27 March 2020 Project No. 1780381-L007-Rev1

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Dixon Sand (No. 1) Pty Ltd

EXTRACTION DEPTH FOR DA 165-7-2005

Introduction

Dixon Sand (No. 1) Pty Ltd (Dixon Sand) operates the Haerses Road Quarry, Maroota. The site covers 128 ha either side of Haerses Rd (Figure 1). The quarry operates in accordance with Development Consent DA 165-7-2005, which has been subsequently modified on two occasions.

An Independent Environmental Audit was completed and the report submitted in January 2020. In accordance of Condition 22 (b) of Schedule 2 of the development consent Dixon Sand is required to review and update the Maximum Extraction Depth Map within 3 months of the completion of an Independent Environmental Audit, to the satisfaction of the Secretary. This review and revision of the Maximum Extraction Depth Map is undertaken to fulfil the above requirement.

The Maximum Extraction Depth Map is the *wet weather groundwater elevation* and is determined by the quarry groundwater monitoring network. In accordance with development consent condition 20 of DA 165-7-2005, we have undertaken a review of historical groundwater level monitoring data and made an assessment of the *wet weather groundwater level* to establish the maximum depths to which extraction can be undertaken within the following areas:

- Teriary sands extraction area; and
- Western friable standstone extraction area (Figure 1).

Extraction depths within the Teriary sands extraction area are restricted to 2 m above the wet weather elevation of the underlying Maroota Tertiary Sands Groundwater Source (MTSGS). Extraction depths within the western friable sandstone extraction area are restricted to 2 m above the wet weather elevation of the underlying Sydney Central Basin Groundwater Source (SBCGS). There is a buffer zone which extends 100 m from the western boundary of the MTSGS, which is referred to as the MTSGS buffer zone (Figure 1). This buffer zone overlies the friable sandstone, however in accordance with Condition 17 of the consent, Dixon Sand must not commence quarrying operations within the MTSGS buffer zone without the prior approval of the Secretary (and groundwater monitoring results have shown that quarrying can be undertaken in this area without incurring water loss from the MTSGS).

There are other buffer zones that prohibit extraction but these a related to land uses rather than for hydrogeological purposes.

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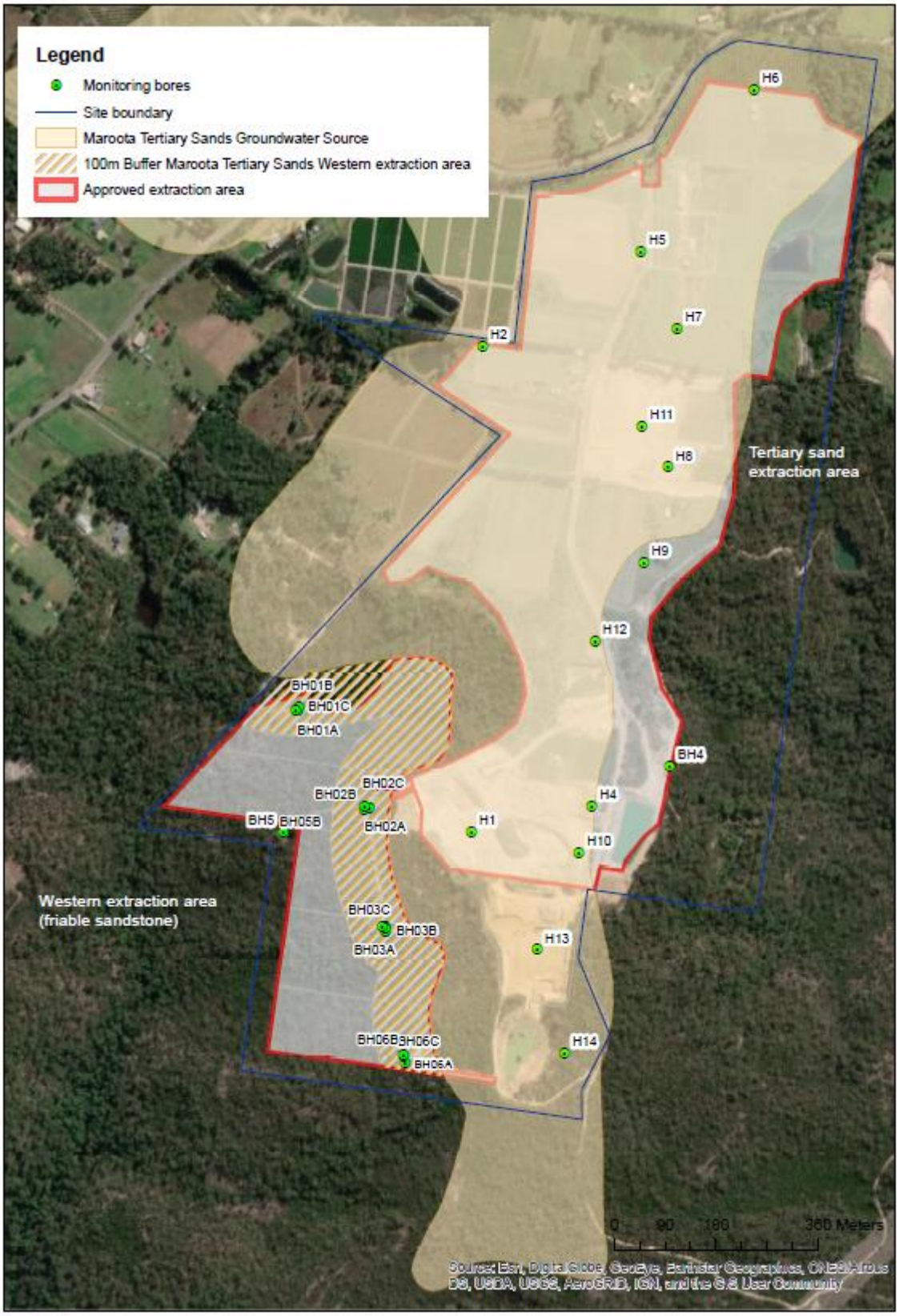
Figure 1: Extraction Areas and Buffer Zones



