, MP-8 and MP-9 will be destroyed by quarrying within the first 15 years of the Project. MP-11 may also be covered by the Eastern Overburden Emplacement.

The groundwater monitoring program should be conducted and reviewed in conjunction with surface water monitoring.

7 MANAGEMENT AND IMPACT MITIGATION MEASURES

The simulation modelling has predicted that impacts from the proposal would be minimal in areas away from the quarry itself, and negligible in areas outside the Project Area.

Nevertheless, it is recommended that the following management measures be followed:

- Due to the expected relatively high salinity of the pit inflows, all groundwater inflows to the quarry should be used in the project operations, and not allowed to discharge into the natural surface water drainage system. In the unlikely event that there is any water surplus to requirements, it should be contained within the pit area or disposed of to an evaporation pond.

- All potentially contaminating materials used or stored on site during the project, including fuels, lubricants, reagents, solvents or other chemicals, as well as domestic and/or industrial wastes generated in the operations, be prevented from entering the groundwater system, either by the method of disposal or accidental spillages.

- The monitoring program outlined in **Section 6** should be reviewed and revised as appropriate throughout the project, to ensure that any unexpected adverse trends in either groundwater level or groundwater quality impacts are identified promptly. If possible adverse trends become apparent, the monitoring data should be reviewed by a hydrogeologist, to verify that the project impacts are within the predicted range, and to recommend any mitigation measures that may need to be implemented.

- Should the Government's proposed Aquifer Interference Policy be implemented, it would be necessary to obtain an Aquifer Interference Approval for the quarry, as it will intersect the water table. At present there is no requirement to obtain a groundwater licence for the pit itself.

- All monitoring piezometers should be constructed with surface seals around the casing to prevent contamination of the groundwater by water penetrating the bore from the surface. A groundwater bore licence must be obtained from DIPNR before any new piezometers are constructed.

Possible mitigation measures may include the following:

- The project is not predicted to impact on any existing groundwater bores. In the unlikely event that any neighbouring licensed bore[2] is impacted, to the extent that the water supply potential becomes adversely affected, then provision may have to be made for restoring the affected water supply. The extent of any

[2] The closest licensed bore is 1.8 km from the proposed quarry (**Figure 20**).

adverse impact would be established by independent assessment by a qualified hydrogeologist, based on the monitoring records.

8 REFERENCES

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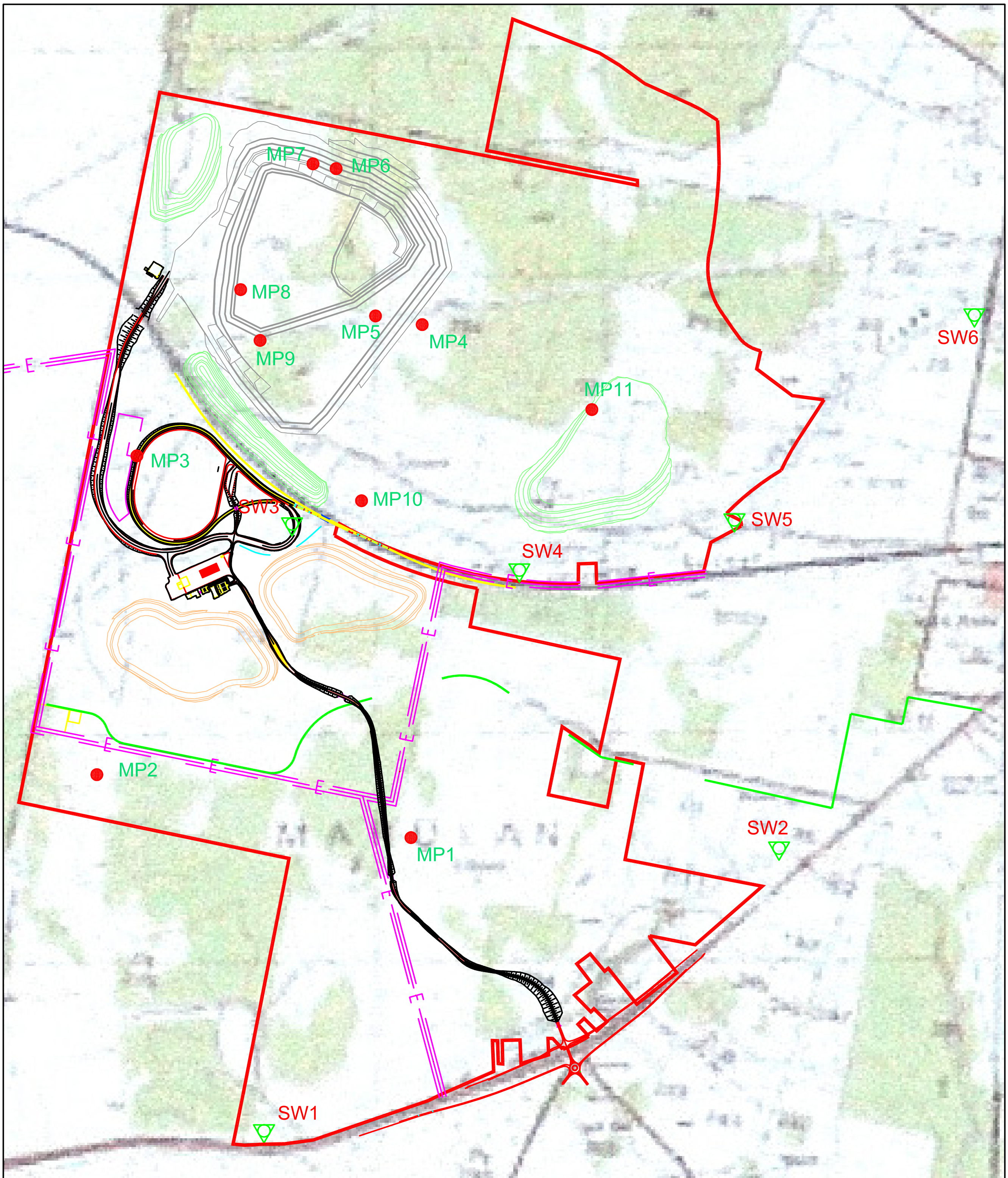
9 GLOSSARY OF TERMS

aquiclude	A saturated unit of rock or soil that is incapable of transmitting significant quantities of water under ordinary hydraulic gradients.
aquifer	A saturated permeable unit of rock or soil which is able to transmit significant quantities of water under ordinary hydraulic gradients.
aquitard	A saturated unit of rock or soil that is capable of transmitting water to and between aquifers, but is not sufficiently permeable to allow water flowing into a bore to be pumped out at a useful rate.
attenuation	The processes whereby the concentration of a chemical in water decreases as a result of the passage of the water through the rock or soil.
bedrock	In this report, bedrock refers to the geological unit that underlies the geological units that are active media for the movement of groundwater.
Devonian	The fourth period of the Paleozoic Era, 375 – 350 million years BP.
discharge	Groundwater discharge from an aquifer is the loss of water from the aquifer, either by natural processes (such as evapotranspiration, outflow to the ocean or other water body, or to another aquifer) or by artificial means (such as pumped extraction). Under conditions of dynamic equilibrium, the average rate of natural discharge from an aquifer is usually equivalent to the average long-term rate of recharge. See “recharge”.
DIPNR	Department of Infrastructure, Planning and Natural Resources
drawdown	The lowering of the water level or the potentiometric head in an aquifer due to the removal of water from a nearby bore or excavation.
ephemeral	Temporary or seasonal.
groundwater	Water that occurs beneath the water table in rock or soil that is fully saturated.
groundwater modelling	Use of mathematical functions to simulate the flow of water below the ground surface.

head	The head in an aquifer is the height above a reference datum of the surface of a column of water that can be supported by the hydraulic pressure in the aquifer against atmospheric pressure. It equates to the elevation of the water table above the datum, and is the sum of the *elevation* head, or the elevation of the point of measurement, and the *pressure* head, or the pressure of the water at that point relative to atmospheric pressure.
hydraulic conductivity	A measure of the ability of a rock or soil to transmit water under a prevailing hydraulic gradient. It has the units of metres/day. In this report, the term is used synonymously with the term “permeability”.
hydraulic gradient	The change in head per unit distance in a particular direction, usually the direction of maximum change, perpendicular to the groundwater contours (equipotentials).
hydrogeological unit	A unit of rock or soil which has reasonably consistent hydraulic properties of permeability and storage
hydrograph	A linear plot of water level versus time.
infiltration	Movement of water through the surface of the ground into the saturated or unsaturated zone beneath.
MODFLOW	A modular three-dimensional groundwater flow model which was developed by the USGS (McDonald and Harbaugh, 1988).
monitoring piezometer	Bore drilled in a location and constructed specifically to enable the sampling and ongoing measurement of groundwater levels, pressure changes and groundwater quality. It is ideally constructed so as to minimise the potential for contamination or interference from external influences, and to enable accurate and reliable sampling and hydraulic measurements from a specific aquifer or zone within an aquifer.
permeability	The permeability of a rock or soil is a measure of the ease with which fluids can flow through it, and is independent of the properties of the fluid. In this report, the term is used synonymously with the term “hydraulic conductivity”.
piezometric surface	See “potentiometric surface”.

porosity	The proportion of a volume of rock or soil that is occupied by voids, or the ratio of the total void space to the total rock or soil volume. For the movement or release of water, only the proportion of porosity that is interconnected is significant, and is referred to as the "effective" porosity, which may be very much less than the total porosity. In a saturated material, the porosity comprises two components – the proportion of porosity that will freely drain under gravity, known as the specific yield, and the proportion that will not drain under gravity, known as the specific retention.
potentiometric surface	An imaginary surface defined by the heads at all points within a particular plane in an aquifer. Where the vertical component of hydraulic gradient is much smaller than the horizontal component, the potentiometric surface can be said to apply to the aquifer as a whole.
pumping test	Test carried out to determine hydraulic properties of the aquifer.
recharge	Groundwater recharge is the addition of water to an aquifer, either by direct infiltration at the ground surface, by percolation through an unsaturated zone, or by inflow of discharge from another aquifer.
runoff	The portion of rainfall precipitation which collects on the surface and flows to surface streams.
saturated zone	That part of a soil or rock in which all the interconnected voids are filled with water under pressure equal to or greater than atmospheric pressure. The top of the saturated zone is defined by the surface at which the water pressure is equal to atmospheric pressure. [Parts of the saturated zone may be temporarily unsaturated due to air entrapment; likewise, in parts of the "unsaturated zone" the voids may be all filled with water, but at less than atmospheric pressure.]
slug test	A type of permeability test conducted by introducing to (or removing from) a bore, a known volume of water and monitoring the progressive return of the water level in the bore back to its former level.
specific yield	The volume of water that will freely drain under gravity from a unit volume of a saturated soil or rock (see "porosity").

transmissivity	The rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient. It is equal to the product of the average hydraulic conductivity (permeability) and the saturated thickness of the aquifer. It is expressed in units of metres^2/day.
Tertiary	The first period of the Cainozoic Era, 65 – 1.5 million years BP.
water table	The surface within an unconfined aquifer at which the water pressure is equal to atmospheric pressure. It is defined by the level to which water would rise in a bore which just penetrates the top of the aquifer.



Reference — Site Boundary

MP1 — Piezometer

SW1 — Surface Water Monitoring Site

Pit Extent Year 30

Overburden Emplacements

Waste / Product Emplacements

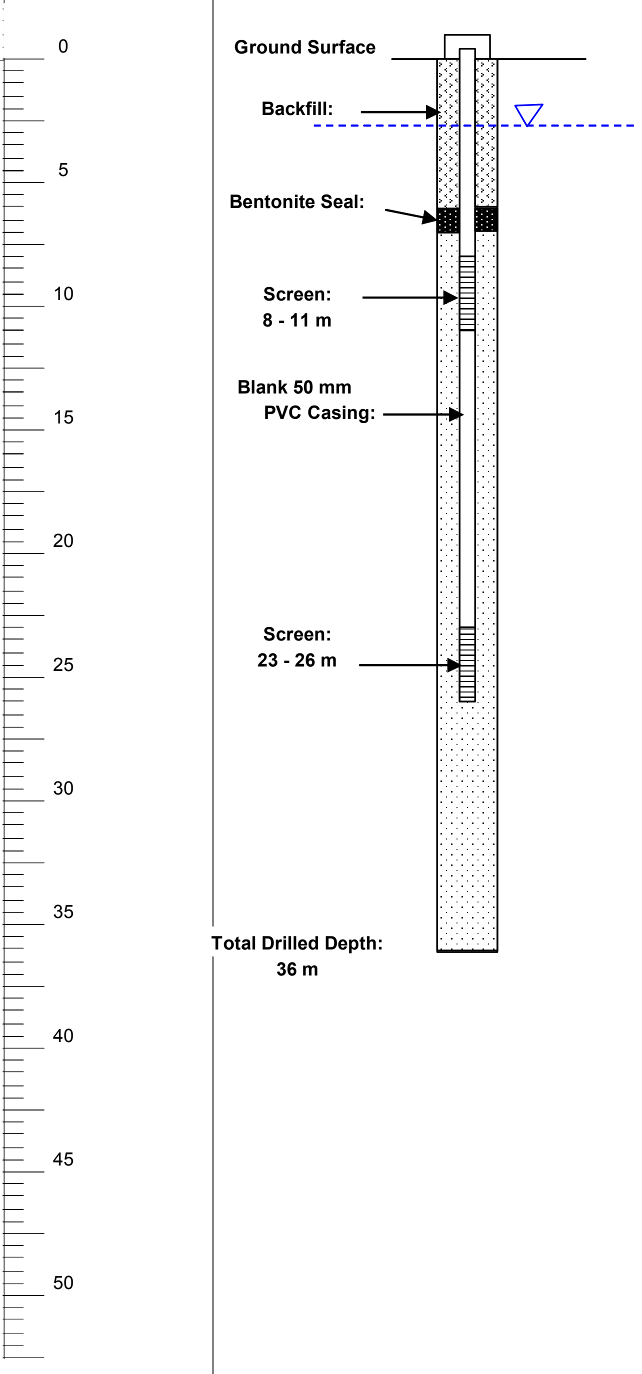
Date: 17 May 2005	Scale: 1:25,000	**LYNWOOD QUARRY PROJECT**
Initials:	Job No: 04-0142	**LOCALITY PLAN**
Drawing No: 04-0142-0015a	Rev: A	
Peter Dundon & Associates Pty Limited		**Figure 1**

Peter Dundon and Associates Pty Ltd.

