Aus 10 Rhyolite Pty Limited

ABN: 90 002 325 144

Water Management Plan

for the

Tinda Creek Quarry

Prepared by:

R.W. CORKERY & CO. PTY. LIMITED

In conjunction with:

Katarina David
RPGeo (Hydrogeology) No 10060

August 2019

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Aus 10 Rhyolite Pty Limited
ABN: 90 002 325 144
Unit 4 Gateway Business Park
63-79 Parramatta Road
SILVERWATER NSW 2128

Telephone: (02) 9647 2866
Fax: (02) 9647 2924
Email: darryl.thiedeke@hy-tec.com.au

Prepared by:

R.W. Corkery & Co. Pty. Limited
Geological & Environmental Consultants
ABN: 31 002 033 712

Brooklyn Office:
1st Floor, 12 Dangar Road
PO Box 239
BROOKLYN NSW 2083

Telephone: (02) 9985 8511
Email: brooklyn@rwcorkery.com

Orange Office:
62 Hill Street
ORANGE NSW 2800

Telephone: (02) 6362 5411
Email: orange@rwcorkery.com

Brisbane Office:
Suite 5, Building 3
Pine Rivers Office Park
205 Leitchs Road
BRENDALE QLD 4500

Telephone: (07) 3205 5400
Email: brisbane@rwcorkery.com

In Conjunction with:

Katarina David
RPGeo (Hydrogeology) No 10060

Telephone: 0412 080 360
Email: katarinadavid@hotmail.com

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R.W. CORKERY & CO. PTY. LIMITED

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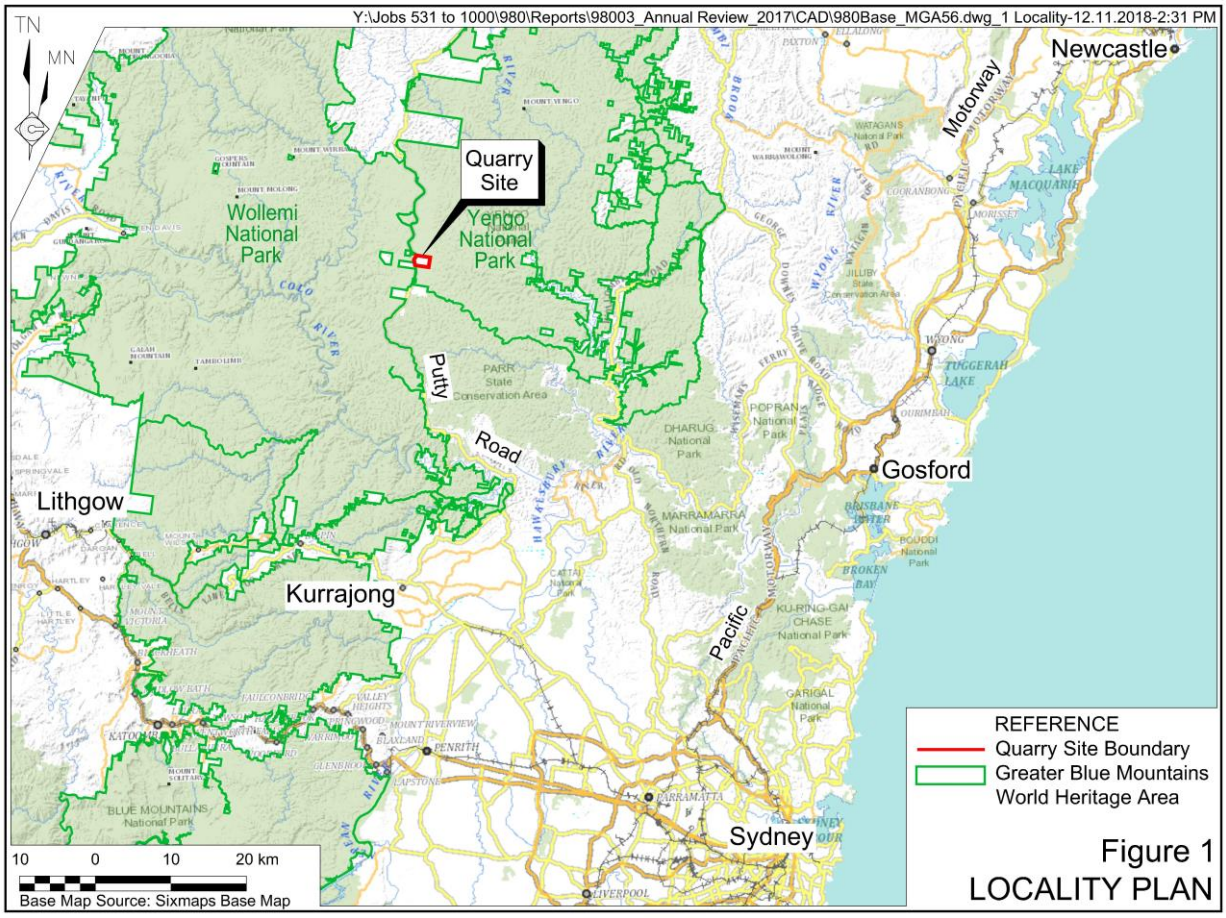
1. INTRODUCTION

The Water Management Plan for the Tinda Creek Quarry (the Quarry) has been prepared to satisfy Condition 13 of Schedule 3 of Development Consent SSD 4978 (SSD 4978). However, the principle objective of the Plan is to provide a practical and accessible document to guide the management of surface water and groundwater resources at the Quarry.

SSD 4978 was granted on 10 April 2015, however it should be recognised that the Quarry has been operating in this location for over 30 years and therefore the management of water resources in the vicinity of the nearby Greater Blue Mountains World Heritage Area, Yengo National Park and Wollemi National Park is well understood.

The Quarry is located on Lot 1, Lot 2 and Lot 3 DP628806 on the Putty Road , approximately 23km north of Colo Heights. **Figure 1** presents the locality of the Quarry in relation to coastal areas, the Greater Sydney Region and surrounding National Park reserves.



This Plan addresses the key requirements of Condition 13 of Schedule 3 of SSD 4978 through provision of the following.

- A Site Water Balance (Section 7)
- A Surface Water Management Plan (Section 8)
- A Groundwater Monitoring Program (Section 10)
- A Surface and Groundwater Contingency Strategy (Section 12)

Progressive development of the Quarry will enable Hy-Tec to implement an adaptive management strategy over the life of the operation. Development of extraction domains and rehabilitation activities are reported in the Annual Review document with projections for the following 12 months presented in each report. The Annual Review will also provide a summary of the development and successful management of water resources.

The water in the dredge ponds of the Quarry is the only available large permanent water source within the surrounding National Park and Greater Blue Mountains World Heritage Areas that is safe for helicopter bucketing and can provide a significant supply for fire tanker refills. The large open area surrounding the Quarry is also invaluable as a safe staging area for fire crews and as a safe area for the refuelling and deployment of helicopters which have become an integral part of modern fire-fighting.

As acknowledged in correspondence from Colo Heights Rural Fire Service, through its dredge ponds, the Quarry provides access to a large volume of permanent water which has proven invaluable during major fire events in the adjoining National Park and Greater Blue Mountains World Heritage Areas such as in 1994, 1997, 2001 and 2013. The Colo Heights Rural Fire Service and the Hawkesbury Region Rural Fire Service is responsible for an area of approximately 1 000km^2 surrounding the quarry. This area is predominantly National Park reserve and therefore heavily vegetated.

Continuing provision of access to and supply of water from the Quarry for bushfire control is an important aspect of the ongoing water management at the Quarry and is critical for bush fire control in the adjoining National Park and Greater Blue Mountains World Heritage Areas.

This document has been prepared by Mr Nicholas Warren, Principal Environmental Consultant, with R.W. Corkery and Co. Pty Limited (B.Sc., M. Bus., M. Env.Sc.) in conjunction with Ms Katarina David (M.Sc. (Hydrogeology), B. Sci (Eng Geo) (Hons)) and with technical peer review undertaken by Mr Paul Ryall, Senior Environmental Consultant, with R.W. Corkery and Co. Pty Limited (B.Sc. (Hydrology).