Groundwater Elevation and Extraction Depth

The wet weather groundwater level of the MTSGS was calculated based on the maximum water level reached in H series monitoring bores following a 50 mm rainfall event in a 24 hour period. The historical daily rainfall records for the nearest BoM rainfall recording station have been analysed to determine the relevant groundwater level at each of the sites that have been monitored over the quarry life. Since 2005, the recorded rainfall at the nearest BoM station 67014 (Maroota Old telegraph Road) have included approximately 32 days when the total daily rainfall exceeded 50 mm, as listed in Appendix A. Table 1 shows the peak water level measured at each of the bores completed in the MTSGS.

Table 1: Peak Water Level After >50 mm/day Rainfall Event – Tertiary Sands Extraction area

Monitoring Bore ID	Peak Water Table Elevation (mAHD)
*H1	176.87
H2	182.05
*H4	183.37
*H5	178.6
H6	184.46
H7	182.6
*H8	187.59
H9	186.93
*H10	176.68
*H11	184.8
H12	183.69
*H13	171.3
H14	177.19

*Denotes obsolete monitoring bores

The length of groundwater monitoring records in the western extraction area (and buffer zone) is much shorter than the MTSGS as the majority of monitoring bores were installed in 2018. For this reason, the wet weather elevation was based on the highest recorded groundwater level to date.Table 2 shows the peak groundwater water level measured at each of the bores completed in the deep SCBGS (BH01A, BH02A, BH03A, BH06A, BH04 and BH05). *Note,* the shallow cluster monitoring bores located in the buffer zone are also shown for reference, but their groundwater levels reflect perched groundwater in the upper unweathered sandstone and as such their purpose is to assess water loss form the adjacent MTSGS. Ongoing monitoring from these bores will be used to assess extraction depth in the buffer zone subject to the approval of the Secritary.

Table 2: Peak Water Level Observed in the Friable Sandstone (Western) Extraction Area

Bore ID	Groundwater source	Peak Water Table Elevation (m AHD)	Monitoring Since
BH01A	SBCGS	133.26	Jul-18
BH02A		136.72	Jul-18
BH03A		101.33*	Jul-18
BH06A		127.66	Jul-18
BH04		140.18	May-11
BH05		123.2	May-11

*groundwater level doesn't reflect the regional tend and has been excluded from the wet weather groundwater elevation contours

Contours of the wet weather groundwater elevation based on the values in Table 1 and Table 2 are shown on Fgure 2. Contours of maximum extraction depth have been created by adding 2 m to each wet weather groundwater level and these are presented on Figure 3. Note whilst extraction depth contours are shown for the MTSGS buffer zone, Dixon Sand must not commence quarrying operations within the MTSGS buffer zone without the prior approval of the Secretary.