Logging Sheet

PIEZOMETER: MP1

Client: **Readymix Holdings Pty Ltd**	Elevation: **664.000 mAHD**	Project No: **04-0142**
Location: **Marulan**	Date Drilled: **1 March 2003**	Date Piezometer Installed: **9 February 2004**
Drilling Contractor / Method: **Drilled by Wessel Drilling (P083)** **Piezometer constructed by Terratest (MP1)**	Hole depth: **36 m** Piezometer depth: **26 m**	Piezometer Installation Supervised By: **S Dundon**
Description	**Depth (metres)**	**Well Construction Details:**



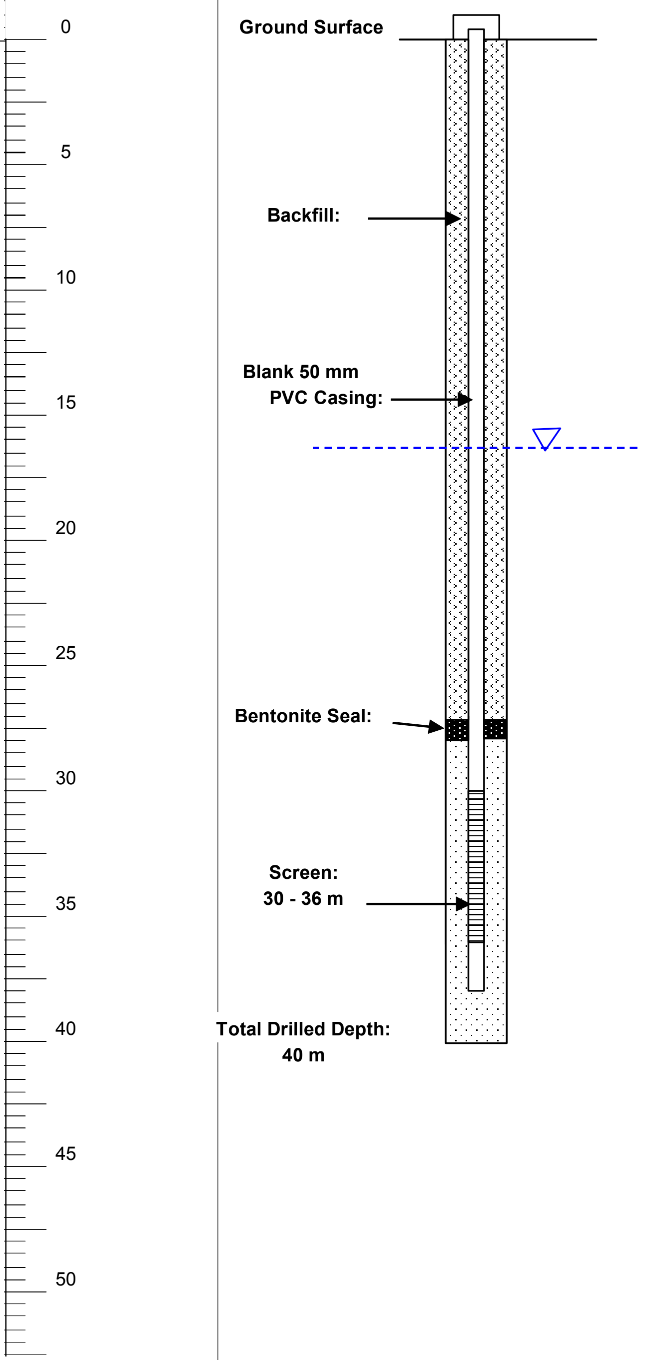
Date: 16 February 2005	Scale: as indicated	**LYNWOOD QUARRY PROJECT**	
Initials: PJD	Job No: 04-0142	**CONSTRUCTION DETAILS PIEZOMETER MP-1**	
Drawing No: 04-0142-1001	Rev: Initial		
Peter Dundon & Associates Pty Limited			**Figure 2**

eter Dundon and Associates Pty Ltd.

ogging Sheet

PIEZOMETER: MP2

ent: **eadymix Holdings Pty Ltd**	Elevation: **688.908 mAHD**	Project No: **04-0142**
cation: **arulan**	Date Drilled: **1 March 2003**	Date Piezometer Installed: **10 February 2004**
illing Contractor / Method: **rilled by Wessel Drilling (P099)** **ezometer constructed by Terratest (MP2)**	Hole depth: **40 m** Piezometer depth: **38 m**	Piezometer Installation Supervised By: **S Dundon**
Description	**Depth (metres)**	**Well Construction Details:**



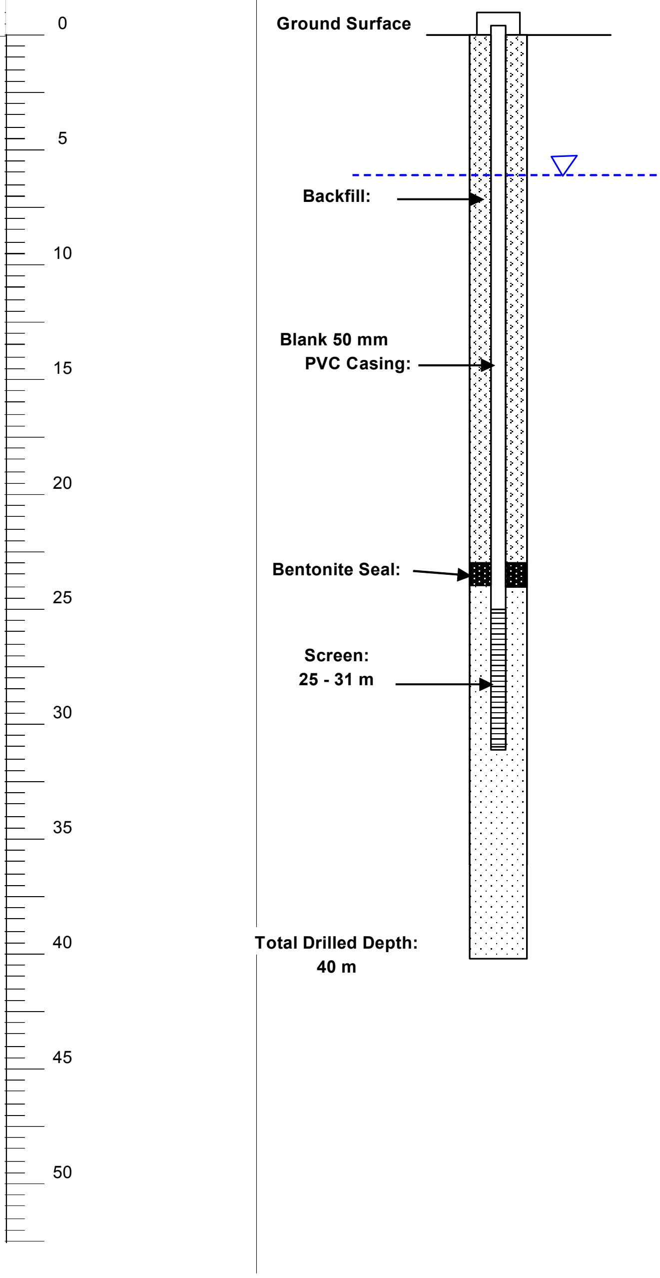
Date:	16 February 2005	Scale:	as indicated	**LYNWOOD QUARRY PROJECT**
Initials:	PJD	Job No:	04-0142	**CONSTRUCTION DETAILS PIEZOMETER MP-2**
Drawing No:	04-0142-1002	Rev:	Initial	
Peter Dundon & Associates Pty Limited				**Figure 3**

Peter Dundon and Associates Pty Ltd.

Logging Sheet

PIEZOMETER: MP3

Client: **Readymix Holdings Pty Ltd**	Elevation: **668.479 mAHD**	Project No: **04-0142**
Location: **Marulan**	Date Drilled: **September 2003**	Date Piezometer Installed: **9 February 2004**
Drilling Contractor / Method: **Drilled by Wessel Drilling (P213)** **Piezometer constructed by Terratest (MP3)**	Hole depth: **40 m** Piezometer depth: **31 m**	Piezometer Installation Supervised By: **S Dundon**
Description	**Depth (metres)**	**Well Construction Details:**



Date: 16 February 2005	Scale: as indicated	**LYNWOOD QUARRY PROJECT**
Initials: PJD	Job No: 04-0142	**CONSTRUCTION DETAILS PIEZOMETER MP-3**
Drawing No: 04-0142-1003	Rev: Initial	
Peter Dundon & Associates Pty Limited		**Figure 4**

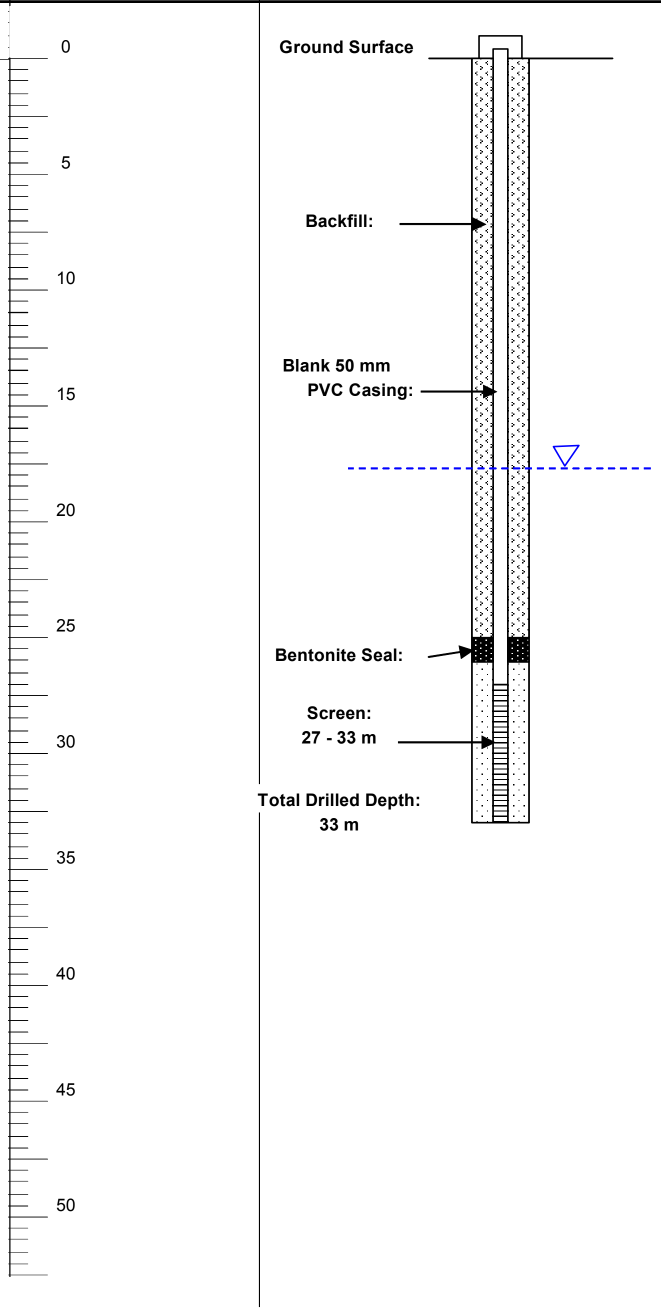
Peter Dundon and Associates Pty Ltd.

Logging Sheet

PIEZOMETER: MP4

Client: **Readymix Holdings Pty Ltd**	Elevation: **685.999 mAHD**	Project No: **04-0142**
Location: **Marulan**	Date Drilled: **1 August 2003**	Date Piezometer Installed: **9 February 2004**
Drilling Contractor / Method: **Drilled by Wessel Drilling (P038)** **Piezometer constructed by Terratest (MP4)**	Hole depth: **33 m** Piezometer depth: **31.5 m**	Piezometer Installation Supervised By: **S Dundon**

Description	Depth (metres)	Well Construction Details:

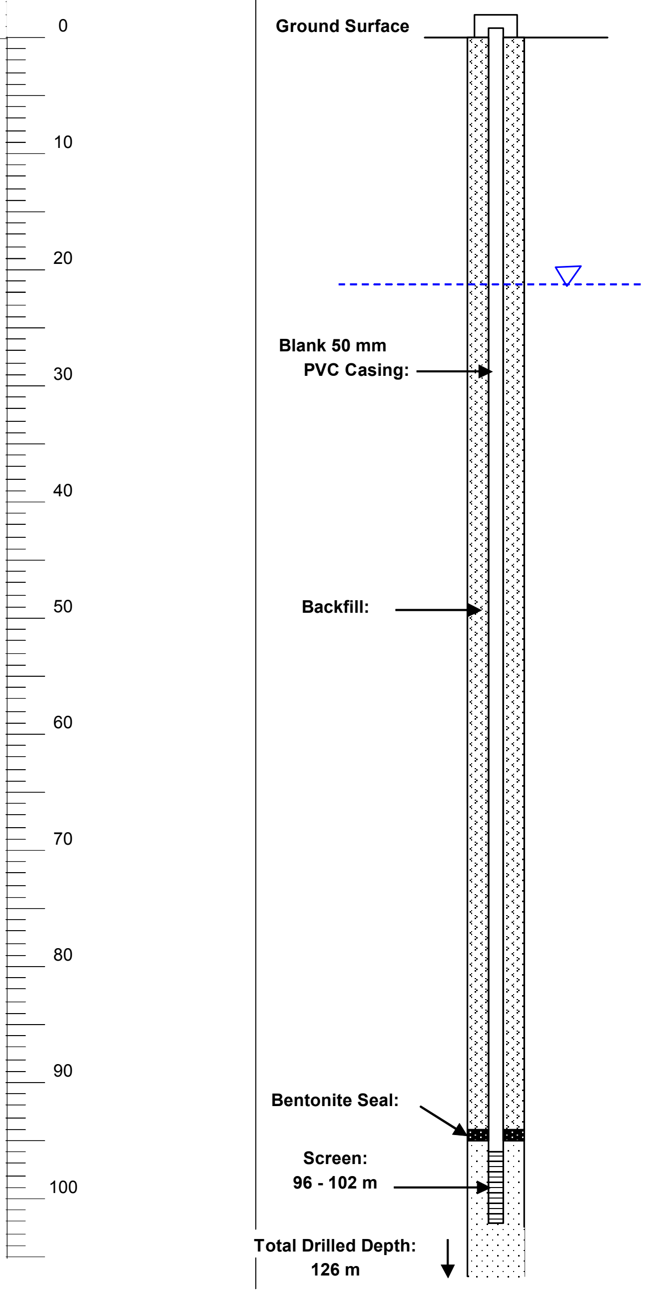


Date: 16 February 2005	Scale: as indicated	**LYNWOOD QUARRY PROJECT**
Initials: PJD	Job No: 04-0142	**CONSTRUCTION DETAILS PIEZOMETER MP-4**
Drawing No: 04-0142-1004	Rev: Initial	
Peter Dundon & Associates Pty Limited		**Figure 5**

Peter Dundon and Associates Pty Ltd.
Logging Sheet

PIEZOMETER: MP5

Client: **Readymix Holdings Pty Ltd**	Elevation: **690.444 mAHD**	Project No: **04-0142**
Location: **Marulan**	Date Drilled: **9 January 2003**	Date Piezometer Installed: **9 February 2004**
Drilling Contractor / Method: **Drilled by ? (D-07)** **Piezometer constructed by Terratest (MP5)**	Hole depth: **150 m** Piezometer depth: **102 m**	Piezometer Installation Supervised By: **S Dundon**
Description	**Depth (metres)**	**Well Construction Details:**