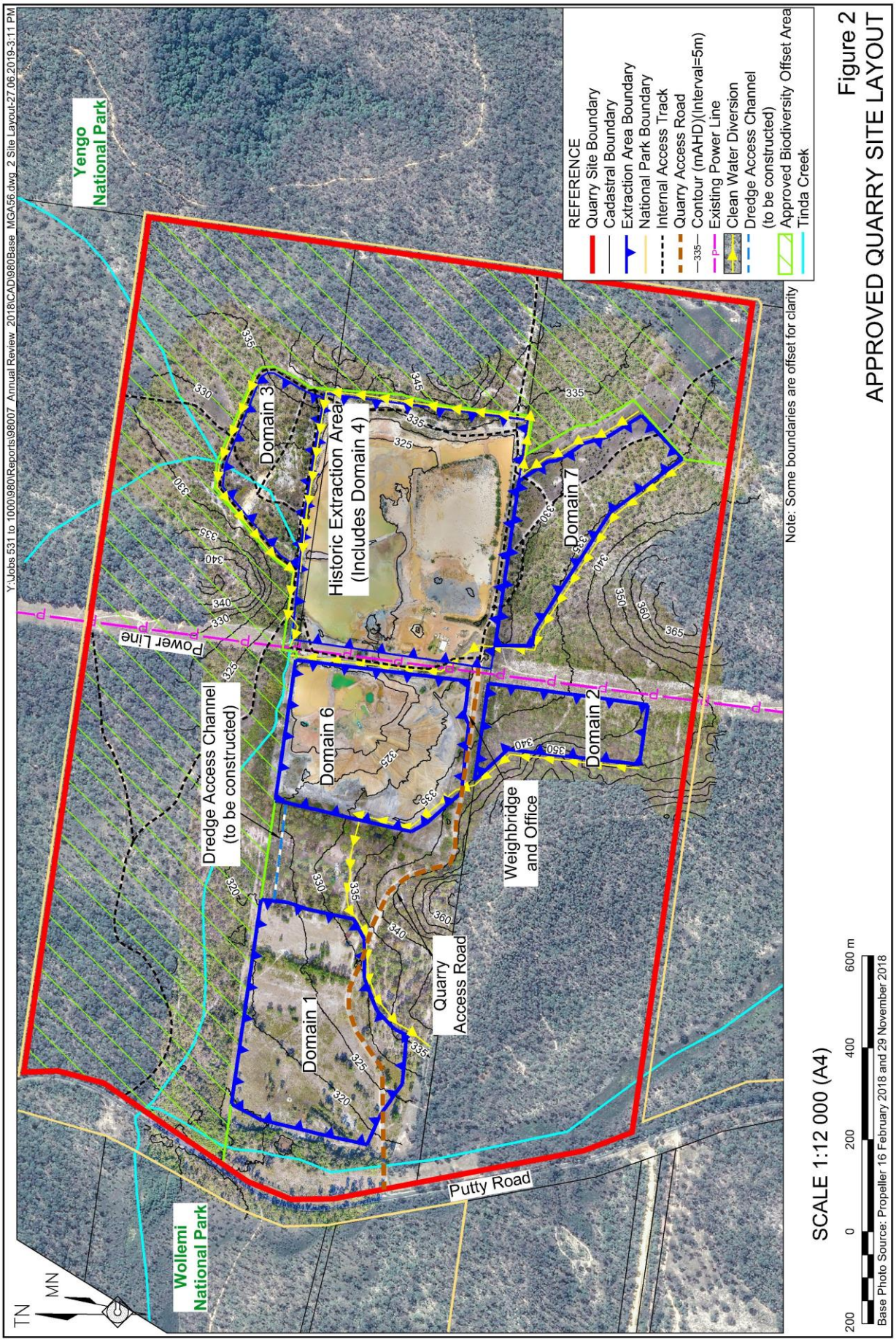
2. APPROVED QUARRY LAYOUT AND OPERATIONS

Figure 2 presents the approved Quarry layout incorporating six extraction domains, Quarry access and a biodiversity offset area. The Quarry layout also includes approved locations for clean water diversions that would be progressively constructed.

SSD 4978 approves the following activities within the Quarry Site.

- Extraction and processing of no more than 300,000t of sand in any calendar year.
- Extraction to a maximum depth of 15m below ground level.
- Progressive development of six extraction domains.
- Extraction using a dredge and where necessary bulldozing and/or excavation of sand into the dredge pond where dredging alone is not feasible.
- Production of a washed sand product by processing extracted sand to separate the clays and silts.
- Development of a closed water management system with a catchment no greater than 40ha, unless agreed with the Secretary of the Department of Planning and Environment.
- Progressive development of clean water diversions within the Quarry Site to separate clean water runoff from undisturbed areas from entering active areas of the Quarry.
- Progressive rehabilitation of completed areas of the Quarry Site.

SSD 4978 also approves a biodiversity offset area that is currently proposed to be dedicated to Yengo National Park.


Y:\Jobs 531 to 1000\980\Reports\98007 Annual Review 2018\CAD\980Base MGA56.dwg 2 Site Layout-27.06.2019-3:11 PM
Yengo National Park
Wollemi National Park
Putty Road
Power Line
Historic Extraction Area (Includes Domain 4)
Domain 1
Domain 2
Domain 3
Domain 6
Domain 7
Dredge Access Channel (to be constructed)
Quarry Access Road
Weighbridge and Office
REFERENCE
Quarry Site Boundary
Cadastral Boundary
Extraction Area Boundary
National Park Boundary
Internal Access Track
Quarry Access Road
Contour (mAHD)(Interval=5m)
Existing Power Line
Clean Water Diversion
Dredge Access Channel (to be constructed)
Approved Biodiversity Offset Area
Tinda Creek
Note: Some boundaries are offset for clarity
TN
MN
SCALE 1:12 000 (A4)
200 0 200 400 600 m
Base Photo Source: Propeller 16 February 2018 and 29 November 2018
Figure 2
APPROVED QUARRY SITE LAYOUT

3. LEGAL AND OTHER REQUIREMENTS

3.1 DEVELOPMENT CONSENT SSD 4978

Development Consent SSD 4978 (SSD 4978) was granted on 10 April 2015 to permit the extraction and despatch of up to 300 000 tonnes of sand from the Quarry each year for the duration of the Project. Water-related conditions of SSD 4978 are presented in **Table 1**, principally relating to water-related operating conditions and the preparation and implementation of this Water Management Plan. It is also noted that Schedule 5 of SSD 4978 presents a range of conditional requirements for all management plans for the Quarry, incident reporting and plan review requirements.

Table 1
Water-Related Approval Conditions of SSD 4978

Page 1 of 3

Condition	Section
Schedule 3	
Condition 12 Operating Conditions	
The Applicant shall:	
(a) Comply with Section 120 of POEO Act unless an EPL authorises otherwise	Noted
(b) Ensure that the catchment of the water management system is not larger than 40 ha, unless the Secretary agrees otherwise	8.3
(c) Maintain dredge and silt ponds to capture a 1 in 100-year storm event plus adequate freeboard to ensure no offsite discharge; and	8.3
(d) Ensure loss of groundwater and surface water to Tinda Creek is no greater than predicted in the EIS.	8.2, 10.3
Condition 13 – Water Management Plan	
The Applicant shall prepare and implement a Water Management Plan for the development to the satisfaction of the Secretary. This plan must:	
a) be prepared by suitably qualified person/s approved by the Secretary;	Noted
b) be prepared in consultation with the EPA and NOW, and be submitted to the Secretary for approval within 6 months of the date of this consent, unless the Secretary agrees otherwise;	4
c) include a Site Water Balance that:	
– includes details of the:	
o quantity of water required to support operations;	7.2
o sources and security of water supply, clearly differentiating between surface water and groundwater, and taking into account rainfall variability;	7.1, 6.2
o water use and management on site;	7.2
o reporting procedures; and	13
o measures to minimise clean water use on site;	7.3
d) include a Surface Water Management Plan, that includes:	
– detailed baseline data on surface water flows and quality in the watercourses that could be affected by the development;	8
– a detailed description of the surface water management system on site, including:	
o clean water diversions;	8.2
o erosion and sediment controls;	8.4
o the dirty water management system; and	8.3
o water storages;	8.3

Table 1 (Cont'd)
Water-Related Approval Conditions of SSD 4978

Condition	Section
Schedule 3 (Cont'd)	
– performance criteria, including trigger levels for investigating any potentially adverse surface water quality impacts;	11
– the measures that would be implemented to ensure compliance with the surface water performance criteria and relevant operating conditions of this consent;	11.1
– a program to monitor and report on:	9
o any surface water discharges;	
o the effectiveness of the water management system; and	
o surface water flows and quality in local watercourses;	
– a comparison of monitoring results with modelled predictions;	9
e) include a Groundwater Monitoring Program, that includes:	
– detailed baseline data on groundwater levels, yield and quality in local aquifers and privately-owned groundwater bores;	10.1
– performance criteria for surrounding aquifers, privately-owned groundwater bores, including trigger levels for investigating any potentially adverse groundwater impacts;	11
– the measures that would be implemented to ensure compliance with the groundwater performance criteria and relevant operating conditions of this consent;	11.2, 11.3
– a program to monitor and report on:	
o groundwater inflows to the quarry pit (quarterly monitoring is required, unless otherwise agreed with the Secretary);	10.3
o the impacts of the development on surrounding aquifers, privately-owned groundwater bores and Tinda Creek; and	10.5
– a program to validate the groundwater model for the development, and compare monitoring results with modelled predictions; and	10.3
f) include a Surface and Groundwater Contingency Strategy, that includes:	
– a protocol for the investigation, notification and mitigation of identified exceedances of the surface water and groundwater impact assessment criteria;	12
– measures to mitigate and/or compensate potentially affected landowners of privately-owned land, including provision of alternative long-term supply of water to the affected landowner that is equivalent to the loss attributed to the development; and	12
– the procedures that would be followed if any unforeseen impacts are detected during the development.	12
Schedule 5	
Condition 2 – Management Plan Requirements	
The Applicant must ensure that the management plans required under this consent are prepared in accordance with any relevant guidelines, and include:	
a) detailed baseline data;	9.2
b) a description of:	
– the relevant statutory requirements (including any relevant approval, licence or lease conditions);	3
– any relevant limits or performance measures/criteria; and	3
– the specific performance indicators that are proposed to be used to judge the performance of, or guide the implementation of, the development or any management measures;	11