Figure 2: Wet weather Groundwater Elevations (mAHD) of the MTSGS and SCBGS

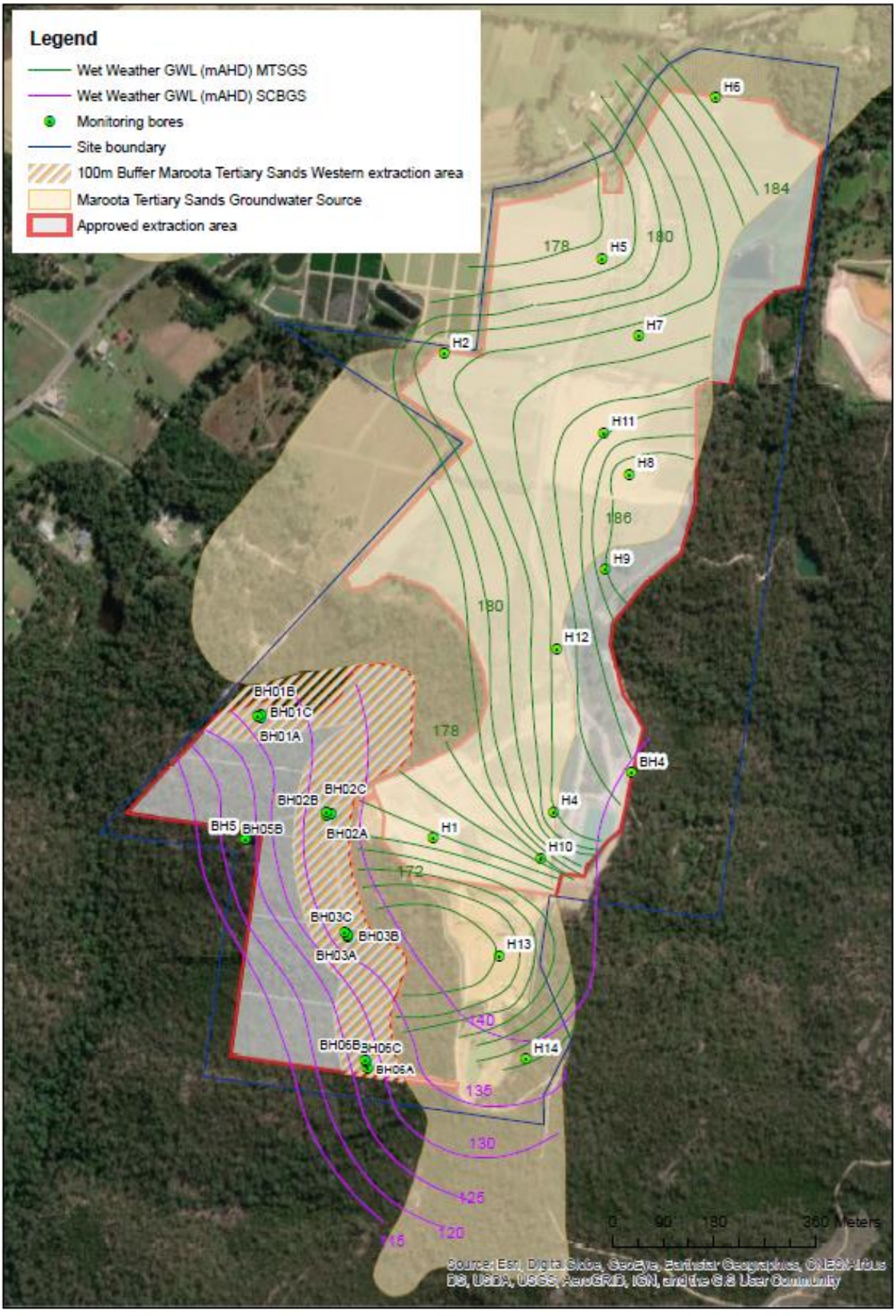
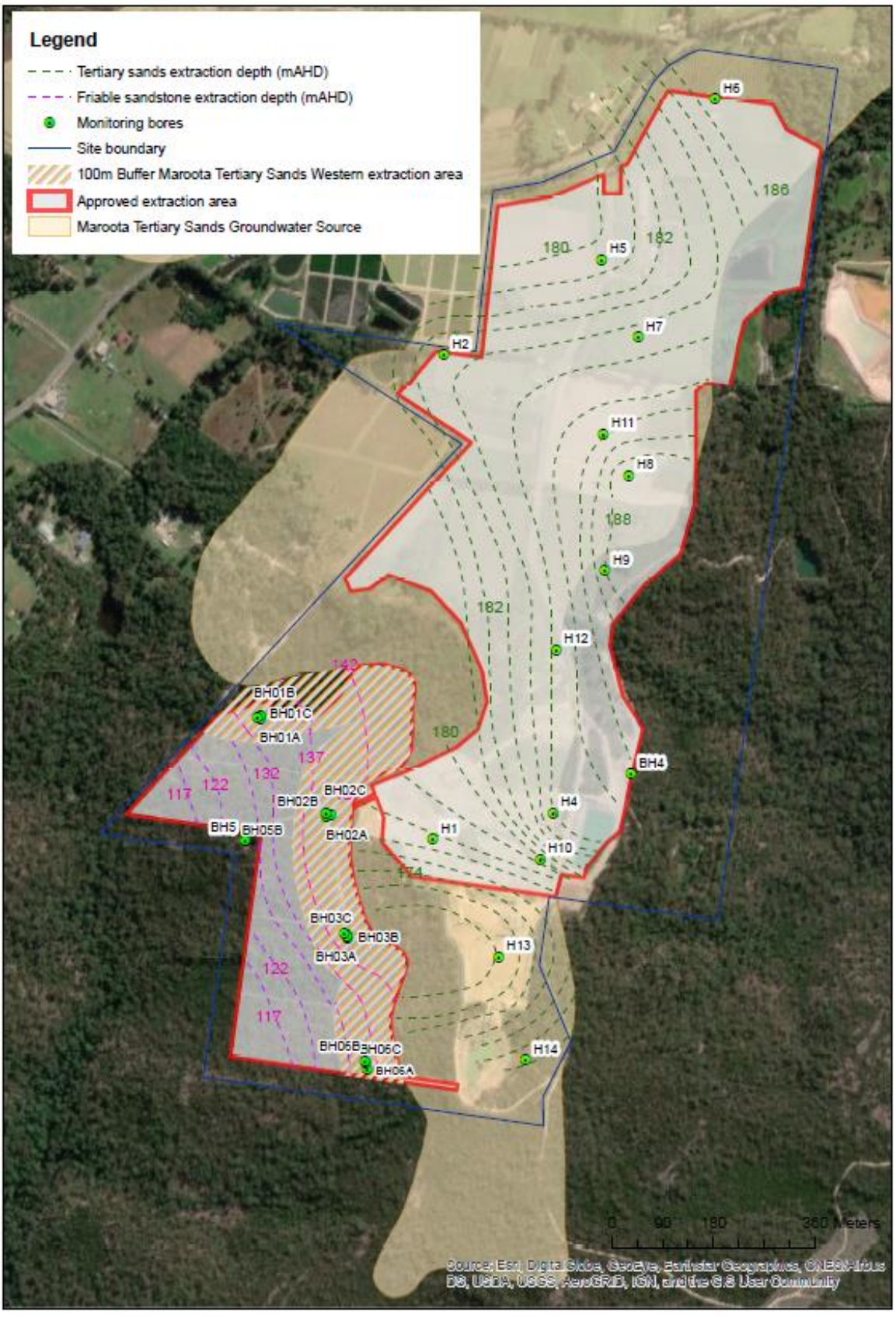