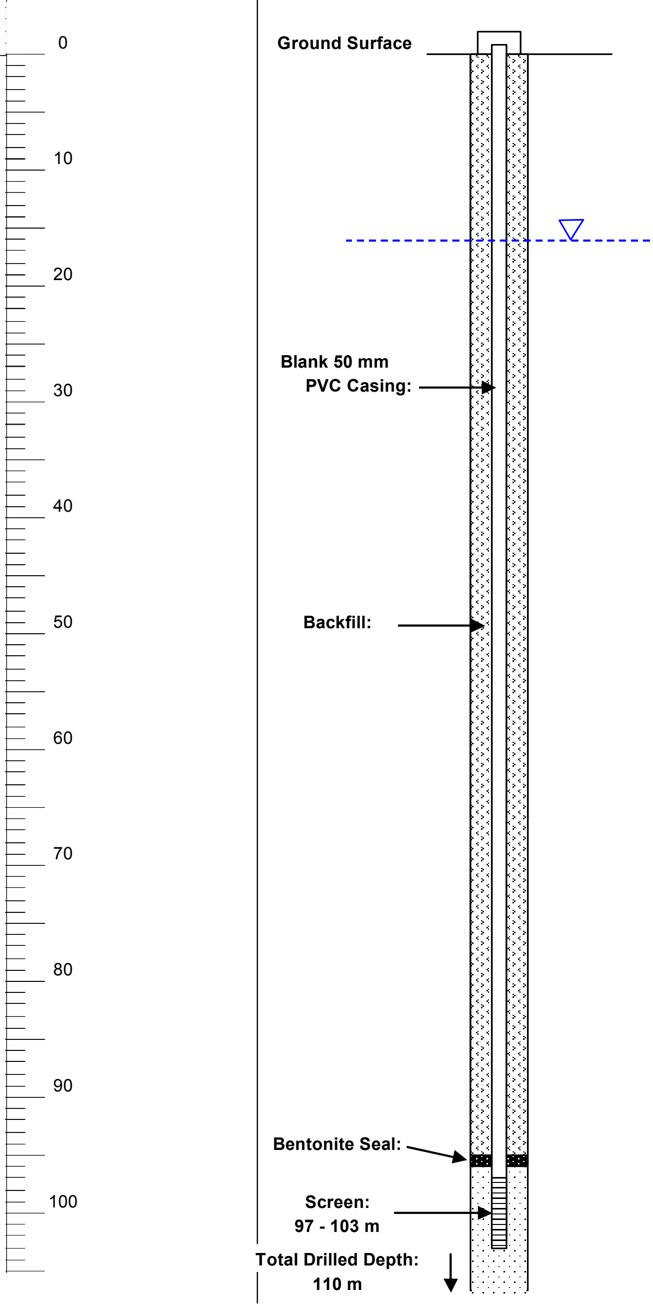


Date:	16 February 2005	Scale:	as indicated	**LYNWOOD QUARRY PROJECT**
Initials:	PJD	Job No:	04-0142	**CONSTRUCTION DETAILS PIEZOMETER MP-5**
Drawing No:	04-0142-1005	Rev:	Initial	
Peter Dundon & Associates Pty Limited				**Figure 6**

Peter Dundon and Associates Pty Ltd.
Logging Sheet

PIEZOMETER: MP6

Client: **Readymix Holdings Pty Ltd**	Elevation: **691.340 mAHD**	Project No: **04-0142**
Location: **Marulan**	Date Drilled: **9 January 2003**	Date Piezometer Installed: **10 February 2004**
Drilling Contractor / Method: **Drilled by ? (D-09)** **Piezometer constructed by Terratest (MP6)**	Hole depth: **150 m** Piezometer depth: **103 m**	Piezometer Installation Supervised By: **S Dundon**
Description	**Depth (metres)**	**Well Construction Details:**



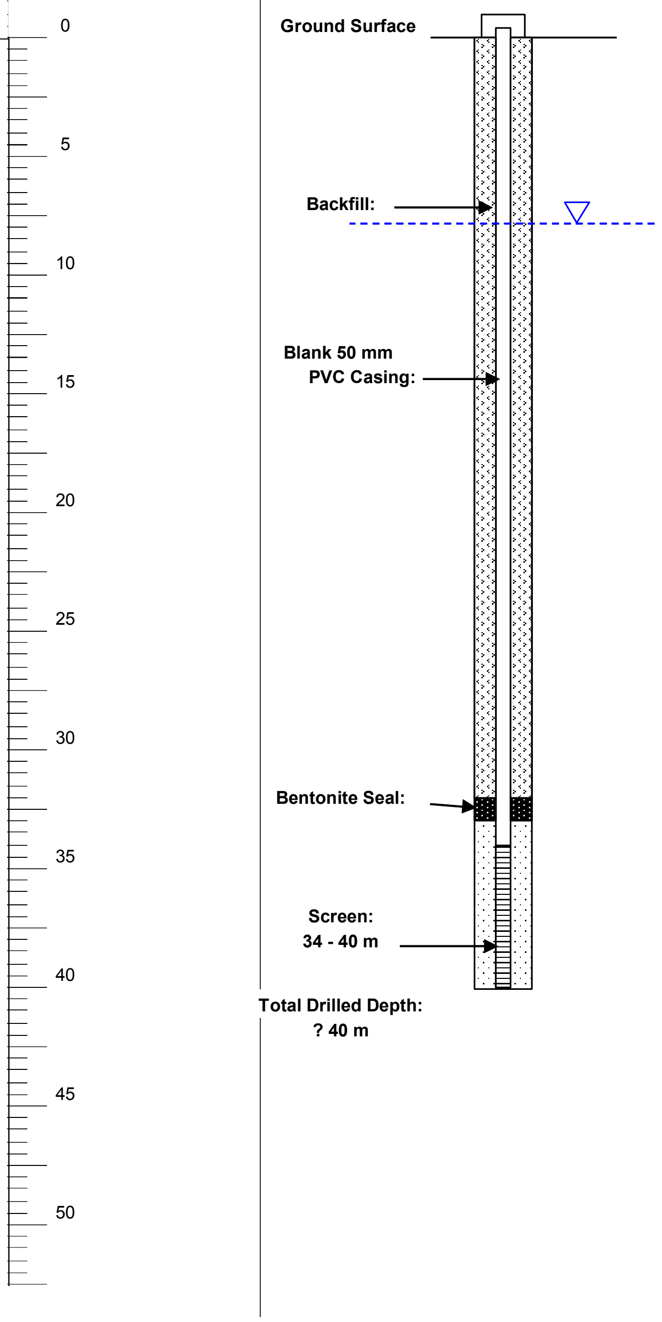
Date:	16 February 2005	Scale:	as indicated	**LYNWOOD QUARRY PROJECT**
Initials:	PJD	Job No:	04-0142	**CONSTRUCTION DETAILS PIEZOMETER MP-6**
Drawing No:	04-0142-1006	Rev:	Initial	
Peter Dundon & Associates Pty Limited				**Figure 7**

Peter Dundon and Associates Pty Ltd.

Logging Sheet

PIEZOMETER: MP7

Client: **Readymix Holdings Pty Ltd**	Elevation: **683.500 mAHD**	Project No: **04-0142**
Location: **Marulan**	Date Drilled: **16 August 2003**	Date Piezometer Installed: **9 February 2004**
Drilling Contractor / Method: **Drilled by Wessel Drilling (P031)** **Piezometer constructed by Terratest (MP7)**	Hole depth: **35 m** Piezometer depth: **40 m**	Piezometer Installation Supervised By: **S Dundon**
Description	**Depth (metres)**	**Well Construction Details:**

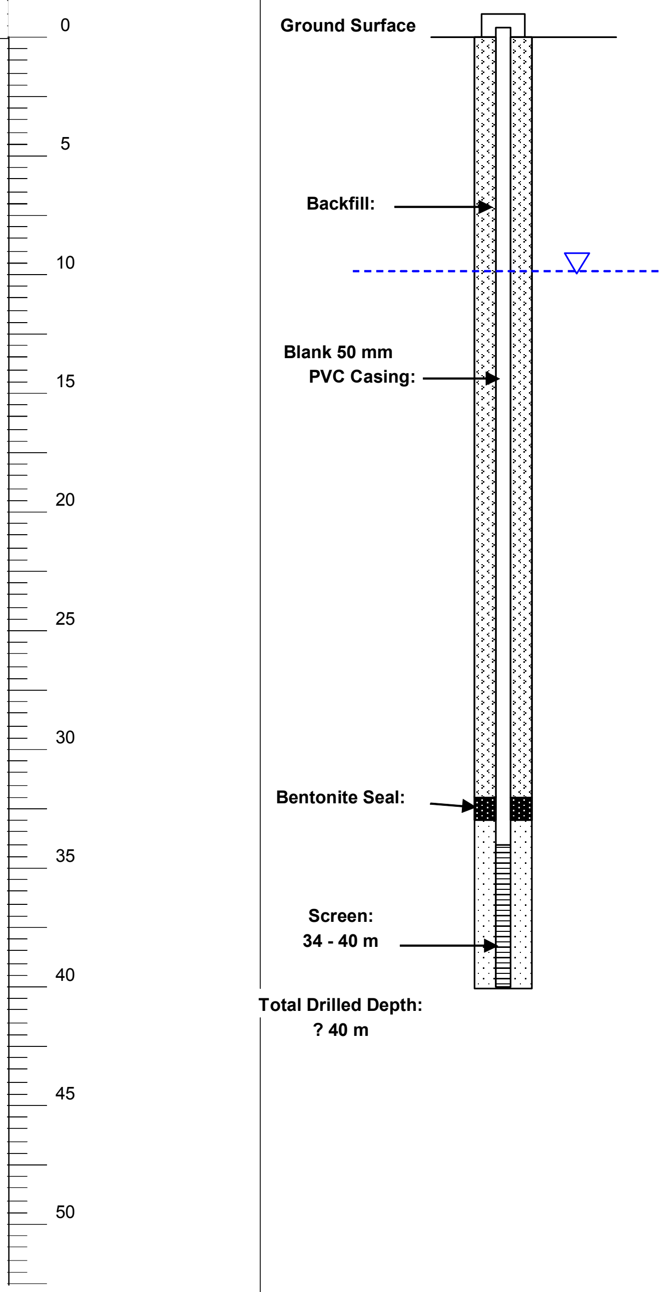


Date: 16 February 2005	Scale: as indicated	**LYNWOOD QUARRY PROJECT**	
Initials: PJD	Job No: 04-0142	**CONSTRUCTION DETAILS PIEZOMETER MP-7**	
Drawing No: 04-0142-1007	Rev: Initial		
Peter Dundon & Associates Pty Limited			**Figure 8**

Peter Dundon and Associates Pty Ltd.
Logging Sheet

PIEZOMETER: MP8

Client: **Readymix Holdings Pty Ltd**	Elevation: **671.553 mAHD**	Project No: **04-0142**
Location: **Marulan**	Date Drilled: **12 August 2003**	Date Piezometer Installed: **11 February 2004**
Drilling Contractor / Method: **Drilled by Wessel Drilling (P013)** **Piezometer constructed by Terratest (MP8)**	Hole depth: **40 m** Piezometer depth: **40 m**	Piezometer Installation Supervised By: **S Dundon**
Description	**Depth (metres)**	**Well Construction Details:**

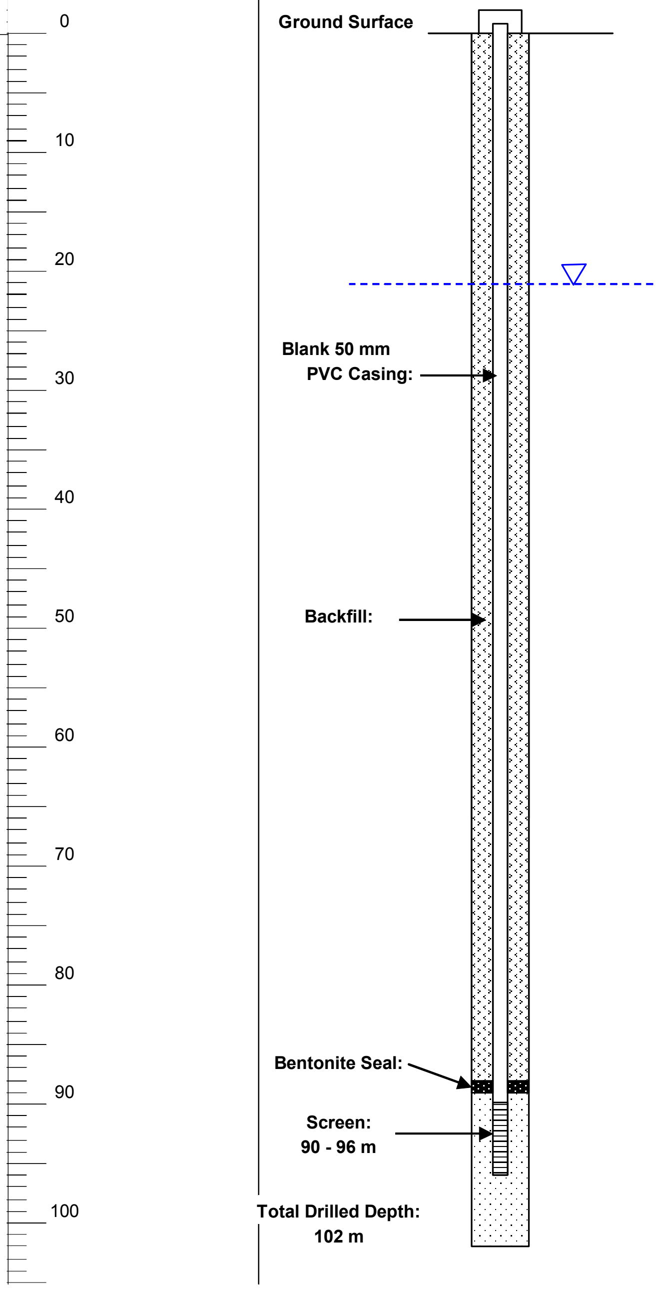


Date: 16 February 2005	Scale: as indicated	**LYNWOOD QUARRY PROJECT**
Initials: PJD	Job No: 04-0142	**CONSTRUCTION DETAILS PIEZOMETER MP-8**
Drawing No: 04-0142-1008	Rev: Initial	
Peter Dundon & Associates Pty Limited		**Figure 9**

Peter Dundon and Associates Pty Ltd.
Logging Sheet

PIEZOMETER: MP9

Client: **Readymix Holdings Pty Ltd**	Elevation: **682.400 mAHD**	Project No: **04-0142**
Location: **Marulan**	Date Drilled: **1 December 2003**	Date Piezometer Installed: **12 February 2004**
Drilling Contractor / Method: **Drilled by ? (D-13)** **Piezometer constructed by Terratest (MP9)**	Hole depth: **102 m** Piezometer depth: **96 m**	Piezometer Installation Supervised By: **S Dundon**
Description	**Depth (metres)**	**Well Construction Details:**



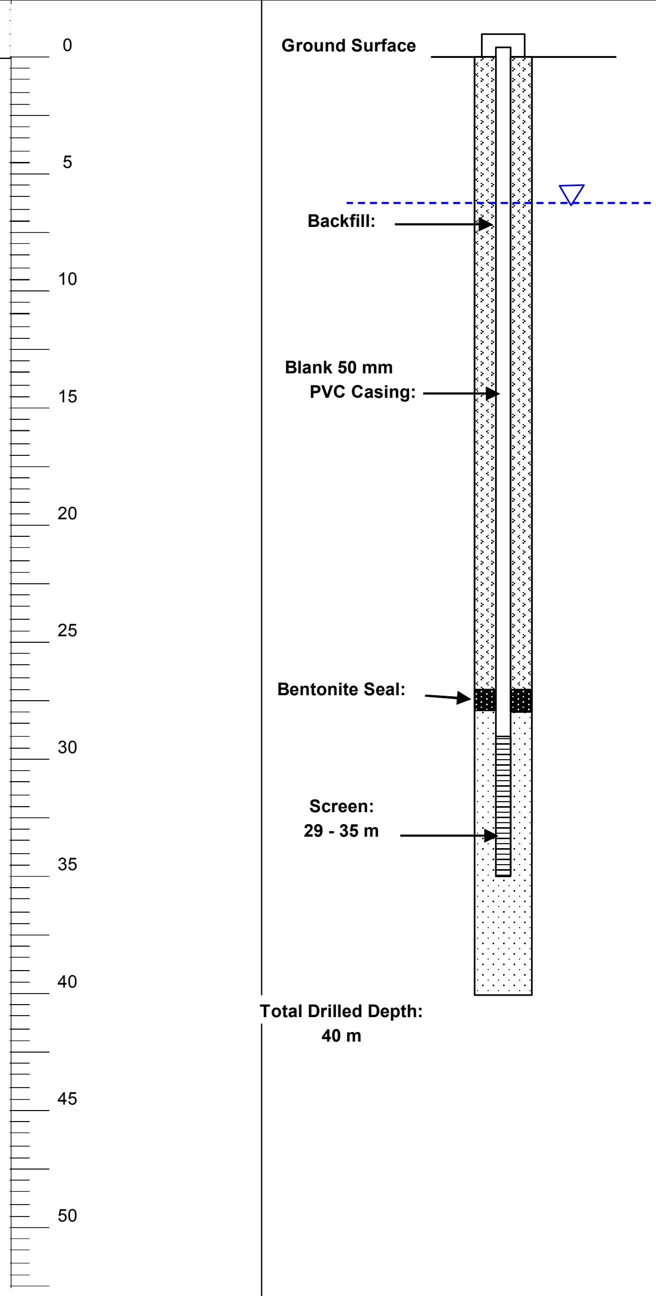
Date: 16 February 2005	Scale: as indicated	**LYNWOOD QUARRY PROJECT**
Initials: PJD	Job No: 04-0142	**CONSTRUCTION DETAILS PIEZOMETER MP-9**
Drawing No: 04-0142-1009	Rev: Initial	
Peter Dundon & Associates Pty Limited		**Figure 10**

Peter Dundon and Associates Pty Ltd.