Table 1 (Cont'd)
Water-Related Approval Conditions of SSD 4978

Condition	Section
Schedule 5 (Cont'd)	
c) a description of the measures that would be implemented to comply with the relevant statutory requirements, limits, or performance measures/criteria;	11, 12
d) a program to monitor and report on the:	9, 10.4
– impacts and environmental performance of the development; and	
– effectiveness of any management measures (see (c) above);	
e) a contingency plan to manage any unpredicted impacts and their consequences and to ensure that ongoing impacts reduce to levels below relevant impact assessment criteria as quickly as possible;	11
f) a program to investigate and implement ways to improve the environmental performance of the development over time;	18
g) a protocol for managing and reporting any:	
– incidents;	14
– complaints;	13
– non-compliances with statutory requirements; and	14
– exceedances of the impact assessment criteria and/or performance criteria; and	14
h) a protocol for periodic review of the plan.	18
Note: The Secretary may waive some of these requirements if they are unnecessary or unwarranted for particular management plans.	
Condition 5 – Revisions of Strategies, Plans & Programs	
Within 3 months of the submission of an:	Noted
a) annual review under condition 4 above;	
b) incident report under condition 6 below;	
c) audit report under condition 8 below; and	
d) any modifications to this consent,	
the Applicant must review the strategies, plans and programs required under this consent, to the satisfaction of the Secretary. Where this review leads to revisions in any such document, then within 4 weeks of the review the revised document must be submitted for the approval of the Secretary.	
Note: The purpose of this condition is to ensure that strategies, plans and programs are regularly updated to incorporate any measures recommended to improve environmental performance of the development.	
Condition 6 – Incident Reporting	
The Applicant must immediately notify the Secretary and any other relevant agencies of any incident. Within 7 days of the date of the incident, the Applicant must provide the Secretary and any relevant agencies with a detailed report on the incident, and such further reports as may be requested.	14

3.2 EPBC APPROVAL 2013/7028

Expansion of the Tinda Creek Quarry was approved under Sections 130(1) and 133 of the Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act) on 4 October 2016. The expansion of the Quarry was determined to be a controlled action due to the potential for impact on the Koala and *Grevillia parviflora* which are threatened species

listed under the EPBC Act and due to the proximity of the Quarry to the Greater Blue Mountains World Heritage Area. **Table 2** presents the water-related conditions of EPBC 2013/7028. These conditions principally relate to the management of the quality and quantity of water that may enter the Greater Blue Mountains World Heritage Area.

Table 2
Water-related Conditions of EPBC 2013/7028

Condition	Section
9. In order to maintain the quantity and quality of water entering the Greater Blue Mountains Area, the approval holder must implement the Tinda Creek Quarry Final Water Management Plan dated August 2016 or as revised under condition 19.	This Plan
10. To minimise impacts to water quantity and quality within the Greater Blue Mountains Area, the approval holder must comply with Operating Conditions provided by NSW approval condition 12.	This Plan
11. In addition to complying with the rehabilitation objectives for the final void in NSW approval condition 17, the approval holder must ensure that water discharging from the project site into the Greater Blue Mountains Area is of equal or better quality to the quality of water upstream of the project site.	9, 10.4

3.3 ENVIRONMENT PROTECTION LICENCE 12007

Risks associated with environmental pollution at the Quarry Site are managed in accordance with Environment Protection Licence (EPL) 12007. The water-related conditions of EPL 12007 are presented in **Table 3** and principally relate to the pollution of water generally and the requirement to report on any water related incidents at the Quarry.

Table 3
Water-related Conditions of EPL 12007

Page 1 of 2

Condition	Section
L1 Pollution of Waters Except as may be expressly provided in any other condition of this licence, the licensee must comply with section 120 of the Protection of the Environment Operations Act 1997.	Noted
M2 Environmental monitoring • The licensee must undertake monthly inspections of the surface water management system at the premises. • The monthly inspections must: – be undertaken immediately upstream and downstream of the quarry disturbance area; – include visual inspection of litter, oil and grease and sediment levels within the surface water system, including diversion channels; – include visual inspection of the physical integrity of the surface water management system, including any signs of erosion; and – include visual inspection of the water level and flow in Tinda Creek.	9
R4.2 In accordance with section 5.3 of the approved Water Management Plan for the premises, the licensee must notify the EPA when surface water triggers are exceeded and provide a written report to the EPA.	14

Table 3 (Cont'd)
Water-related Conditions of EPL 12007

Condition	Section
R4.3 The report to the EPA must include: a) the results of surface water management system inspections required in condition M2.1 for the month related to the exceedance, including photographs; and b) appropriate mitigation and contingency measures to be implemented within one month of the exceedance being detected.	14
R4.4 The report must be submitted to the EPA within one month of surface water triggers being detected and be directed to the Manager, Sydney Industry Section by email to metro.regulation@epa.nsw.gov.au	14

3.4 STATEMENT OF COMMITMENTS

The Statement of Commitment is included in SSD 4978 as Appendix 3 and contains the following water-related commitments.

- 5.10.1 Hy-Tec will continue to undertake monitoring of groundwater bores in accordance with existing licence conditions (Section 10.4).
- 5.10.2 All diversion drains will continue to be maintained in good condition (Section 8.2).
- 5.10.3 The water management system will remain as a closed system (Section 8.3).

3.5 WATER ACCESS LICENCES

Water Access Licence (WAL) 24381 (40ML), WAL24367 (15ML) and WAL 42466 (60ML) have been issued to permit extraction of water from the Sydney Basin North Groundwater Source (see details in **Table 4**). Water within this source is managed through the water sharing plan for the *Greater Metropolitan Region Groundwater Sources 2011*. The WALs permit extraction of groundwater in accordance with the conditions provided in the licences. Two Water Supply Works approvals were issued to Hy-Tec on 1 July 2011 by the then Department of Primary Industries (now the Department of Industry – Crown Lands and Water) to permit extraction of groundwater. WAL 42466 was purchased under a controlled allocation order and commences from 1 July 2019.

Table 4
Tinda Creek Sand Quarry – Water Access Licences

Licence	Issue Date	Expiry Date	Details / Comments
Water Access License 24381	1/9/2014	Continuing	Water Supply Works (Excavation) approval number 10WA112523 issued on 1/7/2011. Valid until 8/11/2025
Water Access License 24367	2/2/2012	Continuing	Water Supply Works (Bore) approval number 10WA112531 issued on 1/7/2011. Valid until 13/4/2025
Water Access License 42446	25 June 2019	Continuing	Nominated Water Supply Works to be confirmed.
+ Anniversary Date			

Operating conditions that apply to the water access licence and the water supply works approvals for the Quarry are presented in **Table 5** as well as where these requirements have been addressed in this document.

Table 5
Water Access Licence and Water Supply Works Approval Conditions

Page 1 of 3

Condition Number	Condition	Section of Plan
WATER ACCESS LICENCE CONDITIONS		
Take of water		
MW0929-00001	From 1 July 2018, if the water supply work nominated on this access licence is located at or less than 40 m from the top of the high bank of a river then: A. water must not be taken in this groundwater source when flows are in the Very Low Flow Class for an unregulated river access licence in that river. B. This restriction will only apply when the system that confirms when water can be taken is available on the relevant licensor website. C. the relevant licensor will inform the licence holder in writing of the applicable restrictions and how to access the information on its website when this system becomes operative.	Not Applicable
MW0919-00001	A maximum water allocation of 0.1 ML/unit share may be carried over in the account for this access licence from one water year to the next water year if a water meter is installed on each water supply work nominated on this licence and each meter is maintained in working order.	7.1
MW0605-00001	Water must be taken in compliance with the conditions of the approval for the nominated work on this access licence through which water is to be taken.	3.5
MW0547-00001	The total volume of water taken under this licence in any water year must not exceed a volume equal to: A the sum of water in the account from the available water determination for the current year, plus B. the water carried over in the account from the previous water year, plus C. the net amount of water assigned to or from the account under a water allocation assignment, plus D. any water re-credited by the Minister to the account.	7.1
Monitoring and recording		
MW2338-00001	The completed logbook must be retained for five (5) years from the last date recorded in the logbook.	10.3
MW2336-00001	The purpose or purposes for which water is taken, as well as details of the type of crop, area cropped, and dates of planting and harvesting, must be recorded in the logbook each time water is taken.	10.3
MW2337-00001	The following information must be recorded in the logbook for each period of time that water is taken: A. date, volume of water, start and end time when water was taken as well as the pump capacity per unit of time, and B. the access licence number under which the water is taken, and C. the approval number under which the water is taken, and D. the volume of water taken for domestic consumption and/or stock watering.	10.3

Table 5 (Cont'd)
Water Access Licence and Water Supply Works Approval Conditions

Condition Number	Condition	Section of Plan
WATER ACCESS LICENCE CONDITIONS (Cont'd)		
Monitoring and recording (Cont'd)		
MW0606-00001	The volume of water taken in the water year must be recorded in the logbook at the end of each water year. The maximum volume of water permitted to be taken in that water year must also be recorded in the logbook.	10.3
MW2339-00001	A logbook must be kept, unless the work is metered and fitted with a data logger. The logbook must be produced for inspection when requested by the relevant licensor.	10.3
Reporting		
MW0051-00002	Once the licence holder becomes aware of a breach of any condition on this access licence, the licence holder must notify the Minister as soon as practicable. The Minister must be notified by: A. email: water.enquiries@dpi.nsw.gov.au, or B. telephone: 1800 353 104. Any notification by telephone must also be confirmed in writing within seven (7) business days of the telephone call.	14
WATER SUPPLY WORKS APPROVAL CONDITIONS		
Take of water		
MW0655-00001	Any water supply work authorised by this approval must take water in compliance with the conditions of the access licence under which water is being taken.	3.5
Water Management Works		
MW0097-00001	If contaminated water is found above the production aquifer during the construction of the water supply work authorised by this approval, the licensed driller must: A. notify the relevant licensor in writing within 48 hours of becoming aware of the contaminated water, and B. adhere to the Minimum Construction Requirements for Water Bores in Australia (2012), as amended or replaced from time to time.	Not Required
MW0487-00001	The water supply work authorised by this approval must be constructed within three (3) years from the date this approval is granted.	Not Required
MW0044-00001	A. When a water supply work authorised by this approval is to be abandoned or replaced, the approval holder must contact the relevant licensor in writing to verify whether the work must be decommissioned. B. The work is to be decommissioned, unless the approval holder receives notice from the Minister not to do so. C. When decommissioning the work the approval holder must: i. comply with the minimum requirements for decommissioning bores prescribed in the Minimum Construction Requirements for Water Bores in Australia (2012), as amended or replaced from time to time, and ii. notify the relevant licensor in writing within sixty (60) days of decommissioning that the work has been decommissioned.	Not Yet Required