Figure 3: Maximum extraction depth (mAHD) in the Tertiary sand extraction area and western friable sandstone extraction area



The maximum extraction depth map on Figure 3 shows:

- Maximum extraction depth of the Tertiary sands extraction area based on revised groundwater level contours should be limited to a depth not greater than 188 m AHD in the east, gradually reducing to 174m AHD in the west.
- Maximum extraction depth outside the buffer zone of the western extraction (friable sandstone) based on revised groundwater level contours should be limited to a depth not greater than 137 m AHD in the east, gradually reducing to 117 m AHD in the west.
- Extraction within the MTSGS buffer zone is not currently permitted and requires approval from the Secritary once the level of hydraulic connection ot the MTSGS has been understtod. This will be established through groundwater level monitoring of the cluster bores within the buffer zone.

Important Information

Your attention is drawn to the document – “Important Information”, which is included in Attachment B of this report. The statements presented in this document are intended to advise you of what your realistic expectations of this report should be. The document is not intended to reduce the level of responsibility accepted by Golder Associates, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing.

We trust the above satisfies your requirements, however please contact us if you would like ot discuss the findings

GOLDER ASSOCIATES PTY LTD

Jason van den Akker
Principal Hydrogeologist

JV/jd

Attachments: A - Wet Weather groundwater level calculations
B – Important Information

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ATTACHMENT A

Wet Weather Groundwater Level Calculations

Table 3: Weat Weather Level Calculated for the MTSGS

Maroota Daily Rainfalls Exceeding 50mm – 2005 to 2020																
Year	Date	Rainfall	Comment	Peak water level after >50mm/day rainfall												
				H1	H2	H4	H5	H6	H7	H8	H9	H10	H11	H12	H13	H14
2006	7 September	65.0		173.86	179.42	183.09	178.50	179.64	178.26	185.32	185.32	175.93	183.39	178.17	169.97	172.35
2007	13 February	52.2		173.79	179.77			179.38	178.35	183.70	185.35	176.23	183.20	178.36	169.98	172.00
	9 June	172.0		173.79	181.30			182.75	179.32	183.45	186.10	176.68	183.26	180.59	169.79	172.11
	20 July	136.5		174.09	181.88			182.96	180.10	183.33	186.14	176.66	184.75	181.88	169.74	172.91
	6 December	50.6		174.68	180.16			183.03	180.64	184.19	185.89	176.59	184.79	183.13	169.66	173.82
2008	5 June	51.0		175.96	180.17			183.26	181.20	187.59	185.68		184.76	183.34	169.63	175.69
2009	2 April	51.0			180.12			182.56	180.39	187.49	185.42		184.35	183.13	169.94	175.53
	22 May	78.0			180.11			182.54	180.39	187.48	185.43		184.34	183.12	170.17	175.52
2010	7 February	75.0			179.02			183.14	180.25		185.11		184.80	181.74	169.80	175.42
2011	20 August	74.5			180.47			183.28	180.20		184.83			180.99	170.70	175.79
2012	18 April	52.0			180.57			184.46	182.60		186.93			183.09		176.19
2013	29 January	118.0			181.08			182.69	180.24		185.73			182.72	170.10	174.57
	23 February	72.0	154.4 mm over 2 days (23-24 February 2013)		181.57			183.36	181.00		185.51			182.39	170.10	174.85
	24 February	82.4			181.57			183.36	181.00		185.51			182.39	170.10	174.85
2014	19 August	52.6			179.67			182.86	180.10		185.03			180.79	170.60	175.99
	7 December	55.0			180.77			182.86	180.20		185.03			181.29	170.50	175.99
2015	21 April	161.0	279 mm over 2 days (21		180.57			183.46	182.50		186.03			183.69	171.20	177.09
	22 April	118.0			180.57			183.46	182.50		186.03			183.69	171.20	177.09

Maroota Daily Rainfalls Exceeding 50mm – 2005 to 2020																
			to 22 April 2015)													
	22 December	63.6			180.87			183.96	182.30		186.13			183.69		176.89
2016	5 January	108.0	221.2 mm over 4 days (4 to 7 January 2016)		180.37			184.46	182.60		186.13			183.69		177.19
	6 January	68.0			180.37			184.46	182.60		186.13			183.69		177.19
	5 June	69.0	147.4 mm over 3 days (4 to 6 June 2016)		180.87			183.66	181.60		185.53			183.29		176.79
	6 June	68.0			180.87			183.66	181.60		185.53			183.29		176.79
2017	18-Mar	54.8			180.97			183.36	181.50	-	185.63			182.79	171.3	176.49
	31-Mar	55.0			180.97			183.36	181.50	-	185.63			182.79	171.3	176.49
2018	26-Feb	66.0			180.57			182.86	180.00		184.73			180.99	170.3	176.29
	5-Oct	55.0			182.05			182.01	180.28		184.92			181.24		175.06
2019	16-Mar	86.0	86 mm from 16 to 18 March 2019		181.90			181.43	180.32		184.95			181.12		174.91
2020	17-Jan	51.0	51 mm over 17th to 20th Jan													
Average peak water level after >50mm/day rainfall event				174.90	180.48	183.23	178.58	182.72	180.62	185.33	185.50	176.25	184.18	182.18	170.13	175.42
Highest peak water level after >50mm/day rainfall event				176.87	182.05	183.37	#####	184.46	182.60	#####	186.93	176.68	#####	183.69	171.30	#####

ATTACHMENT B

Important Information

The document ("Report") to which this page is attached and which this page forms a part of, has been issued by Golder Associates Pty Ltd ("Golder") subject to the important limitations and other qualifications set out below.

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Where permitted by the Contract, Golder may have retained subconsultants affiliated with Golder to provide some or all of the Services. However, it is Golder which remains solely responsible for the Services and there is no legal recourse against any of Golder's affiliated companies or the employees, officers or directors of any of them.

By date, or revision, the Report supersedes any prior report or other document issued by Golder dealing with any matter that is addressed in the Report.

Any uncertainty as to the extent to which this Report can be used or relied upon in any respect should be referred to Golder for clarification