Logging Sheet

PIEZOMETER: MP10

Client: **Readymix Holdings Pty Ltd**	Elevation: **656.001 mAHD**	Project No: **04-0142**
Location: **Marulan**	Date Drilled: **1 August 2003**	Date Piezometer Installed: **12 February 2004**
Drilling Contractor / Method: **Drilled by Wessell Drilling (P196)** **Piezometer constructed by Terratest (MP10)**	Hole depth: **40 m** Piezometer depth: **35 m**	Piezometer Installation Supervised By: **S Dundon**
Description	**Depth (metres)**	**Well Construction Details:**



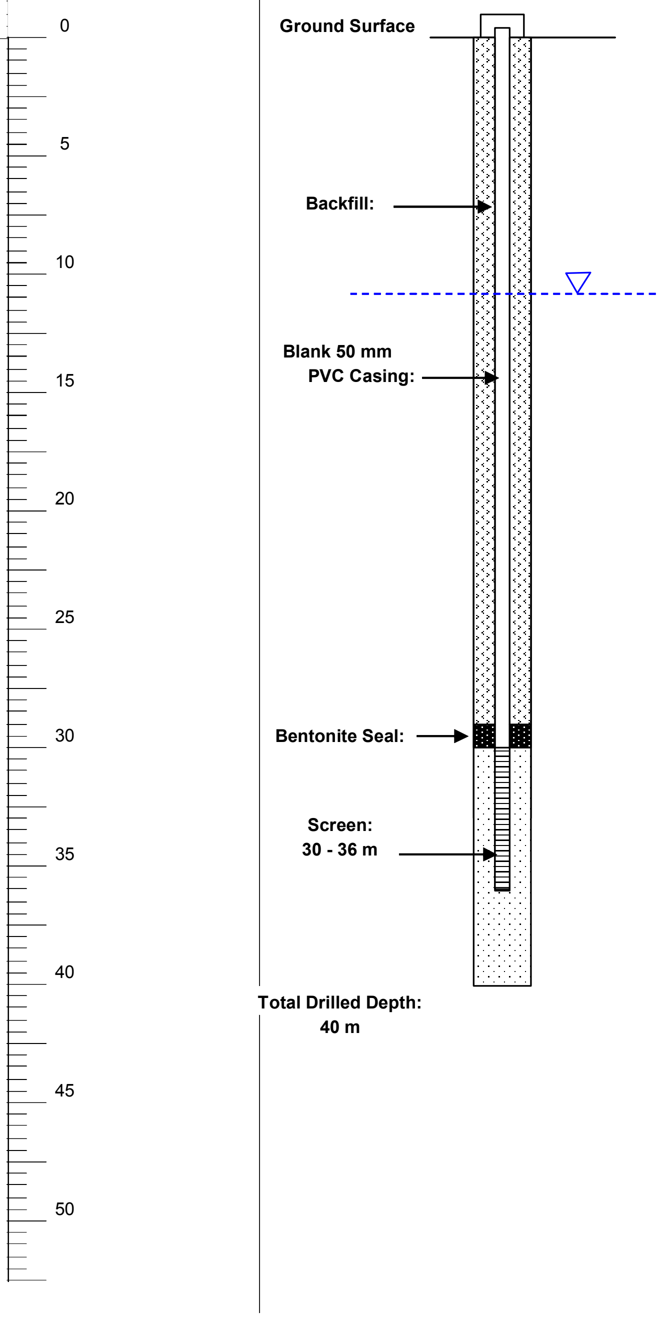
Date:	16 February 2005	Scale:	as indicated	**LYNWOOD QUARRY PROJECT**
Initials:	PJD	Job No:	04-0142	**CONSTRUCTION DETAILS PIEZOMETER MP-10**
Drawing No:	04-0142-1010	Rev:	Initial	
Peter Dundon & Associates Pty Limited				**Figure 11**

Peter Dundon and Associates Pty Ltd.

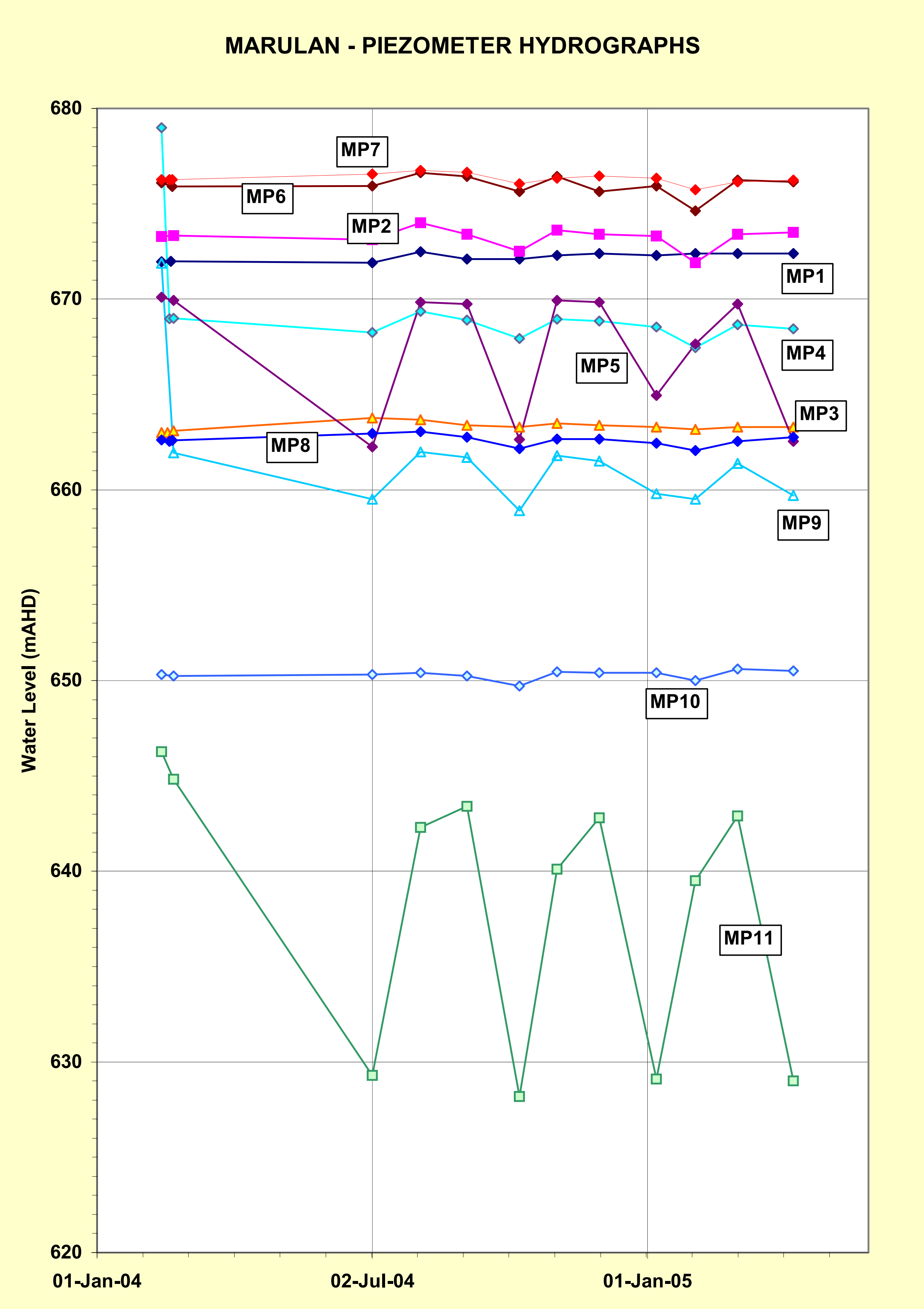
Logging Sheet

PIEZOMETER: MP11

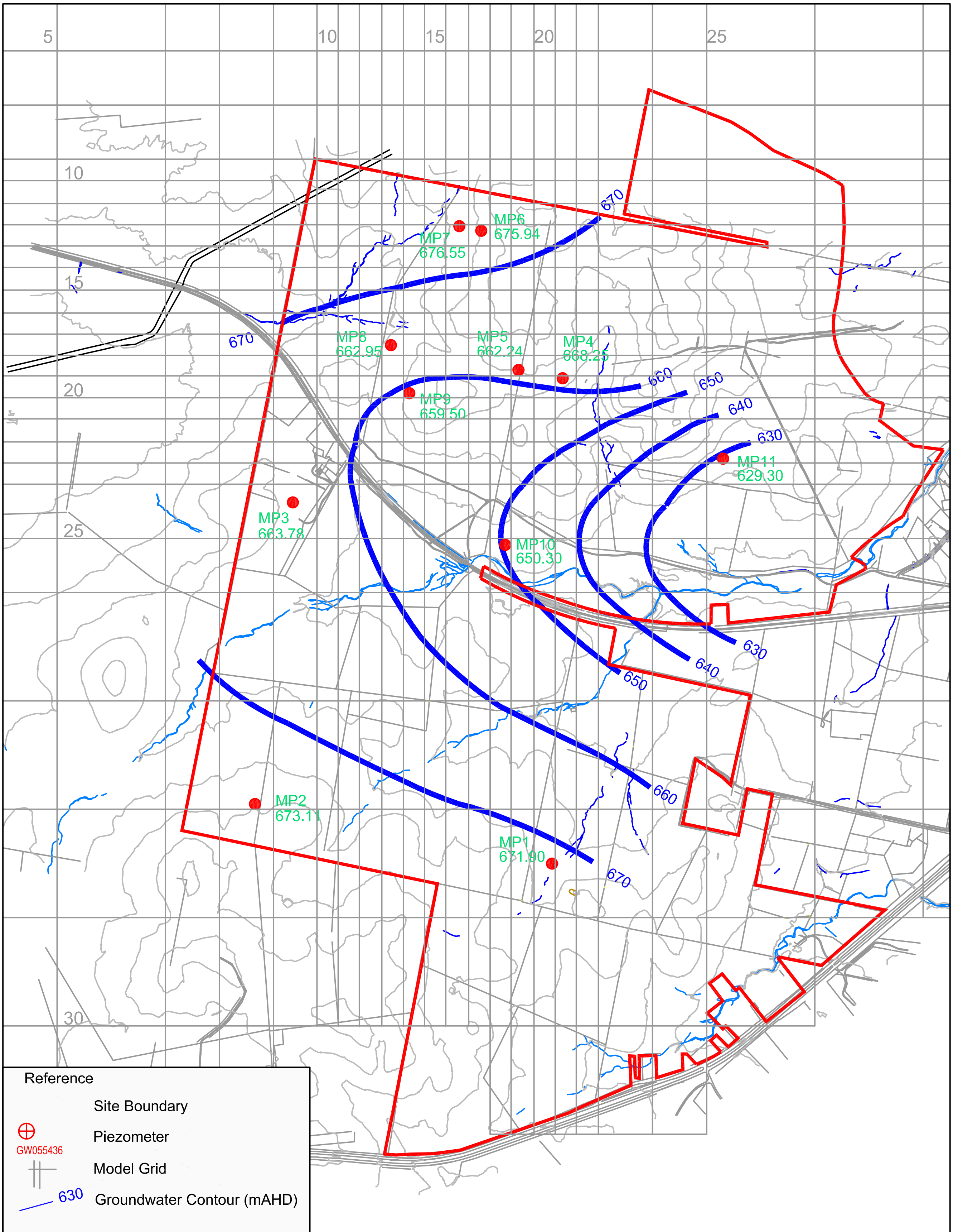
Client: **Readymix Holdings Pty Ltd**	Elevation: **654.998 mAHD**	Project No: **04-0142**
Location: **Marulan**	Date Drilled: **17 August 2003**	Date Piezometer Installed: **12 February 2004**
Drilling Contractor / Method: **Drilled by Wessell Drilling (P124)** **Piezometer constructed by Terratest (MP11)**	Hole depth: **40 m** Piezometer depth: **36 m**	Piezometer Installation Supervised By: **S Dundon**
Description	**Depth (metres)**	**Well Construction Details:**



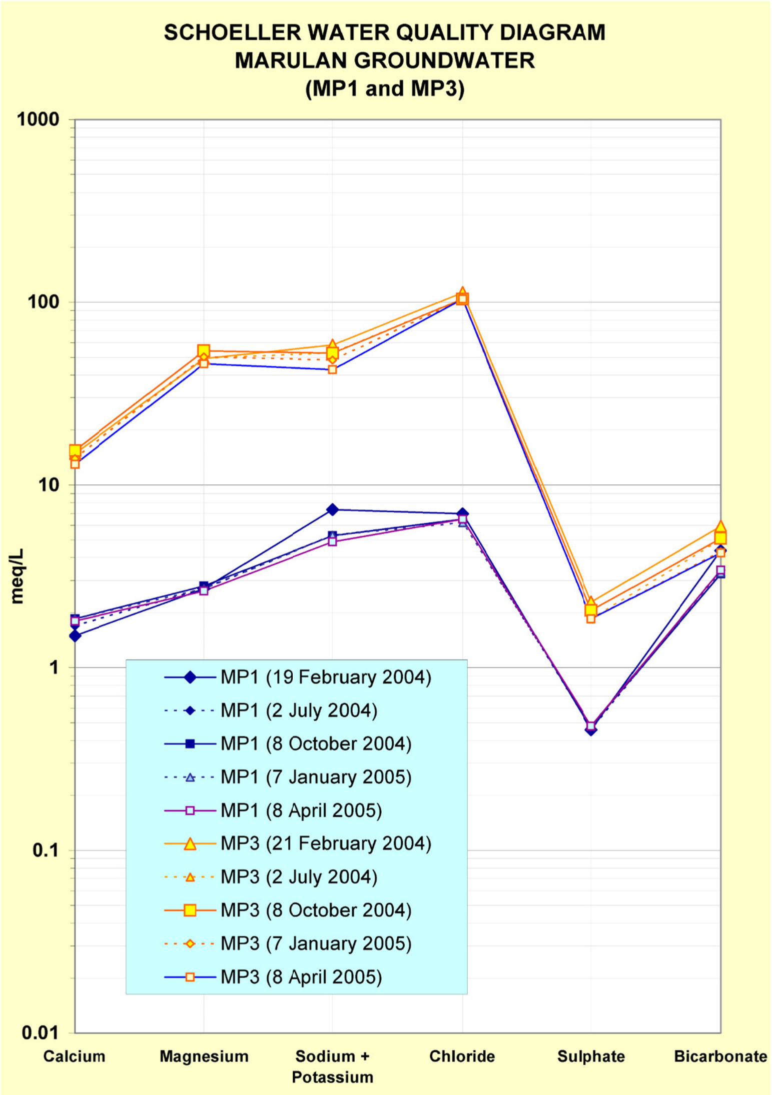
Date: 16 February 2005	Scale: as indicated	**LYNWOOD QUARRY PROJECT**	
Initials: PJD	Job No: 04-0142	**CONSTRUCTION DETAILS PIEZOMETER MP-11**	
Drawing No: 04-0142-1011	Rev: Initial		
Peter Dundon & Associates Pty Limited			**Figure 12**