Table 5 (Cont'd)
Water Access Licence and Water Supply Works Approval Conditions

Condition Number	Condition	Section of Plan
WATER SUPPLY WORKS APPROVAL CONDITIONS (Cont'd)		
Monitoring and recording		
MW0484-00001	Before water is taken through the water supply work authorised by this approval, confirmation must be recorded in the logbook that cease to take conditions do not apply and water may be taken. The method of confirming that water may be taken, such as visual inspection, internet search, must also be recorded in the logbook. If water may be taken, the: A. date, and B. time of the confirmation, and C. flow rate or water level at the reference point in the water source must be recorded in the logbook.	10.3
MW2338-00001	The completed logbook must be retained for five (5) years from the last date recorded in the logbook.	10.3
MW2336-00001	The purpose or purposes for which water is taken, as well as details of the type of crop, area cropped, and dates of planting and harvesting, must be recorded in the logbook each time water is taken.	10.3
MW2337-00001	The following information must be recorded in the logbook for each period of time that water is taken: A. date, volume of water, start and end time when water was taken as well as the pump capacity per unit of time, and B. the access licence number under which the water is taken, and C. the approval number under which the water is taken, and D. the volume of water taken for domestic consumption and/or stock watering.	10.3
MW0482-00001	Where a water meter is installed on a water supply work authorised by this approval, the meter reading must be recorded in the logbook before taking water. This reading must be recorded every time water is to be taken.	10.3
MW2339-00001	A logbook must be kept, unless the work is metered and fitted with a data logger. The logbook must be produced for inspection when requested by the relevant licensor.	10.3
Reporting		
MW0051-00001	Once the approval holder becomes aware of a breach of any condition on this approval, the approval holder must notify the Minister as soon as practicable. The Minister must be notified by: A. email: water.enquiries@dpi.nsw.gov.au, or B. telephone: 1800 353 104. Any notification by telephone must also be confirmed in writing within seven (7) business days of the telephone call.	14

4. CONSULTATION

Condition 13 of Schedule 3 of SSD 4978 requires that this Plan be prepared in consultation with the EPA and DoI Water before it is approved by the Secretary of DPE.

A final draft version of this Plan was provided to the EPA on 29 January 2019. Comments from the EPA on this Plan have been addressed and incorporated into the final draft document.

A final draft version of this Plan was provided to DoI Water on 29 January 2019. Comments from DoI Water on this Plan have been addressed and incorporated into the final draft document.

5. LOCAL SETTING

5.1 INTRODUCTION

The management of water resources at the Quarry is heavily influenced by the local setting including the local topography and drainage, climate, geology and hydrogeology. These factors also influence the likelihood and severity of any impacts from Quarry operations. This section provides a brief summary of the local setting to inform water resource management at the Quarry.

Detailed information on the local surface water setting and the regional and local groundwater setting including baseline data is also presented in this section.

5.2 CLIMATE

Rainfall records for the Quarry have been recorded consistently since 2007. Monthly rainfall records for the period 2007 to 2018 (to October) and the calculated average monthly annual rainfall for this period provided in **Table 6**.

Table 6
Rainfall (mm) 2007 – 2018

Month/Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Average
January	50.5	95.5	29.0	48.5	66.5	133.0	138.0	8.0	163.0	272.0	36.2	25.6	88.8
February	152.0	146.5	137.5	119.5	47.0	179.0	202.0	64.0	46.5	0.0	34.2	58.4	98.9
March	80.5	43.0	30.0	85.5	97.0	145.0	103.0	135.2	96.5	0.0	208.0	64.4	90.7
April	61.5	81.5	117.0	26.0	60.0	64.0	63.5	60.5	285.5	0.0	22.4	13.4	71.3
May	29.0	10.5	56.5	59.5	96.0	NR	31.0	0.0	56.5	0.0	16.6	6.2	32.9
June	210.0	94.0	39.5	43.0	85.5	29.0	84.5	29.0	20.5	126.0	54.0	33.0	70.7
July	13.0	24.5	17.5	38.5	25.5	27.0	18.5	13.0	34.0	55.0	2.6	5.0	22.8
August	107.0	40.5	4.0	13.5	90.0	4.0	11.0	74.5	26.5	36.5	11.6	10.0	35.8
September	18.5	58.5	21.0	18.0	69.0	27.5	31.5	29.0	26.5	45.5	0.0	20.0	30.4
October	22.0	93.5	85.5	85.0	65.5	17.5	26.5	48.0	34.0	40.4	61.6	88.8	55.7
November	157.5	75.0	31.5	127.5	159.0	70.5	106.5	16.5	141.0	72.2	35.8	13.2	83.9
December	76.0	71.0	103.5	120.5	72.5	18.5	27.0	150.0	116.0	69.0	65.0	2.8	74.3
TOTAL	**977.5**	**834.0**	**672.5**	**785.0**	**933.5**	**715.0**	**843.0**	**627.7**	**1046.5**	**716.6**	**548.0**	**340.8**	**752.0**

Annual rainfall over the monitoring period has varied between 548mm in 2017 and 977.5mm in 2007, however is it noted that rainfall in 2018 was well below average.

Specific evaporation data is not available for the Quarry, however Average Annual Pan Evaporation mapping sourced from the Australian Bureau of Meteorology was used by Umwelt (2014b) in assessment of the groundwater setting for the EIS. Umwelt (2014b) adopted an annual evaporation level in the area of the Quarry of 1 500mm. It was further assumed that evaporation from dams such as the dredge pond and silt ponds at the Quarry was 0.7 times pan evaporation and therefore an evaporation level of 1 050mm has been assumed for the Quarry.

5.3 SURFACE WATER SETTING

The property on which the Quarry is located within the catchment of the Hawkesbury and Upper Nepean Rivers and is adjacent to the Greater Blue Mountains World Heritage Area, with Yengo National Park to the east and Wollemi National Park to the west of the active Quarry areas. The Quarry is located at the confluence of two second order ephemeral drainage lines in the upper reaches of the Tinda Creek Catchment. The *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources* applies to the operation.

The Quarry is in the floor of a small valley approximately 500m wide and at an elevation of approximately 330m AHD. The valley is bounded to the east by the Mellong Range (approximately 400m AHD) and by two unnamed ridges to the north (approximately 370m AHD) and south (approximately 380m AHD). The elevation at the western edge of the Quarry at the Putty Road is approximately 314m AHD.

The Quarry is located at the headwaters of Tinda Creek which is evidenced by the intermittent nature of flow in this location (only following heavy or prolonged rainfall). To the southeast of the active areas of the Quarry is an area comprising sedgelands that becomes swampy during prolonged rainfall. Drainage lines to the north of existing disturbed areas and to the west of the Quarry adjacent to Putty Road direct rainfall runoff towards Tinda Creek.

The first significant area of permanent pooled water in Tinda Creek is at Gibba Swamp, approximately 1.3km downstream of the Quarry. Flow from Tinda Creek, ultimately enters the Colo River approximately 15km west of the Quarry.

The results of surface water quality monitoring undertaken within the Quarry Site in 2017 are presented in **Table 7** to provide an indicative base line for surface water at the Quarry. However, it is acknowledged this is not representative of ephemeral drainage line conditions.

Table 7
Surface Water Monitoring – 3 August 2017

Parameter	ANZECC Trigger*	Dredge Pond	Fresh Water Pond
pH	6.5 – 8.0	6.25	5.16
Electrical Conductivity	30 - 350	89	87
Turbidity	2 - 25	15.0	5.1
* ANZECC (2000) guideline triggers are based on values for upland streams in NSW (see Table 3.3.2 and Table 3.3.3 of ANZECC (2000).			
Source: ALS Laboratories (2017)			

It is noted that the pH values recorded at the Quarry are below the ANZECC (2000) trigger for upland creek systems. However, runoff from sedgelands tends to have lower pH due to the presence of humic acid in the surface litter and the upper soil profile. This can result in pH values as low as 4.5 to 5.0 in surface runoff. Site-specific trigger values relevant to the intermittent and infrequent flow conditions in Tinda Creek and proximity to sedgelands will be developed over time. Trigger values will be reviewed on an annual basis based on ANZECC guidelines for upland streams in NSW and available water quality monitoring results for Tinda Creek.

5.4 GROUNDWATER SETTING

The Quarry is located in the Sydney Basin which generally consists of bedrock strata belonging to the Narrabeen Group (sandstone, mudstone, shale) overlain by Hawkesbury Sandstone with some basalt formations evident as mountains or plugs. In the vicinity of the Quarry the weathered sandstone layer is overlain by weathered clay and sand.

Geological investigations of the Quarry Site have identified the following material and depths (below ground level).

- Sandy clay to a depth of 23m.
- Yellow or white sandstone from a depth of 23m to 67m.
- Clay and more competent sandstone or quartzite from a depth of 69m to 90m.

The sandy clay that is currently being quarried occurs from ground level to a depth of between 18m to 23m. Extraction is limited to a depth of 15m below ground level to avoid the material with high clay content which overlays the weathered sandstone layer. The sandstone is regionally extensive and holds the regional groundwater resources.

A conceptual model of the hydrogeological setting was developed by Umwelt (2014b) and consisted of three layers including the clayey sand (to a depth of 20m to 30m) underlain by weathered Hawkesbury sandstone (to a depth of 40m to 60m) which is underlain by competent low permeability Hawkesbury Sandstone bedrock.

Hydraulic conductivities for the various layers were obtained by model calibration and are provided in **Table 8**.

Table 8
Range of Hydraulic Conductivities from Conceptual Model

Material	Hydraulic Conductivity (cm/s)
Clay	1×10^{-9} to 1×10^{-6}
Silt, sandy silts, clayey sands, till	1×10^{-6} to 1×10^{-4}
Silty sands, fine sands	1×10^{-5} to 1×10^{-3}
Source: Umwelt (2014b) after Fetter, 1980	

The conceptual model layers were assessed to have the following general properties.

- Clayey Sand Aquifer – Locally occurring deposit associated with the Tinda Creek Valley. Shallow and variable in nature and typically responsive to rainfall. The sandy aquifer is interlayered with thin low permeability layers which can act as an aquiclude or "low permeability aquifer", reducing the overall permeability of this layer. The clay content across the site varies from SE to NW increasing from 25-50% clay, respectively. At around 20m below ground (except where sandstone outcrops) the clayey layer occurs relatively uniformly across the Quarry Site (Stitt and Associates, 2010) and directly overlays the Hawkesbury sandstone.

- Hawkesbury Sandstone – Major aquifer for the Sydney region that comprises layered sedimentary units (sandstone, siltstone and mudstone). As a result of horizontal layering there is little vertical movement between layers. In the vicinity of the Quarry a band of clay shale may act as an aquitard between the upper weathered sandstone and more competent bedrock. On a regional scale groundwater recharge is likely to occur by direct infiltration of rainfall in outcrop areas, runoff in upland areas and minor inter-aquifer leakage. Groundwater flow direction generally mimics topography.

Figure 3 presents the Quarry Site layout with locations of existing private bores, production bores and groundwater monitoring bores. Data collected from drilling records and groundwater monitoring in these bores has been used to prepare three hydrogeological cross sections which are presented in **Figure 4**, **Figure 5** and **Figure 6.** The cross sections provide further conceptual information on the groundwater setting. Groundwater levels in bores installed in the upper sand and lower clayey sand unit varies due to artesian pressures near the creek in the vicinity of the western Quarry Site boundary (up to 9m below surface depending on the location of the monitoring points).

Figure 6 presents a deep transect through both the unconsolidated Clayey Sand Aquifer and the consolidated Hawkesbury Sandstone aquifer. It is observed that the potentiometric surface in the Hawkesbury Sandstone regional aquifer (as measured at GW11087 on bore installation) is significantly deeper compared to the shallow water table and is below the approved lowest level of the dredge pond at around 20m below surface. This difference of at least 10m in water levels indicates the hydraulic isolation of the dredge pond from the deeper regional groundwater system. The difference between water levels in the same cross section also shows separation between the deep consolidated and shallow unconsolidated layers. It is inferred that water located in the dredge pond that is currently used for dredging activities has limited connectivity with the underlying regional aquifer. This conclusion is based on the difference in between the water levels in the deep and shallow layers is likely to be caused by the difference in the hydraulic permeability of the surficial and deeper units and the fact that sandy clay is limiting the groundwater seepage to deeper units. The presence of a uniform clayey layer at approximately 20m below ground levels would also influence vertical groundwater flow (Stitt and Associates, 2010).

Two contour maps have also been prepared to demonstrate the inferred groundwater flow direction: one for the shallow sand and silty sand (**Figure 7**) and the other for the deeper clayey sand and clay (**Figure 8**). The direction of flow in the upper shallow silty sand unit generally follows the topography with the flow from the southeast and northeast to the west and northwest. In the deeper clayey sand unit the groundwater flow is influenced to a lesser extent by the topography with a flow from the upland area in the southeast generally to the north.

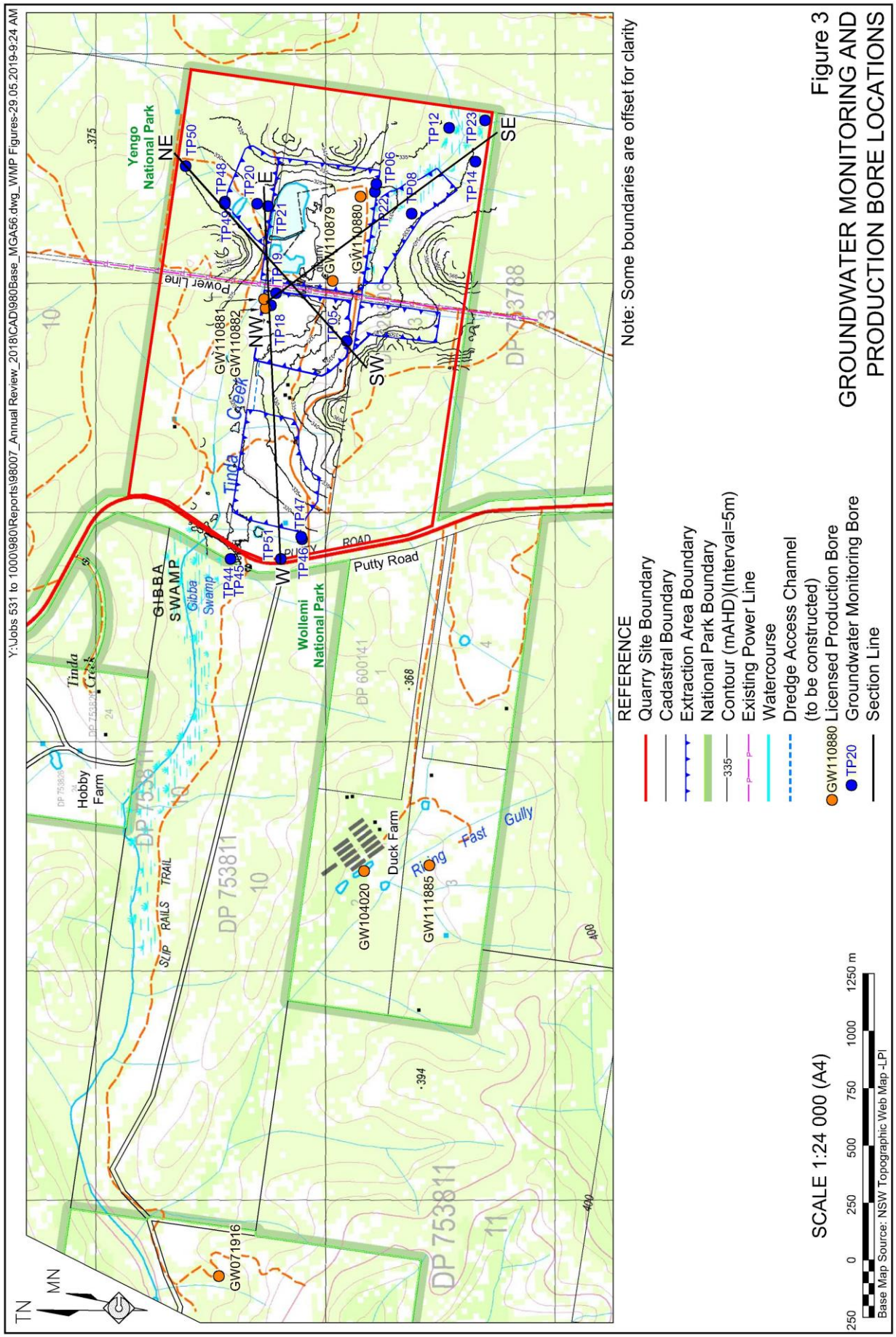

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Figure 3
GROUNDWATER MONITORING AND PRODUCTION BORE LOCATIONS
Note: Some boundaries are offset for clarity
REFERENCE
Quarry Site Boundary
Cadastral Boundary
Extraction Area Boundary
National Park Boundary
Contour (mAHD)(Interval=5m)
Existing Power Line
Watercourse
Dredge Access Channel (to be constructed)
GW110880 Licensed Production Bore
TP20 Groundwater Monitoring Bore
Section Line
SCALE 1:24 000 (A4)
250 0 250 500 750 1000 1250 m
Base Map Source: NSW Topographic Web Map -LPI
TN MN
Yengo National Park
Wollemi National Park
Tinda Creek
Gibba Swamp
Hobby Farm
Duck Farm
Putty Road
Power Line
Ring Fast Gully
SLIP RAILS TRAIL
DP 753811
DP 753788
DP 600141
NE
SE
NW
SW
TP50
TP48
TP20
TP21
TP19
TP18
TP05
TP06
TP08
TP12
TP14
TP22
TP23
TP47
TP46
TP51
TP44
TP45
GW110881
GW110882
GW110879
GW110880
GW104020
GW111885
GW071916

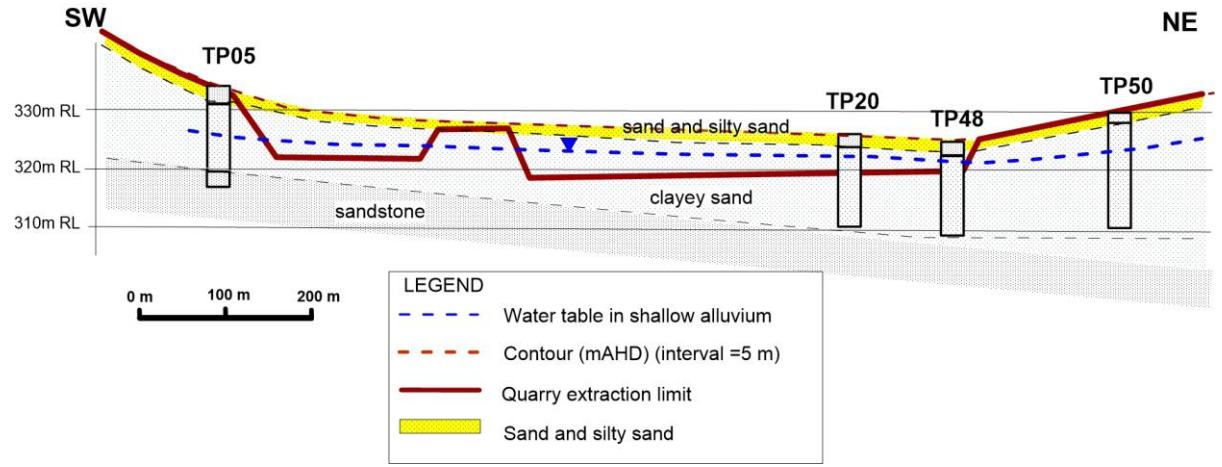


Figure 4
HYDROGEOLOGICAL CROSS SECTION (SW-NE)