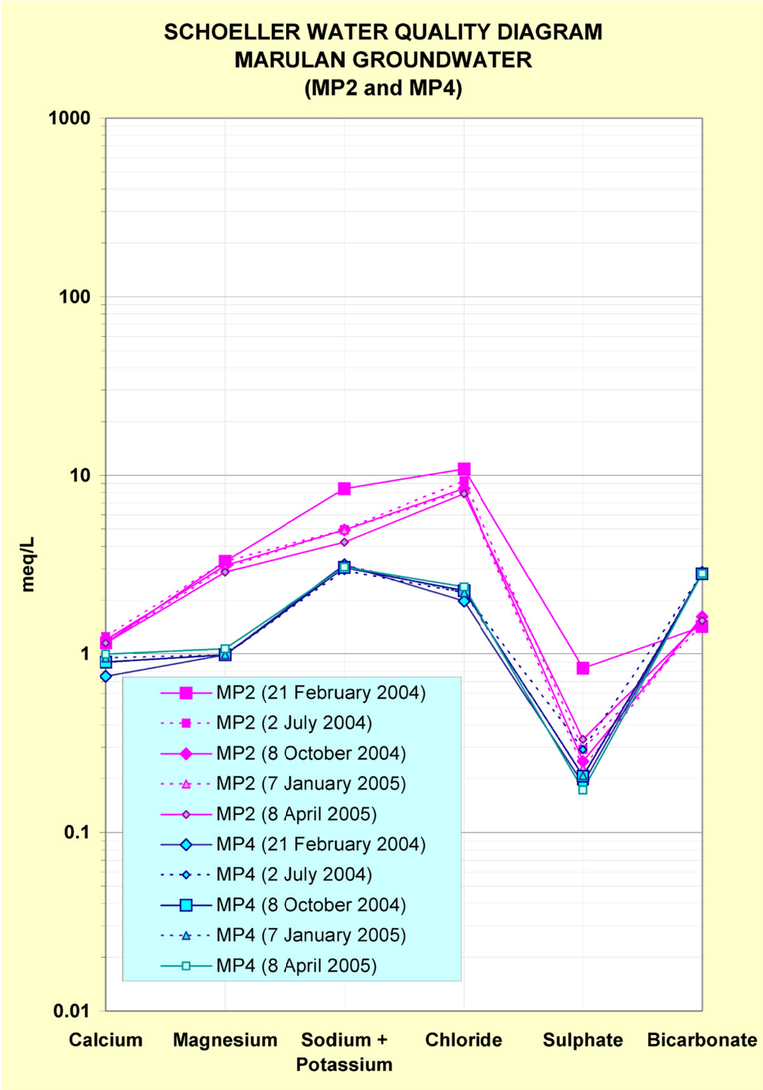


Date: 16 February 2005	Scale: as indicated	**LYNWOOD QUARRY PROJECT**	
Initials: PJD	Job No: 04-0142	**LYNWOOD - PIEZOMETER HYDROGRAPHS**	
Drawing No: 04-0142-1012	Rev: Initial		
Peter Dundon & Associates Pty Limited			**Figure 13**

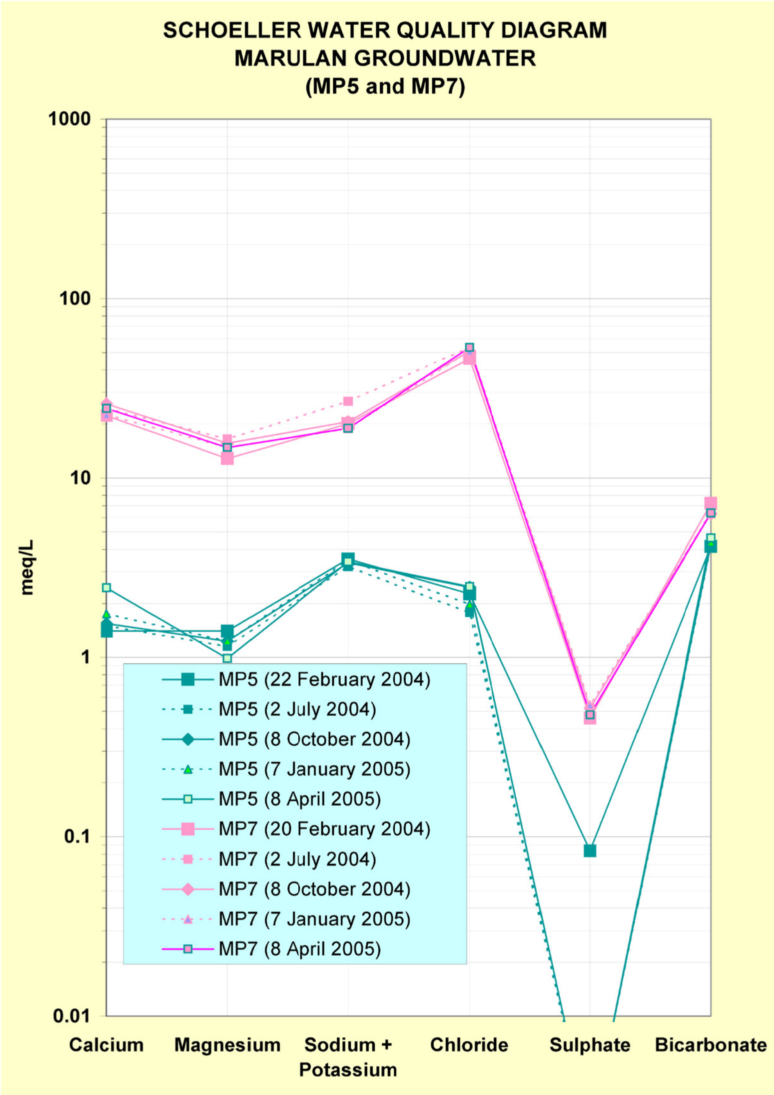


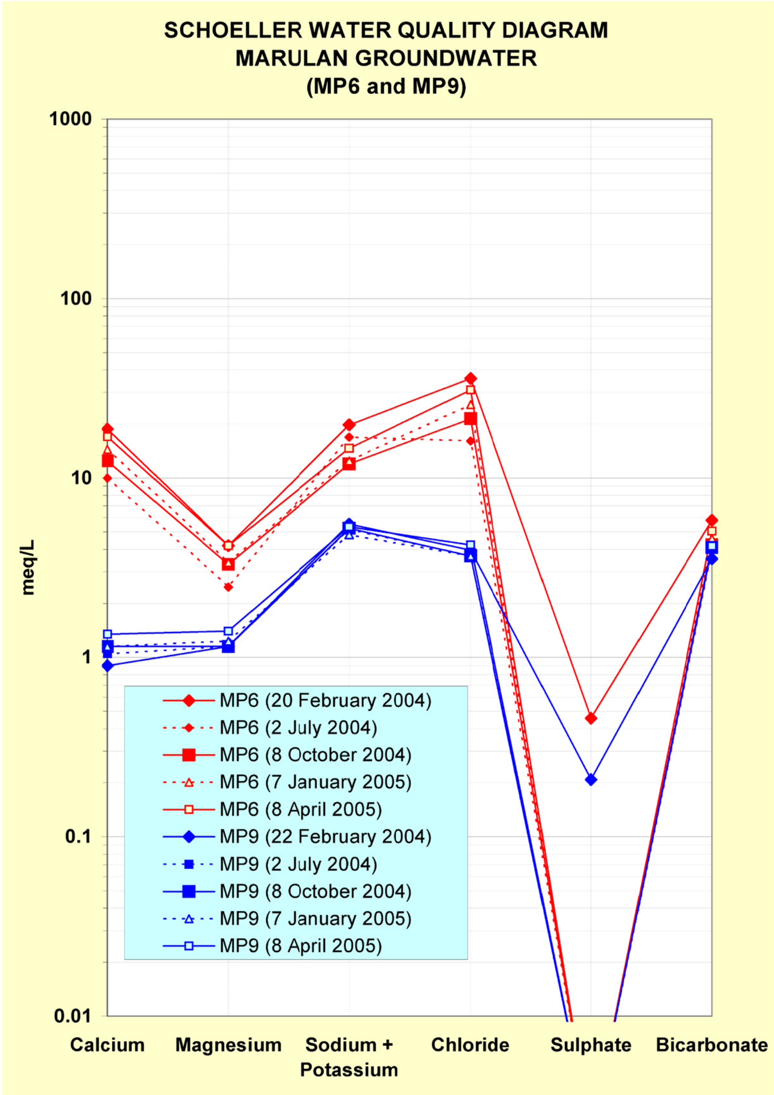
Date:	25 March 2005	Scale:	1 : 25 000	**LYNWOOD QUARRY PROJECT**
Initials:	PJD	Job No:	04-0142	**Groundwater Contours (2 July 2004)**
Drawing No:	04-0142-0005f	Rev:	Rev F	
Peter Dundon & Associates Pty Limited				**Figure 14**





LEGEND	Date: 16 February 2005	Scale: As shown	LYNWOOD QUARRY PROJECT
	Initials: PJD	Job No: 04-0142	SCHOELLER WATER QUALITY DIAGRAMS MP-1, MP-2, MP-3 and MP-4
	Drawing No: 04-0142-1013	Rev: 0	
	Peter Dundon & Associates Pty Limited		Figure 15





LEGEND			
Date: 16 February 2005	Scale: As shown	**LYNWOOD QUARRY PROJECT**
Initials: PJD	Job No: 04-0142	**SCHOELLER WATER QUALITY DIAGRAMS MP-5, MP-6, MP-7 and MP-9**
Drawing No: 04-0142-1014	Rev: 0	
Peter Dundon & Associates Pty Limited		**Figure 16**

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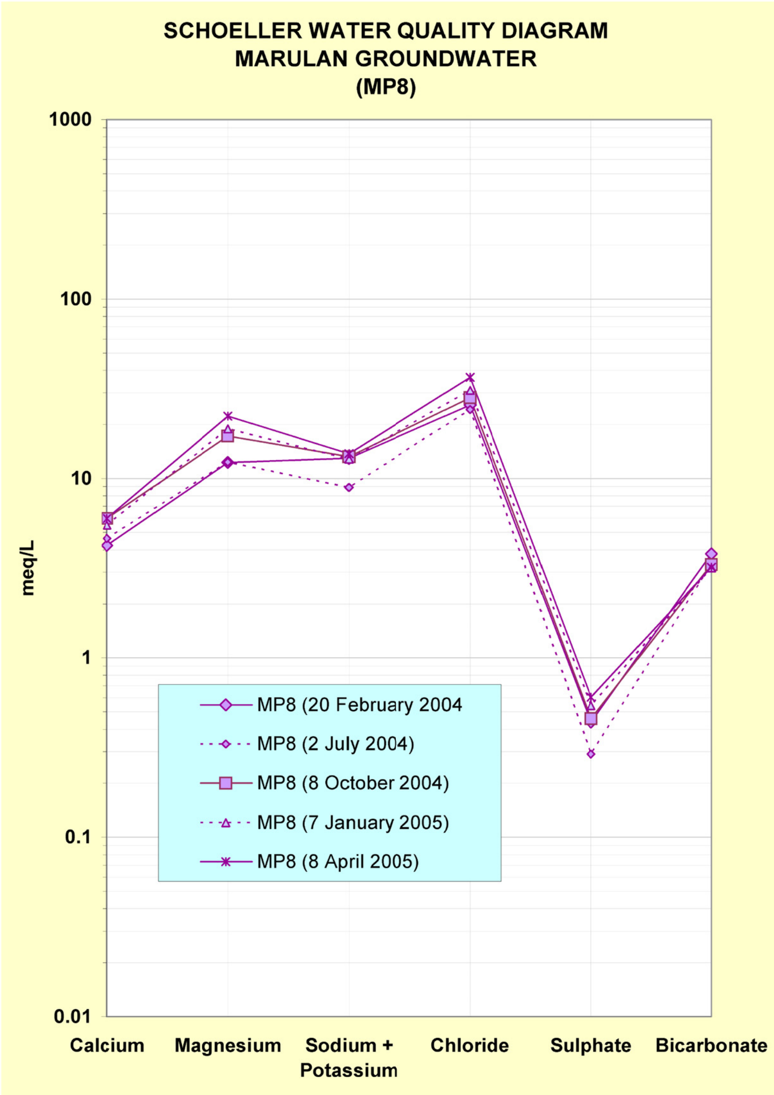
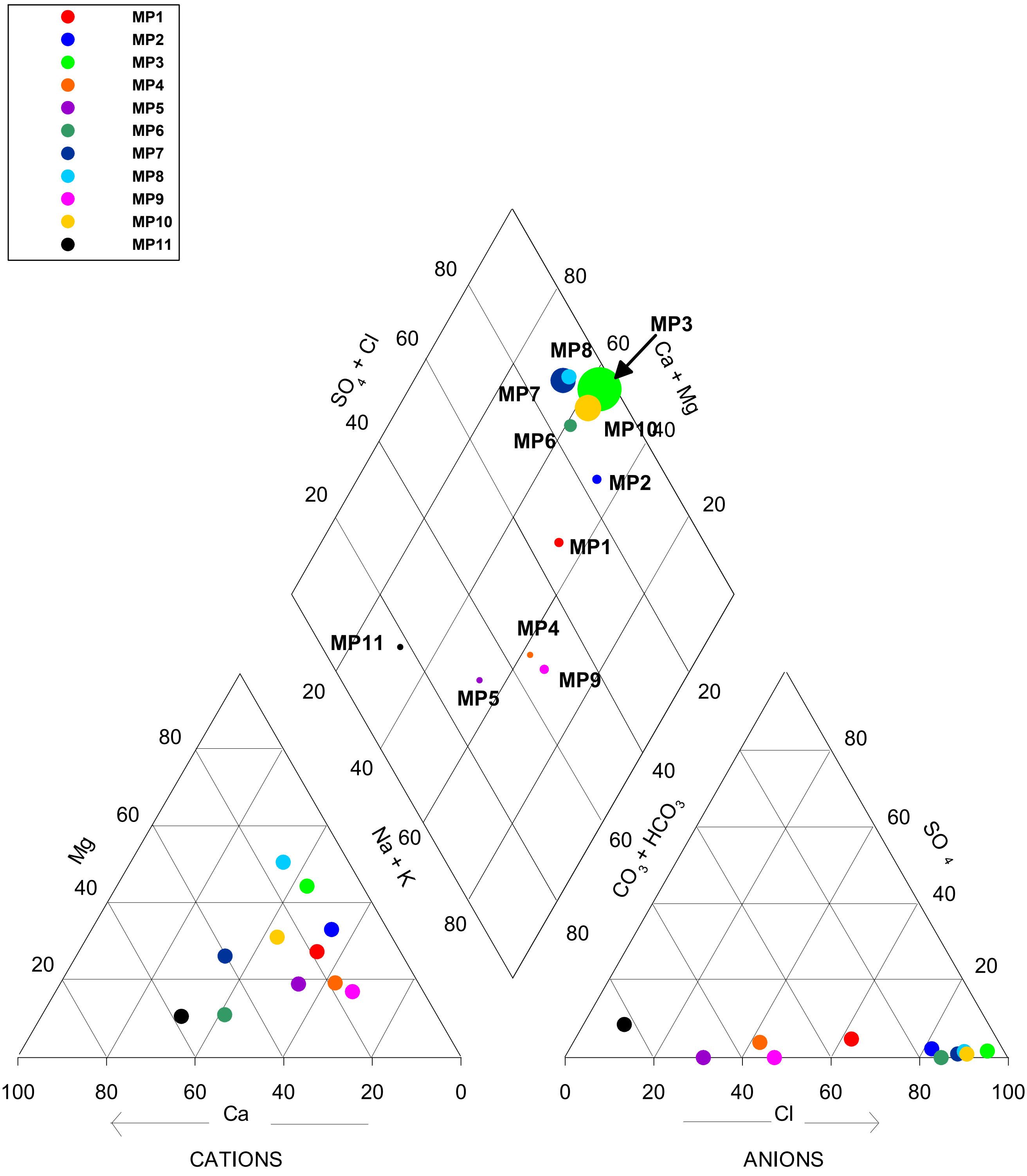