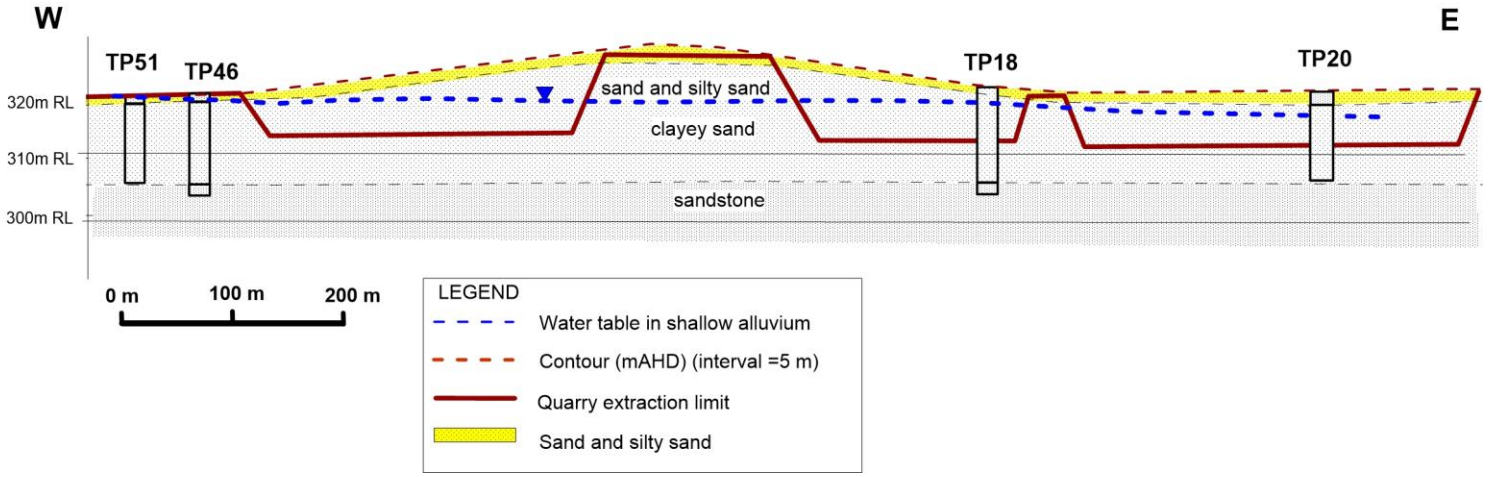


Figure 5
HYDROGEOLOGICAL CROSS SECTION (W-E)

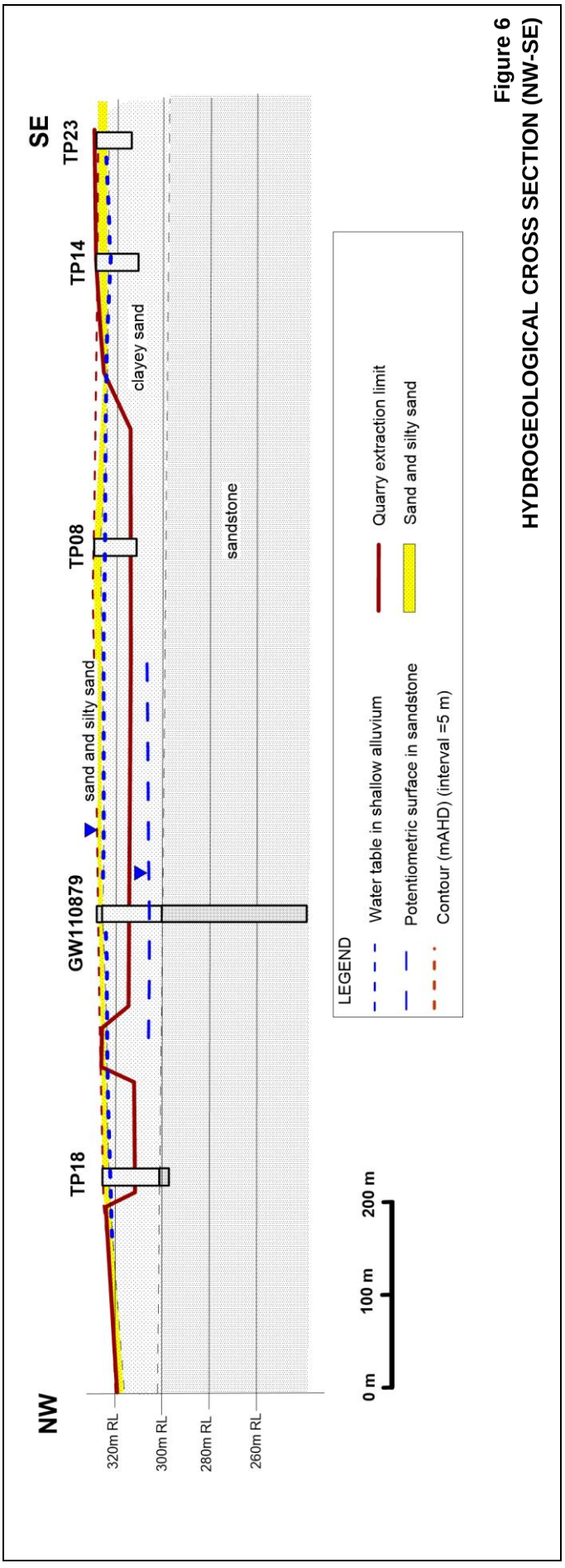


Figure 6
HYDROGEOLOGICAL CROSS SECTION (NW-SE)