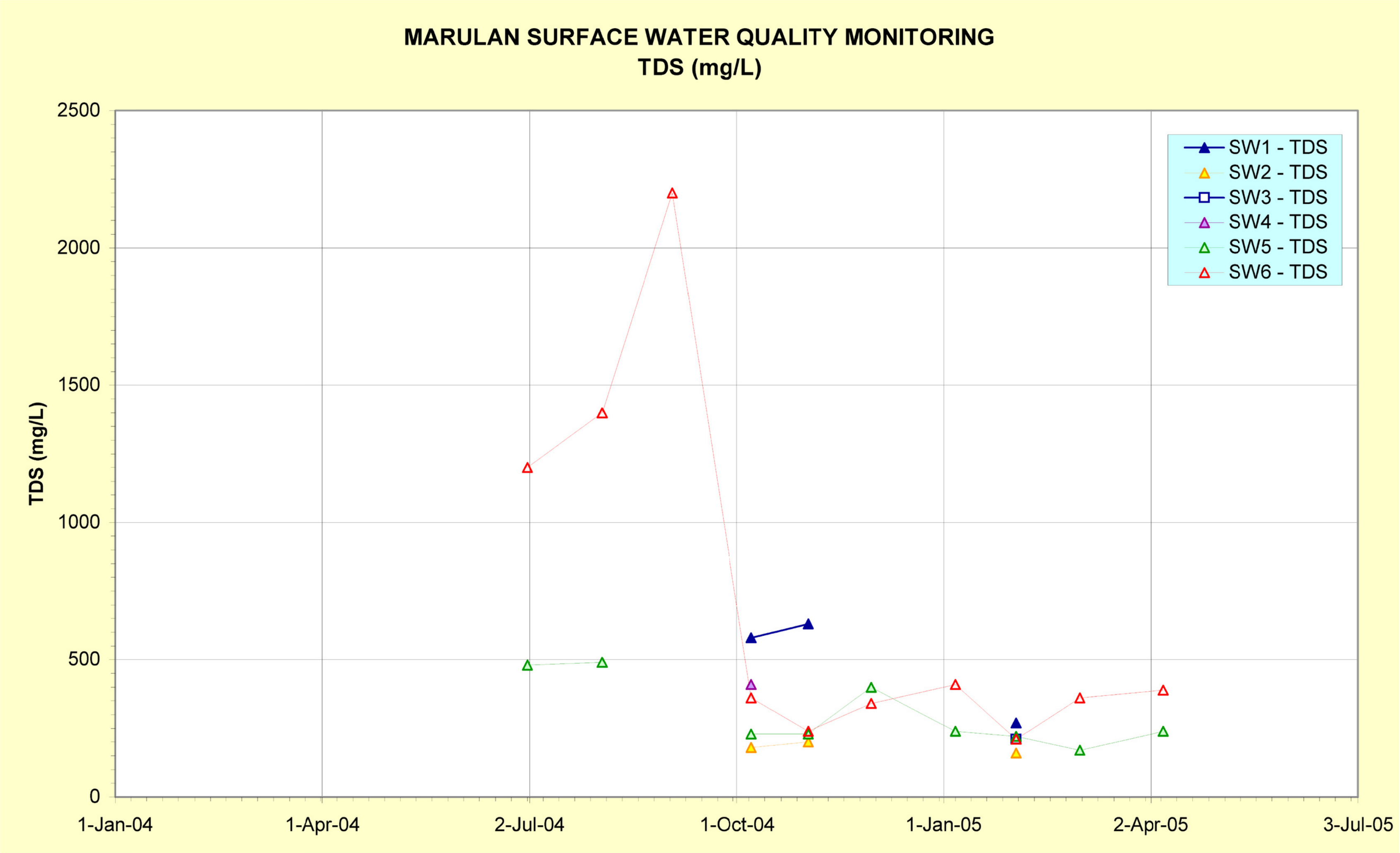
LEGEND	Date: 16 February 2005	Scale: As shown	LYNWOOD QUARRY PROJECT
	Initials: PJD	Job No: 04-0142	SCHOELLER WATER QUALITY DIAGRAMS MP-8, MP-10 and MP-11
	Drawing No: 04-0142-1015	Rev: 0	
	Peter Dundon & Associates Pty Limited		Figure 17



Peter Dundon and Associates Pty Ltd
12 Dakara Close
Pymble NSW 2073
ph 61 2 9440 2666
fx 61 2 94493193
mb 0418 476 799
pjdundon@ozemail.com.au

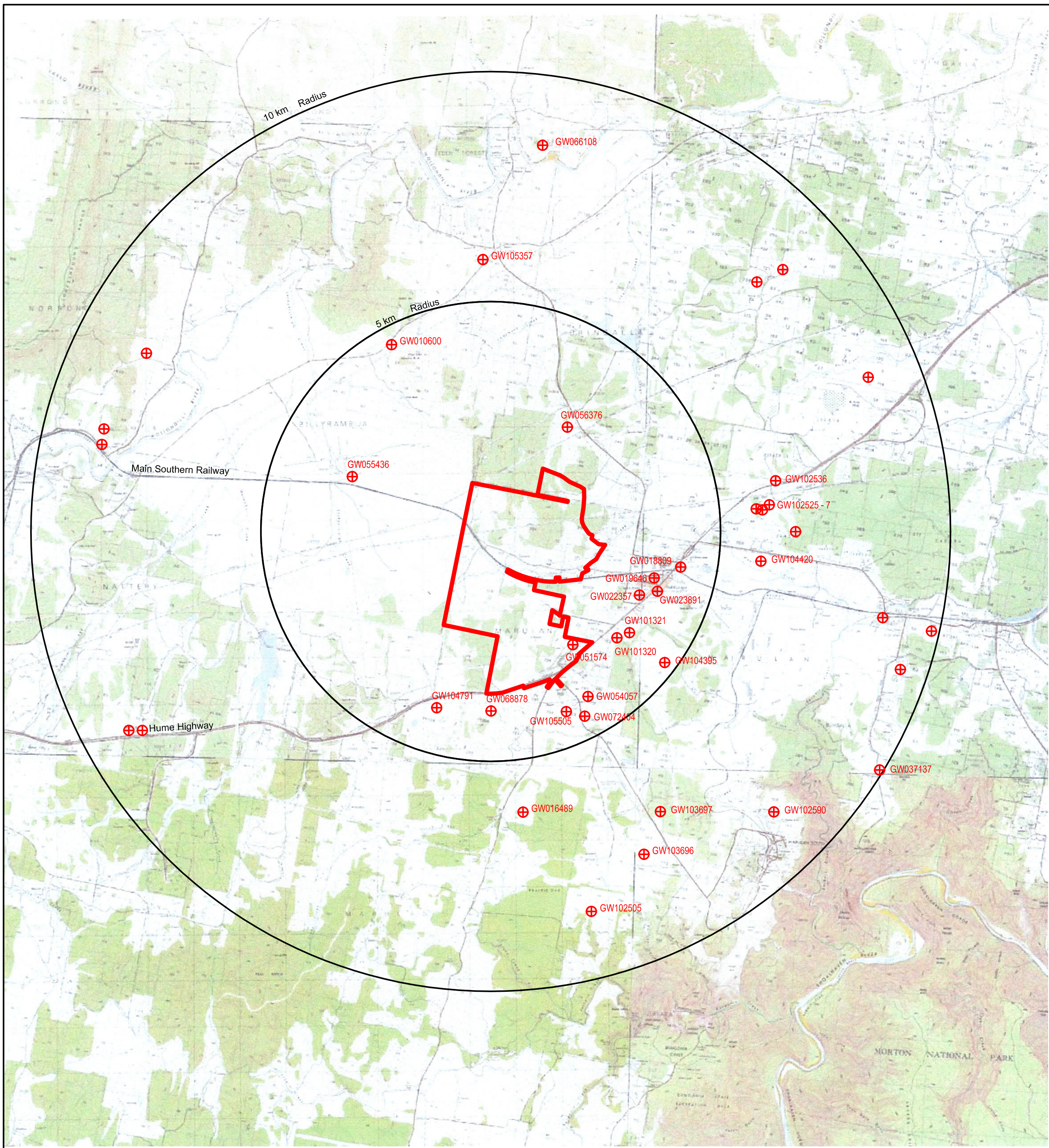
CLIENT Readymix Holdings		PROJECT LYNWOOD QUARRY PROJECT	
DRAWN PJD	DATE 9 February 2005	TITLE PIPER TRILINEAR DIAGRAM GROUNDWATER MP-1 to MP-11	
CHECKED	DATE		
SCALE As Shown Dwg 04-0142-1017 a	A4	PROJECT No 04-0142	Figure 18

c:\...\04-0142\Figure 18 (1017a).grt



LEGEND

Date:	16 February 2005	Scale:	As shown	LYNWOOD QUARRY PROJECT
Initials:	PJD	Job No:	04-0142	MARULAN SURFACE WATER QUALITY MONITORING TDS (mg/L)
Drawing No:	04-0142-1016	Rev:	0	
Peter Dundon & Associates Pty Limited				Figure 19



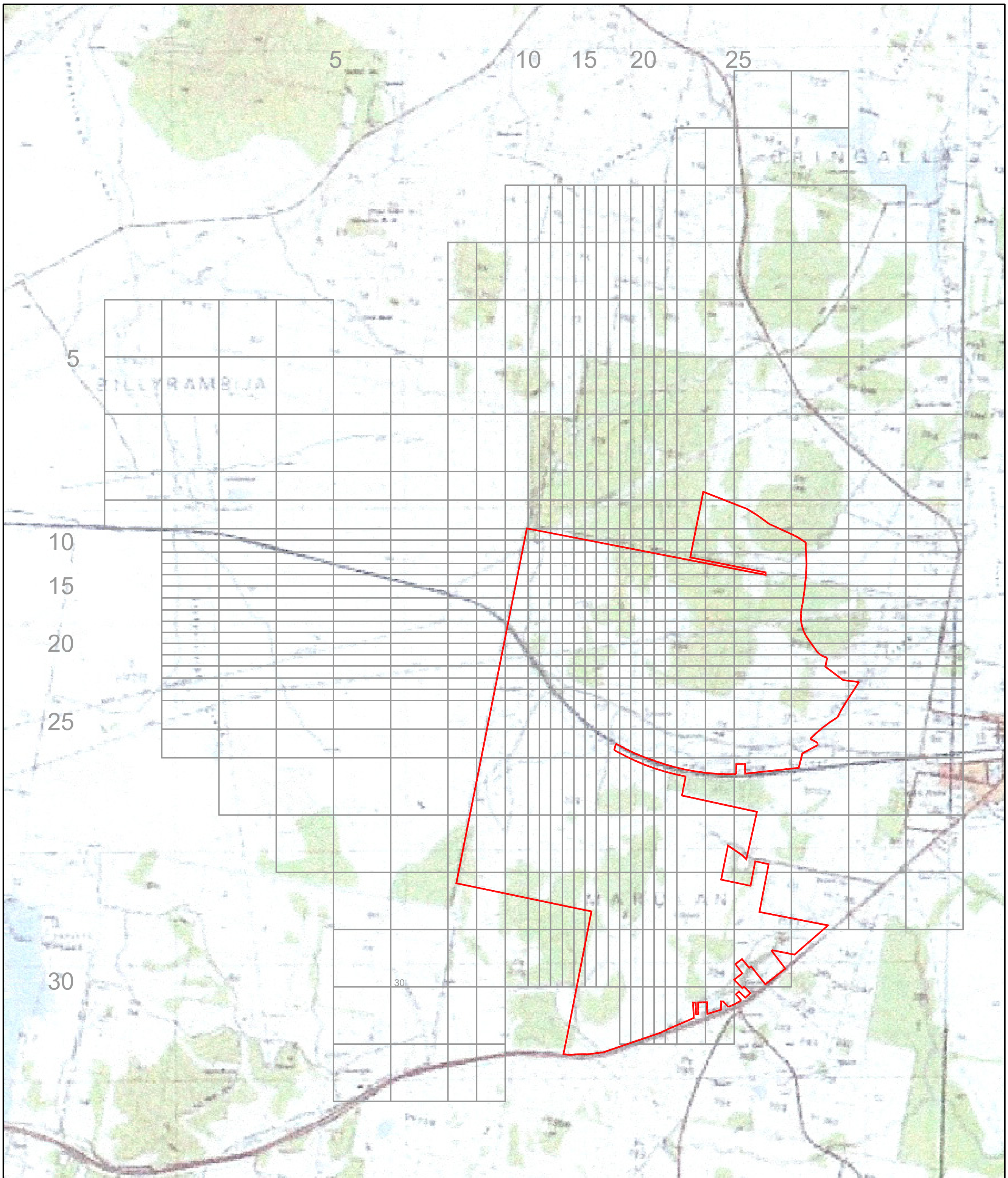
Reference

Site Boundary

Model Grid

⊕ GW055436 DIPNR Licensed Bore

Date: 15 March 2005	Scale: as indicated	**LYNWOOD QUARRY PROJECT**
Initials: PJD	Job No: 04-0142	**LOCATIONS OF DIPNR REGISTERED BORES**
Drawing No: 04-0142-1017	Rev: Initial	
Peter Dundon & Associates Pty Limited		**Figure 20**



Reference

Site Boundary

Model Grid

Date:	16 May 2005	Scale:	1:50,000	LYNWOOD QUARRY PROJECT
Initials:		Job No:	04-0142	GROUNDWATER MODEL GRID
Drawing No:	04-0142-0016	Rev:	Initial	
Peter Dundon & Associates Pty Limited				Figure 21