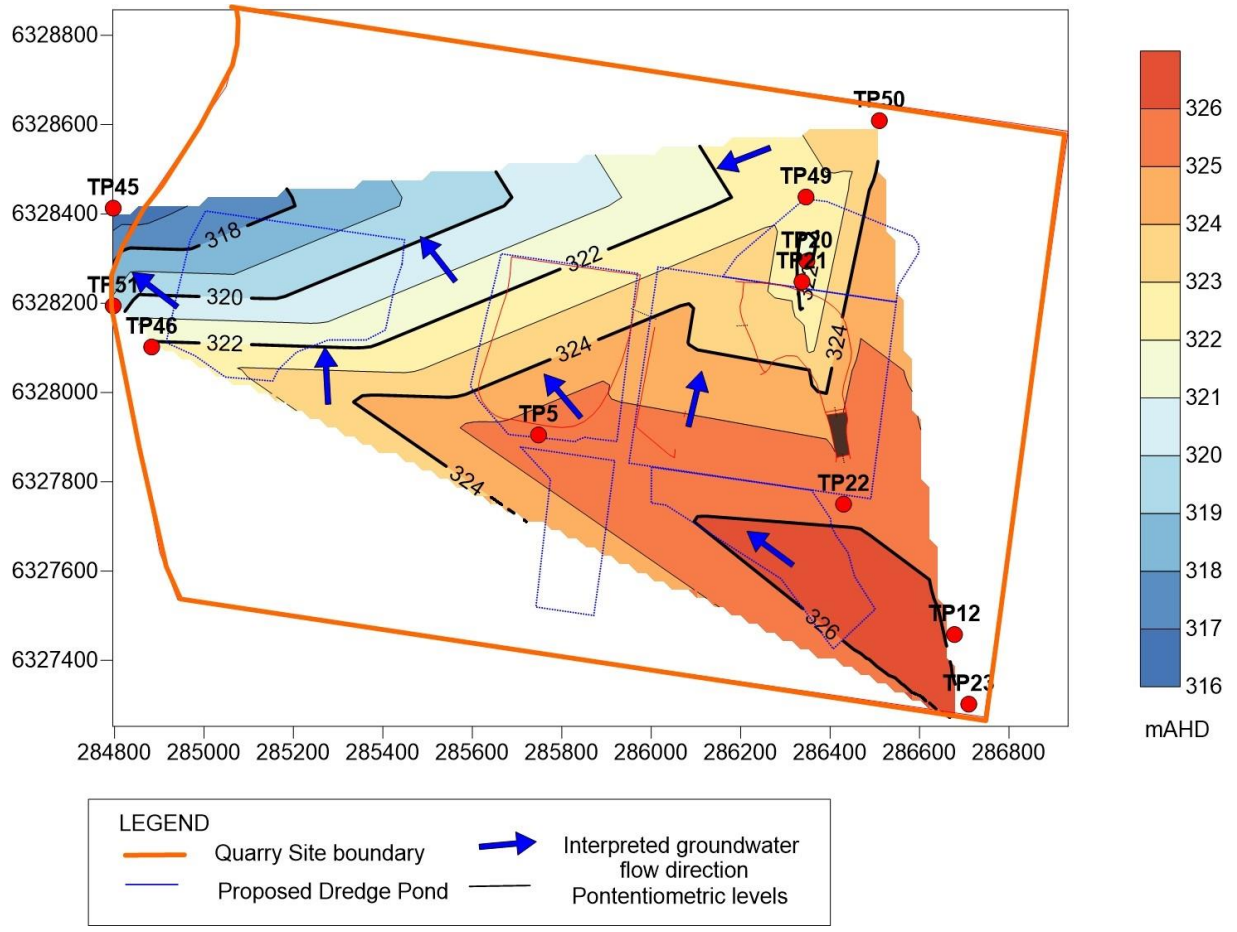


Figure 7
HYDROGEOLOGICAL CONTOUR PLAN – SHALLOW SAND AND SILTY SAND

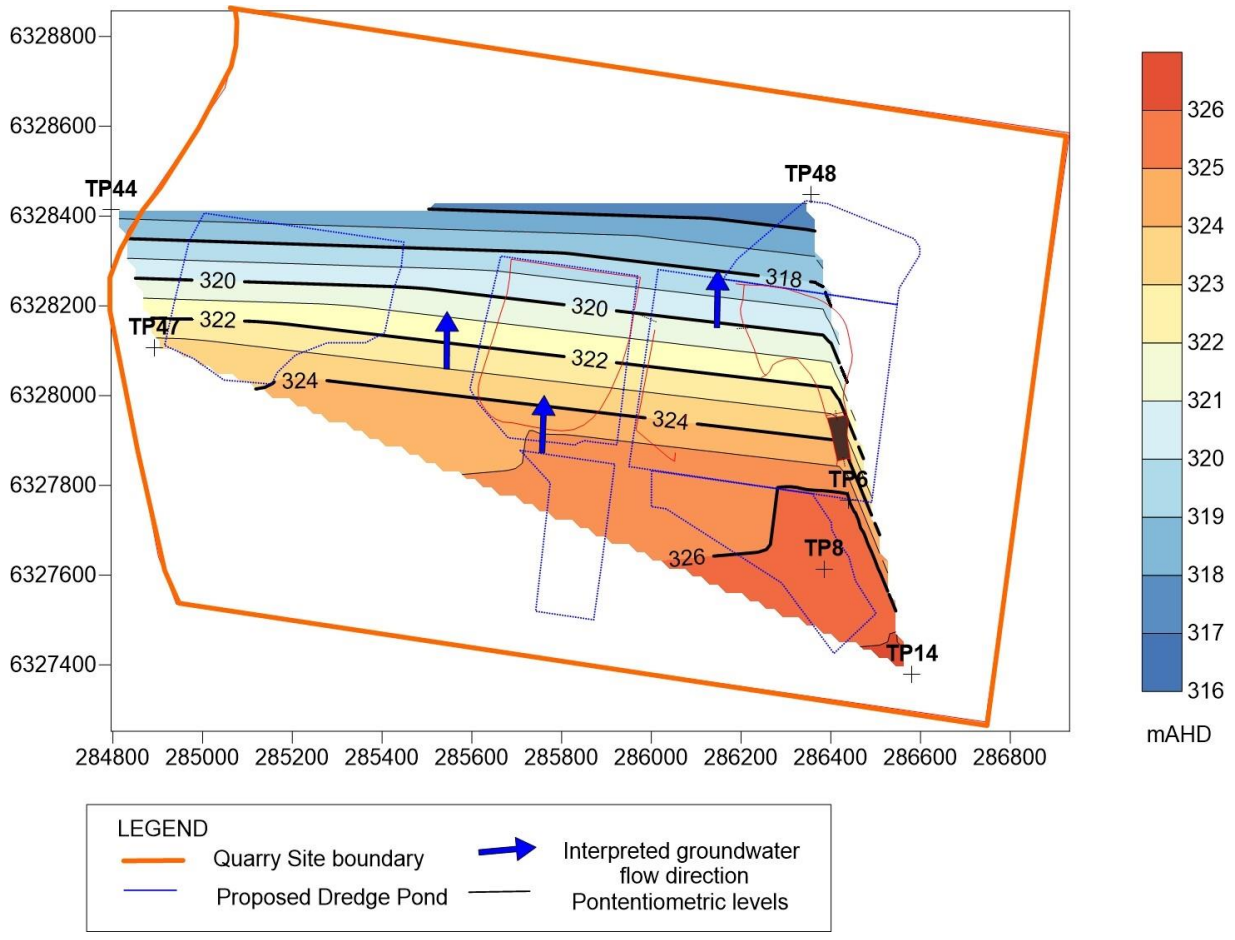


Figure 8
HYDROGEOLOGICAL CONTOUR PLAN – DEEPER CLAYEY SAND AND CLAY

5.5 REGIONAL GROUNDWATER BORE NETWORK

5.5.1 Registered Bores

There are seven registered groundwater bores in proximity to the Quarry. Four of these are registered as Quarry production bores (three of which have been removed for extraction activities). Three other bores are located to the west of the Putty Road. Available data on these bores is presented in **Table 9**. The locations of these bores are included in **Figure 3** which also presents the Quarry groundwater monitoring network. Bore GW071916 is located off Slip Rails Trail approximately 2.7km from the western extent of the Quarry. Bores GW104020 and GW111885 are located approximately 1.5km west of the Quarry on privately-owned land. Bores GW110882 and GW110881 have been removed as extraction in Domain 6 has progressed, while bore GW110880 was removed during extraction activities in Domain 4. It is planned to re-instate this bore in the imminent future and all relevant licences would be sought and confirm prior to reinstating its use.

Table 9
Registered Groundwater Bore Details

Bore Number	Location	Final Depth	Standing Water Level (at time of drilling)	Estimated Yield (L/s)
GW110882	Quarry	40	N/A	N/A
GW110881	Quarry	10	N/A	N/A
GW110879	Quarry	90	18	4
GW110880	Quarry	120	N/A	3.5
GW071916	Private	114.5	21	1
GW104020	Private	60	N/A	N/A
GW111885	Private	72	28	2.5

The available drilling records indicate that the regional groundwater table is between 18m and 28m below ground level. Only bores GW110879 and GW110880 located at the Quarry and drilled to depths of 90m and 120m, respectively, have reasonable groundwater yields. Bore GW110881 (now removed) was drilled to a depth of 10m into the sandy clay layer and had no reported groundwater yield. This is consistent with the observed low permeability of the shallow aquifer.

Groundwater bores GW071916, GW104020 and GW111885 are on private land and are in a different catchment to the quarry operations. These bores are located in the underlying regional aquifer and are physically separated from the shallow alluvium that is extracted at the Quarry by an intervening sandstone ridge.

Due to the limited possibility that operations would impact water levels in these bores, they are not included in the monitoring network.

5.5.2 Quarry Groundwater Monitoring Network

Figure 3 displays the groundwater monitoring network within the Quarry Site.

Groundwater level and quality monitoring has occurred at 11 bores since October 2010 (bores TP05, TP06, TP08, TP12, TP14, TP18, TP19, TP20, TP21, TP22, TP23).

Monitoring has also commenced in a further five bores located to the west of the Quarry (TP44, TP45, TP46, TP47, and TP51) and three bores in the vicinity of Domain 3 (TP49, TP48 and TP50). Manual monitoring of these bores, including water quality samples, commenced in March 2018.

From July and December 2017, data loggers were placed in all bores and this data is compared to manually collected water level data. The data loggers take a reading of water levels every four hours. Automatic monitoring of the more recently constructed bores also commenced from 2017.

Samples for testing water quality are taken every six months.

5.5.3 Groundwater Levels in World Heritage Area and adjoining Private Land

It is noted that extraction operations would not intercept the underlying Hawkesbury sandstone regional aquifer. Therefore, it is unlikely that groundwater levels in neighbouring bores would be impacted by Quarry operations.

A groundwater assessment for the extension project was prepared by Umwelt (2014b). Modelling assessment predicted that the development of the Quarry may reduce groundwater levels by up to approximately 1m at the boundaries of the adjoining World Heritage Area to the northwest of the Quarry at Tinda Creek, to the southeast and the northeast of the Quarry. However, this impact would be confined to the shallow sandy clay layer and localised to small sections off the Greater Blue Mountains World Heritage Area. However, groundwater monitoring in bores to the west of Domain 1 would also be used to trigger investigations of potential impacts to water levels in privately-owned bores to the west of the Putty Road.

Subsequently, it is considered unnecessary to construct monitoring bores within the Greater Blue Mountains World Heritage Area as information relating to groundwater level changes can be recorded on-site. Monitoring bores to the west of Domain 1 would provide an indication of changes to water levels to the west of operating areas and would provide the necessary triggers for investigations of potential impacts in this location. Bores TP44, TP45, TP46 and TP47 are nested at locations approximately 25m and 50m to the west of boundary of Domain 1These nested bores will enable the relationship between groundwater levels in these bores at the western edge of the Quarry to be monitored and recorded over the life of the Quarry. Bore TP 51 has been established on the western side of a drainage line that is located to the west of Domain 1.

5.6 GROUNDWATER USE

Groundwater use is monitored monthly using a meter on the production bore. Recording of groundwater use commenced in September 2015 with records presented in **Table 10**. Significant dry conditions experienced in 2018 (see rainfall records in **Table 6**) have required a much greater reliance on groundwater to maintain the operating depth in the dredge pond over that year.

Table 10
Annual Groundwater Use (2015 to 2018)

Year	Meter Reading (L) (December)	Water Use (ML)
2015/16*	4 014 (Sept to June only)	0.55
2016/17	4 766	0.75
2017/18	17 060	12.3
* Part Year		

5.7 BASELINE GROUNDWATER LEVELS

Groundwater levels within the monitoring network are recorded manually each month and presented in *Annual Review* reporting. As noted previously, monitoring at eleven bores has occurred since 2010 with monitoring within a further eight bores commencing in March 2018.

A summary of the recorded data is presented in **Table 11** and a chart of historic manually collected groundwater level data for the long-term and more recent monitoring is presented in as **Appendix 1**. Manual monitoring is cross-checked with records from data loggers placed within each of the bores.