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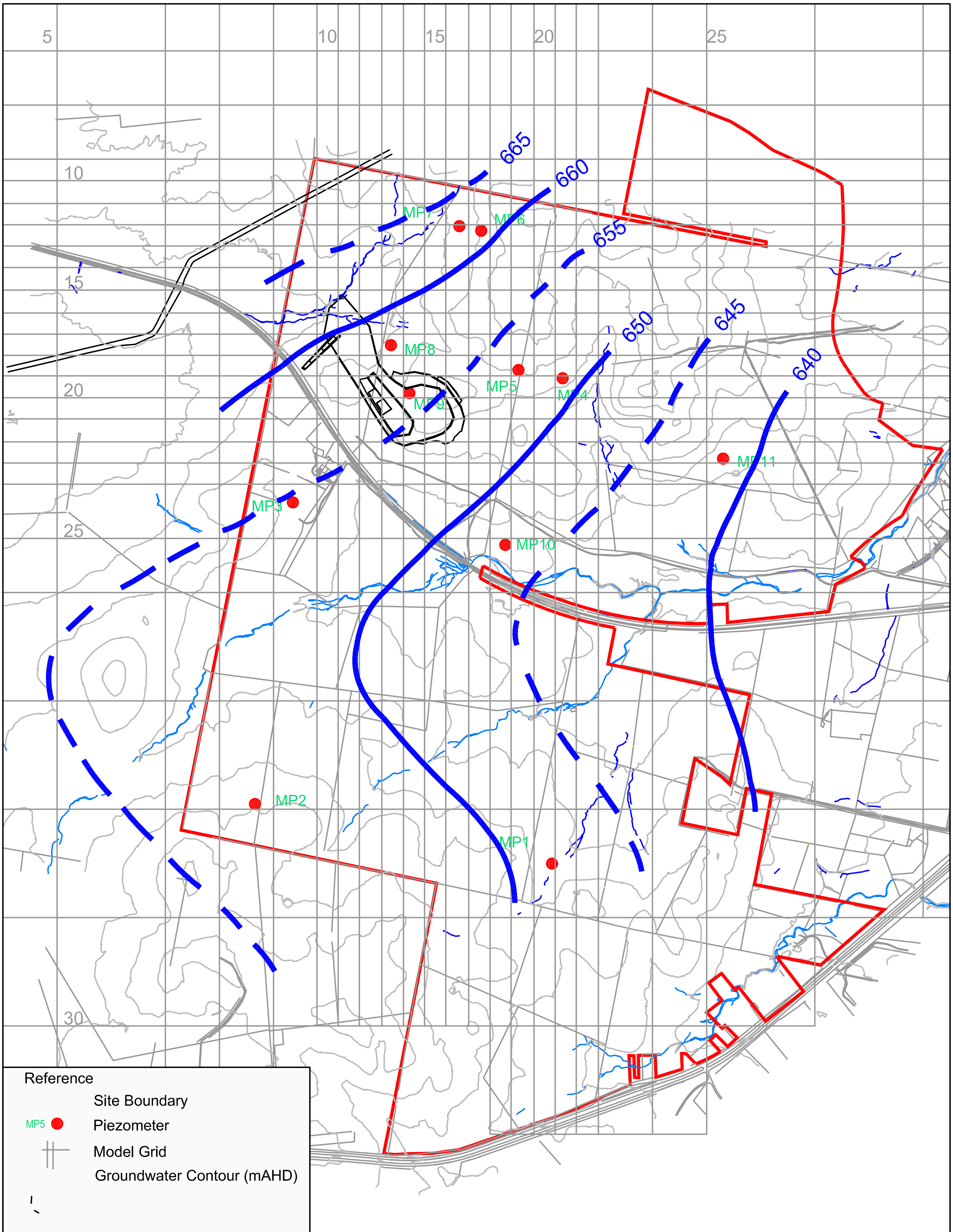
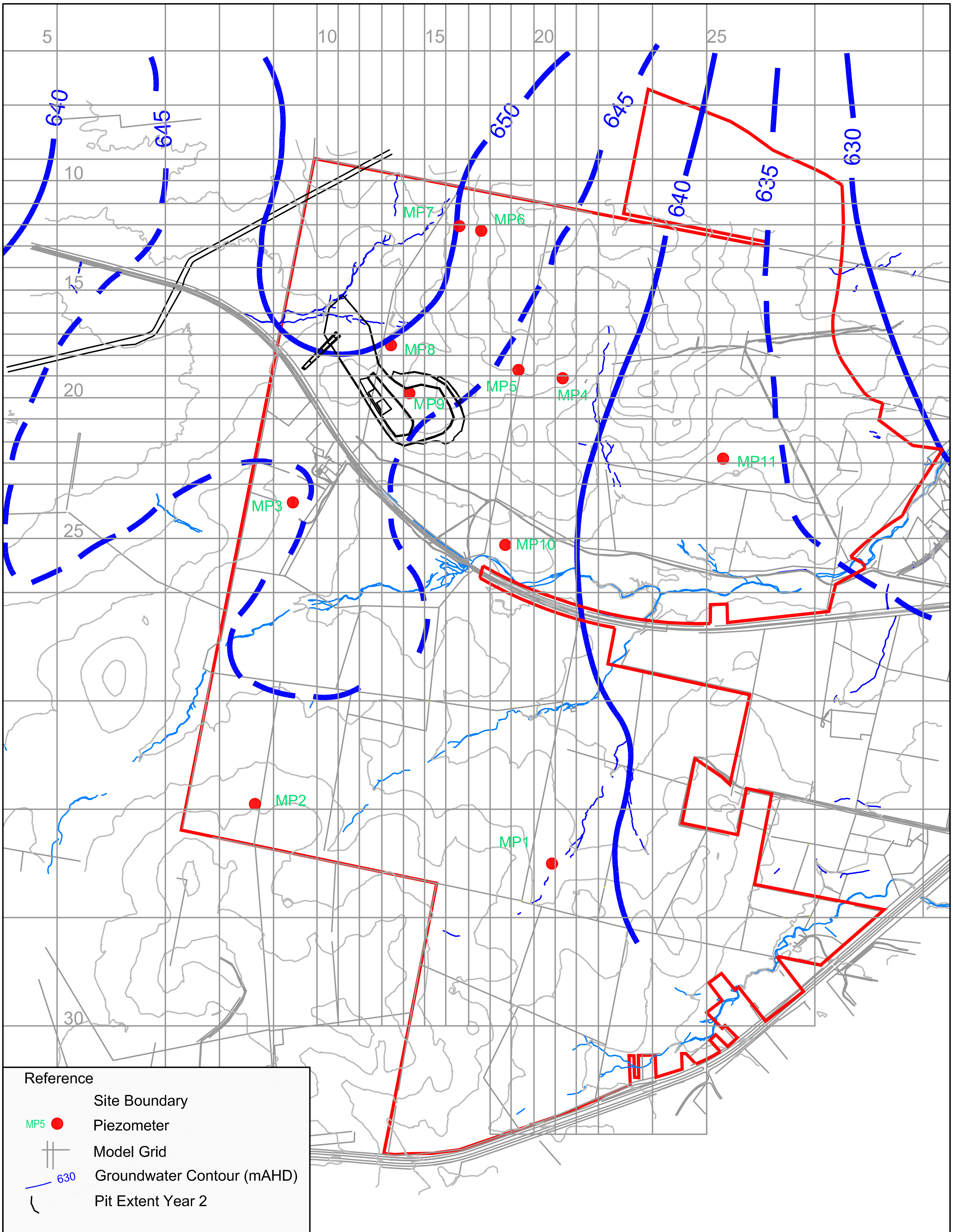
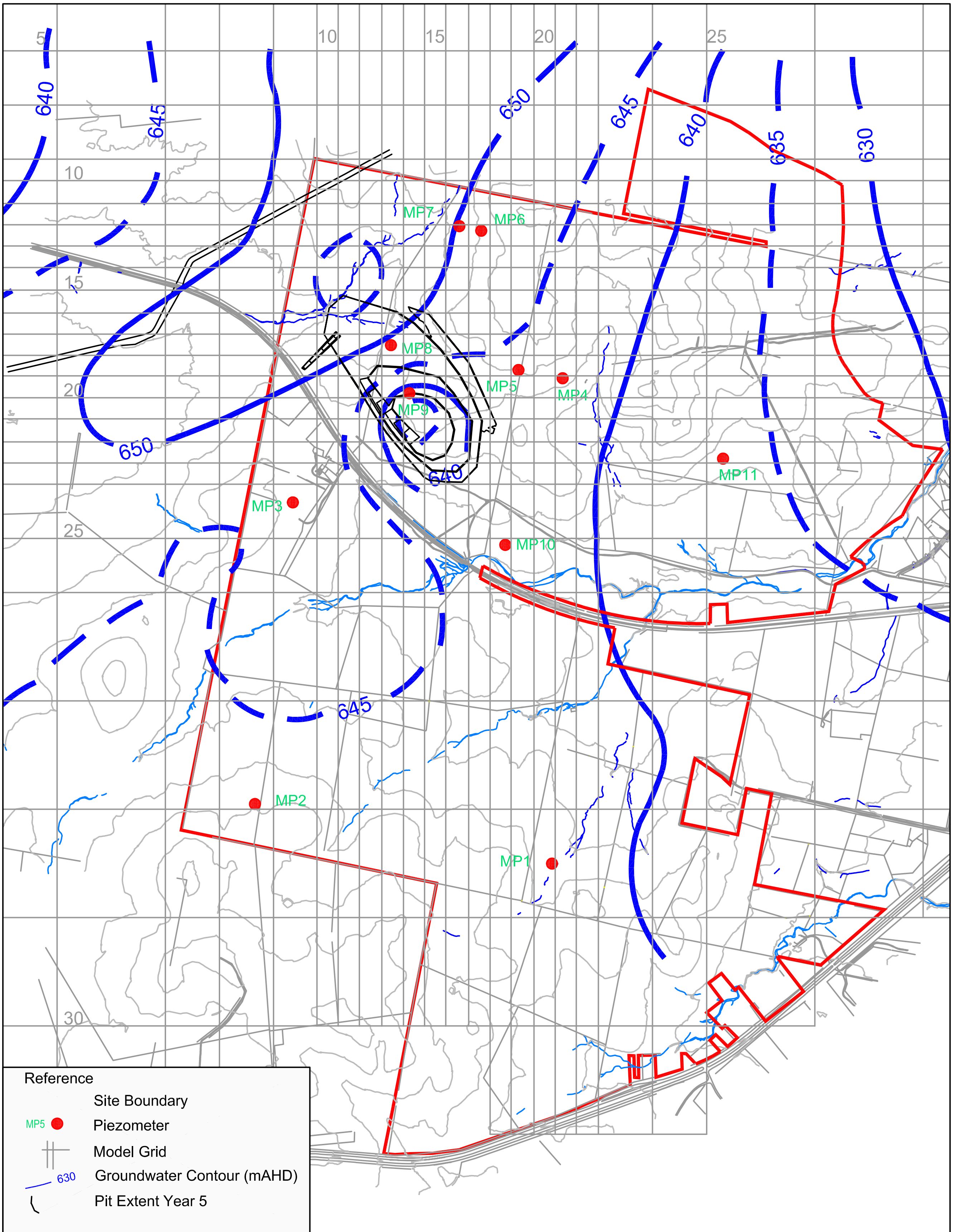


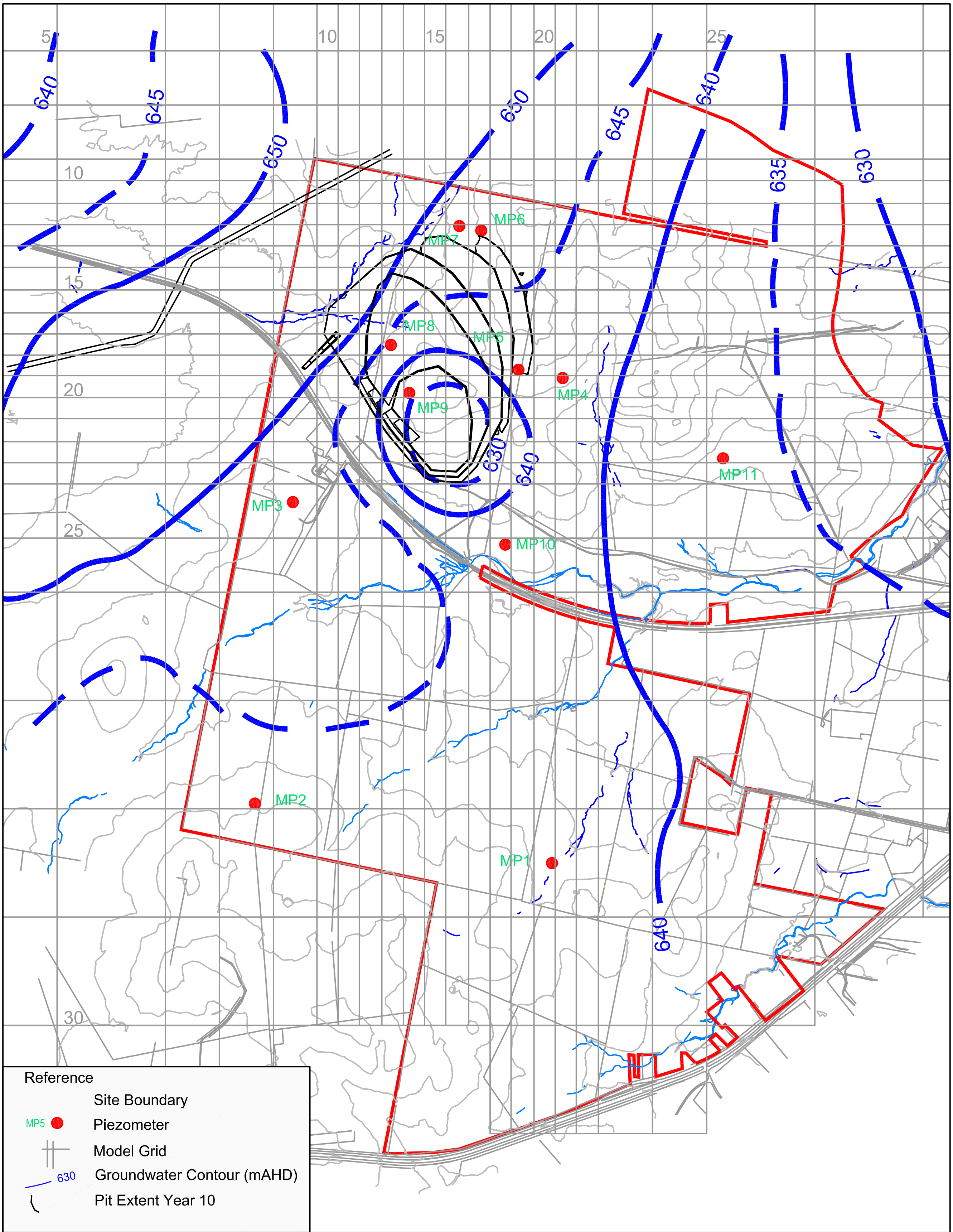
Date:	16 May 2005	Scale:	1 : 25 000	**LYNWOOD QUARRY PROJECT**
Initials:	PJD	Job No:	04-0142	**Steady State Simulation - Pre-Project Groundwater Levels**
Drawing No:	04-0142-0017	Rev:	0	
Peter Dundon & Associates Pty Limited				**Figure 22**



Date:	25 March 2005	Scale:	1 : 25 000	**LYNWOOD QUARRY PROJECT**
Initials:	PJD	Job No:	04-0142	**Model Predicted Water Levels at Year 2**
Drawing No:	04-0142-0007c	Rev:	C	
Peter Dundon & Associates Pty Limited				**Figure 23**



Date: 25 March 2005	Scale: 1 : 25 000	**LYNWOOD QUARRY PROJECT**
Initials: PJD	Job No: 04-0142	**Model Predicted Water Levels at Year 5**
Drawing No: 04-0142-0008c	Rev: C	
Peter Dundon & Associates Pty Limited		**Figure 24**



Date:	25 March 2005	Scale:	1 : 25 000	**LYNWOOD QUARRY PROJECT**
Initials:	PJD	Job No:	04-0142	**Model Predicted Water Levels at Year 10**
Drawing No:	04-0142-0009c	Rev:	C	
Peter Dundon & Associates Pty Limited				**Figure 25**

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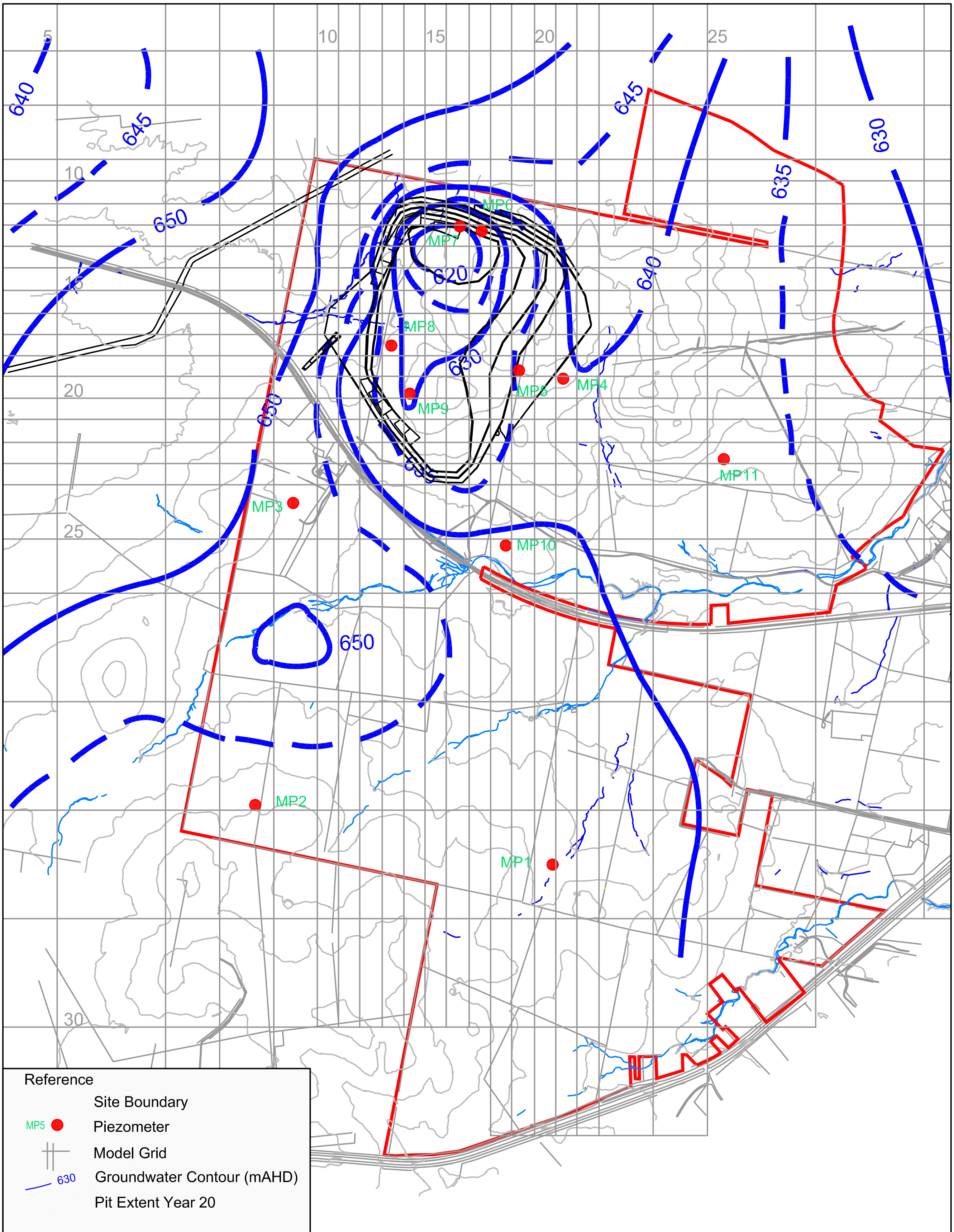
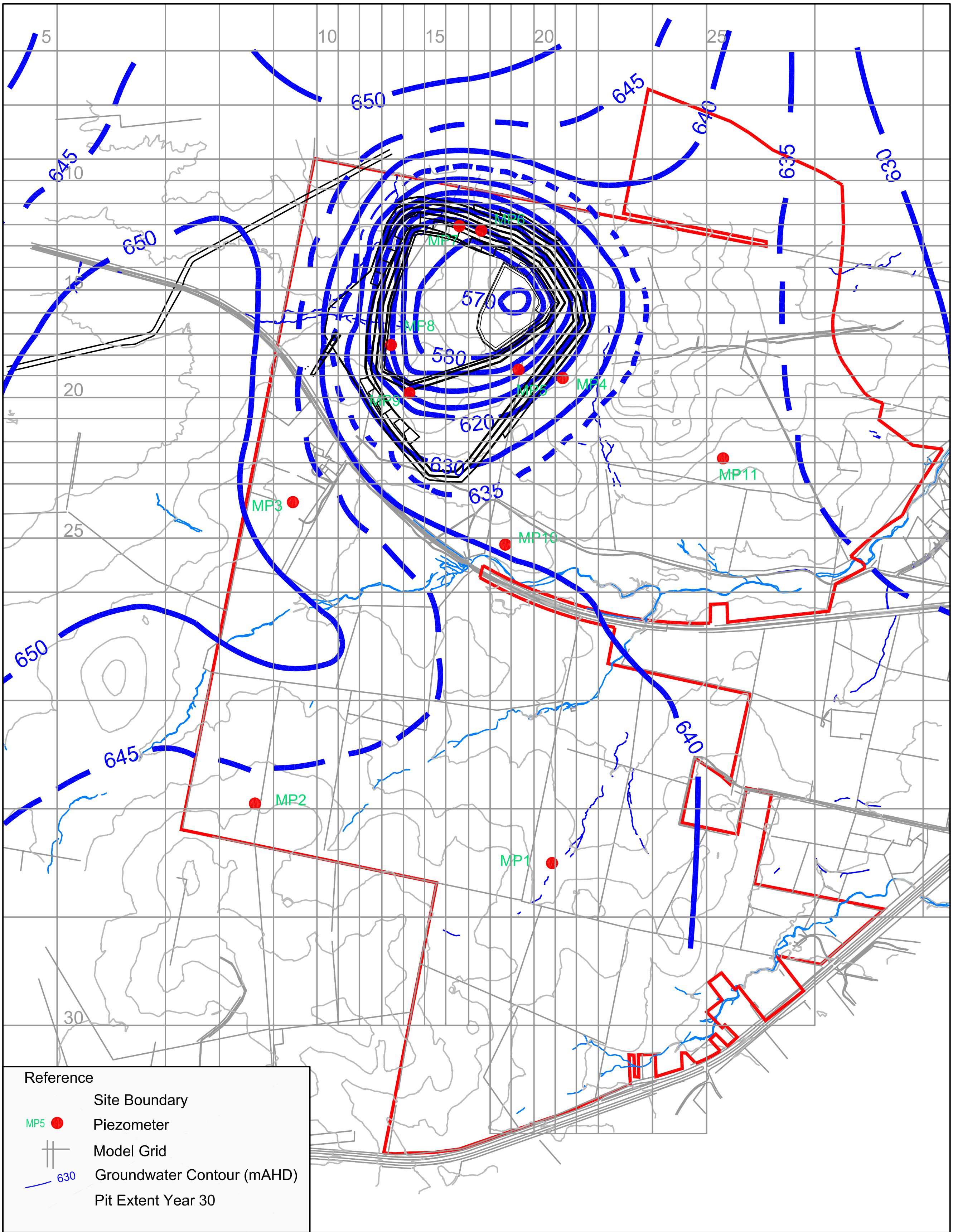
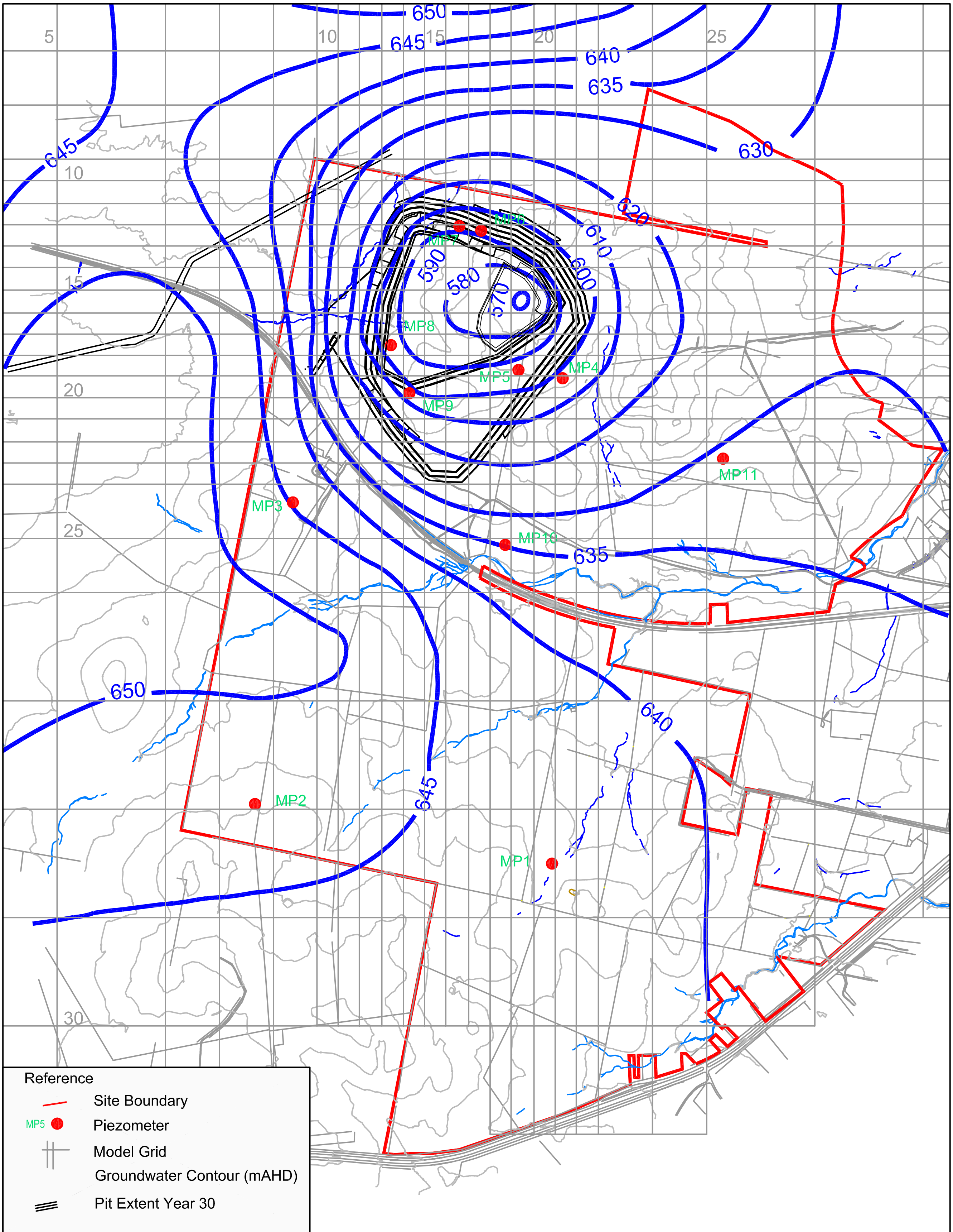


Date:	25 March 2005	Scale:	1 : 25 000	**LYNWOOD QUARRY PROJECT**
Initials:	PJD	Job No:	04-0142	**Model Predicted Water Levels at Year 20**
Drawing No:	04-0142-0010c	Rev:	C	
Peter Dundon & Associates Pty Limited				**Figure 26**



Date:	17 May 2005	Scale:	1 : 25 000	**LYNWOOD QUARRY PROJECT**
Initials:	PJD	Job No:	04-0142	**Model Predicted Water Levels at Year 30**
Drawing No:	04-0142-0011d	Rev:	D	
Peter Dundon & Associates Pty Limited				**Figure 27**



Date:	17 May 2005	Scale:	1 : 25 000
Initials:	PJD	Job No:	04-0142
Drawing No:	04-0142-0012b	Rev:	B

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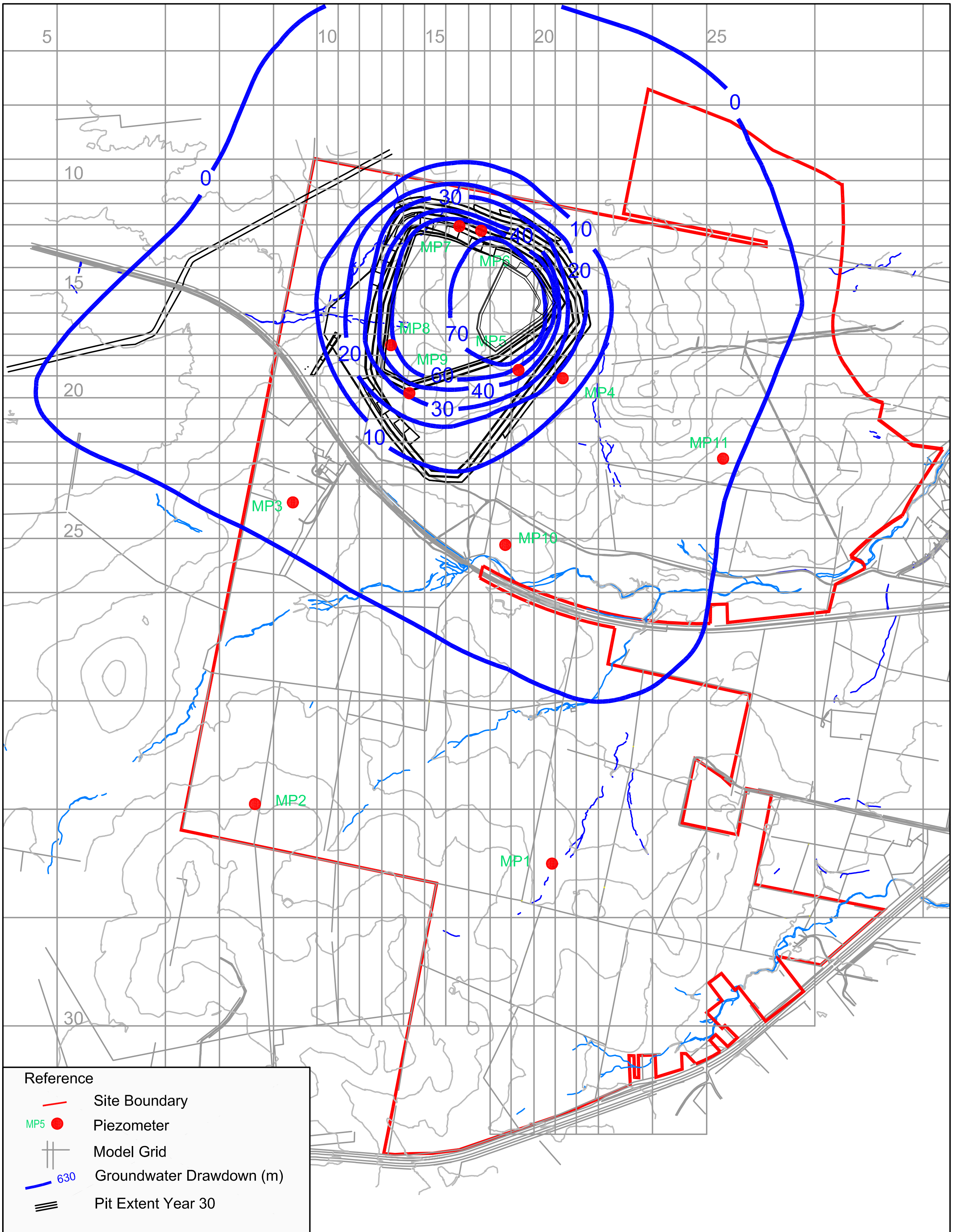
LYNWOOD QUARRY PROJECT

Model Predicted Water Levels 100 Years After Completion

Figure 28



Date:	17 May 2005	Scale:	1 : 25 000
Initials:	PJD	Job No:	04-0142
Drawing No:	04-0142-0013c	Rev:	Rev C

Peter Dundon & Associates Pty Limited

LYNWOOD QUARRY PROJECT

Model Predicted Accumulated Drawdown at Year 30

Figure 29