Table 11
Baseline Groundwater Level Monitoring Summary

Bore	Drilled Depth (m)	No of Records and Period	Standing Water Level (metres below ground level)		
			Max	Average	Minimum
TP22	12	96 (2010-2018)	4.85	2.08	0.72
TP06	18	95 (2010-2018)	6.33	3.36	1.28
TP12	15	96 (2010-2018)	6.80	3.47	0.89
TP23	15	96 (2010-2018)	6.91	3.26	0.71
TP14	20	96 (2010-2018)	8.81	5.61	1.35
TP08	18	96 (2010-2018)	6.62	4.39	2.48
TP05	15	97 (2010-2018)	8.45	6.74	1.00
TP18*	18	55 (2010-2015)	3.62	1.28	0.12
TP19*	12	53 (2010-2015)	4.95	1.92	0.29
TP20	12	97 (2010-2018)	6.33	3.44	0.71
TP21	12	97 (2010-2018)	6.22	3.38	1.02
TP44	18.5	11 (2018)	2.18	1.86	1.57
TP45	9	11 (2018)	2.41	2.08	1.77
TP46	20	11 (2018)	0.72	0.37	0.02
TP47	12	11 (2018)	-0.22#	-0.82#	-1.12#
TP48	18	11 (2018)	4.89	4.58	4.16
TP49	10	11 (2018)	4.86	4.55	4.13
TP50	20	11 (2018)	6.73	6.30	5.77
TP51	16	11 (2018)	1.53	1.13	0.77

* Bore removed by extraction.
# Negative values indicate water level above ground level

Baseline groundwater monitoring presented in **Table 11** indicates that groundwater levels vary across the Quarry. Water levels in some of the new bores has been recorded above ground level (within an extended stand pipe) and represents artesian conditions in these locations. Only one bore continues to have a potentiometric level above ground level. These bores are located in areas to the west of the Quarry. These conditions will be monitored carefully once extraction commences in Domain 1 (the most western domain).

5.8 BASELINE GROUNDWATER QUALITY

Groundwater quality has been monitored on a six-monthly basis since October 2010. Water quality parameters that are currently being monitored and will continue to be monitored include pH, Conductivity, Nitrate, Ammonia and TPH (now Total Recoverable Hydrocarbon – Silica).

A summary of historic groundwater monitoring data is presented in **Table 12**.

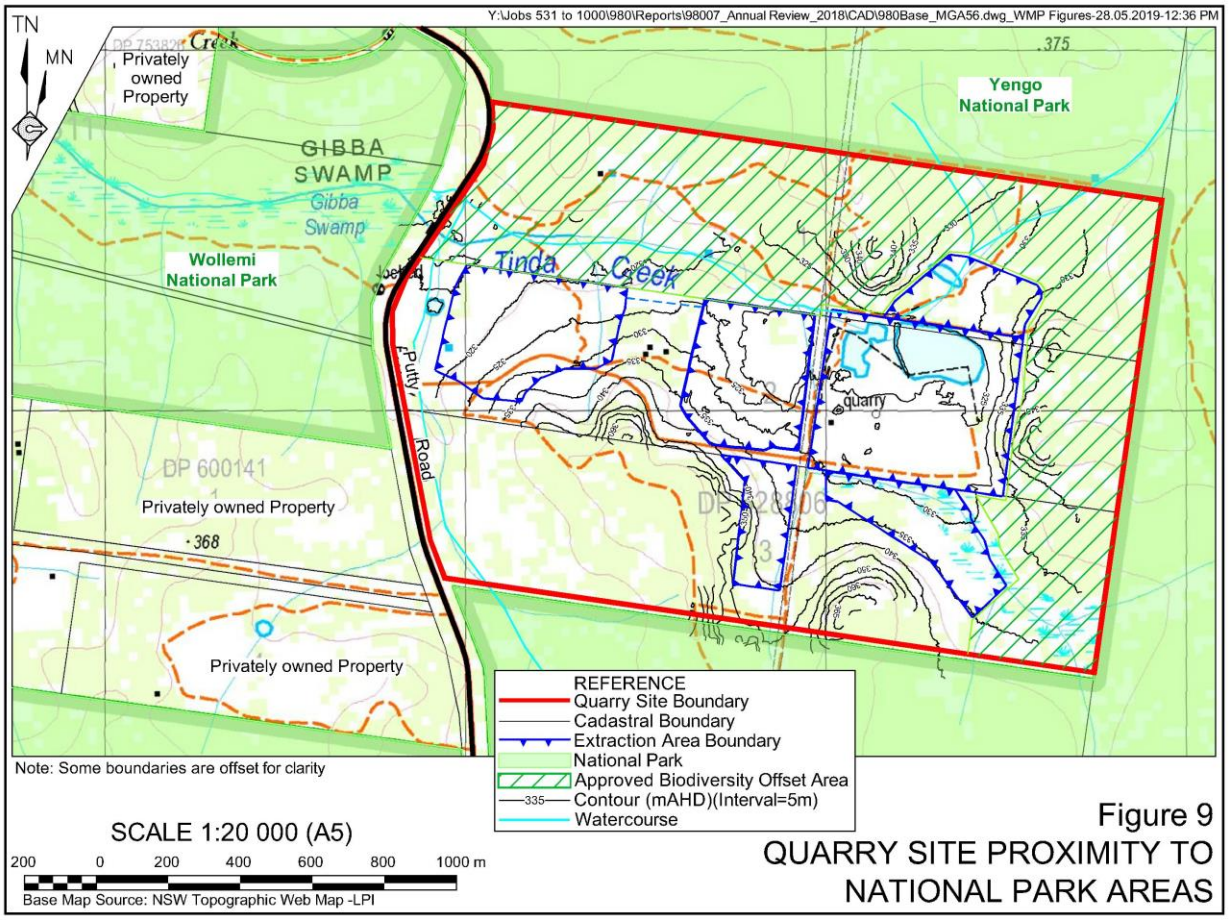
Table 12
Groundwater Quality Trigger Criteria

Analyte	Historic Minimum Monitored Value	Historic Maximum Monitored Value
pH	4.5	6.7
Conductivity (µS/cm)	45	1320
Nitrate (mg/L)	<0.10	9.30
Ammonia (mg/L)	<0.10	0.40
TPH (C6-C9) (mg/L)	<0.01	0.05
TPH (C10-C14) (mg/L)	<0.05	0.15
TPH (C15-C28) (mg/L)	<0.10	6.43
TPH (C29-C36) (mg/L)	<0.05	0.87

6. POTENTIAL IMPACTS AND RISKS

6.1 SURFACE WATER QUALITY AND QUANTITY

Figure 9 demonstrates the proximity of the Quarry to the Greater Blue Mountains World Heritage Area that includes Wollemi National Park and Yengo National Park. Potential impacts to water quality and water quantity entering the Greater Blue Mountains World Heritage Area has been recognised during assessment of the extension of the Quarry and through the operation being determined a controlled action under the EPBC Act.



The Quarry operations are not predicted to change water flow or increase the sediment load to areas where the threatened plant *Grevillia parviflora* have been identified. An annual ecological monitoring program will report on the condition of this vegetation in accordance with an approved Landscape Management Plan.

The Quarry Site lies within the catchment of Tinda Creek that flows to the west towards Wollemi National Park. Due to the local topography, it is unlikely that water would flow towards the east into Yengo National Park or to the north or south. Within the Quarry Site, Tinda Creek is an ephemeral drainage line that is mostly dry, only flowing during periods of heavy or prolonged rainfall. However, it is acknowledged that during high rainfall events that are greater than the 1 in a 100 year storm, sediment-laden runoff may flow from surrounding areas and in extreme cases from the Quarry Site towards Wollemi National Park and potentially impact water quality in this area.

In addition, the development of the Quarry will modify the catchment area and will therefore change the volume of water that flows towards Wollemi National Park. The approved Quarry layout (**Figure 2**) includes several clean water diversions that would be constructed progressively as extraction proceeds to maximise the diversion of clean water to Tinda Creek and reduce the potential for sediment-laden water to leave the closed water system.

It is also noted that due to the sandy and erodible nature of the catchment upslope of Quarry operations, rainfall runoff that has not entered the disturbed areas of the Quarry Site and is therefore considered 'clean' is likely to contain sediment that would flow to Tinda Creek under natural circumstances. This would not represent an impact from Quarry operations but is an entirely natural process. However, diversion of clean water flow may cause this sediment to build up in diversion drainage, reducing the volume of flow to Tinda Creek hence the monitoring and management measures proposed in Section 8 and Section 9.

6.2 GROUNDWATER QUALITY AND QUANTITY

A groundwater assessment prepared by Umwelt (Australia) (2014b) for the Environmental Impact Assessment assessed the potential impacts of the Quarry operations to groundwater quality and quantity in accordance with the Aquifer Interference Policy. The assessment reported the following conclusions.

- Operations would not result in a reduction in the groundwater level of more than 2m at any water supply works or more than 10% cumulative variation within 40m of any high priority Groundwater Dependent Ecosystem.
- Groundwater quality is highly unlikely to be impacted by operations.

It is noted that extraction is limited to 15m below ground level and would be unlikely to intersect the broader regional groundwater table.

Extraction operations will intersect groundwater within the shallow sandy clay layer that is the target for extraction. This layer is predicted to have little interaction with the regional aquifer. However, the potential to influence groundwater availability and quality in the immediate vicinity of the active dredge pond (within 100m) exists and a groundwater monitoring program (Section 10) is proposed to monitor groundwater levels and groundwater quality over the life of the Quarry.

It is noted that changes to groundwater availability within the Quarry Site may influence the condition of threatened plant, *Grevillia parviflora.* As described in Section 6.1, an annual ecological monitoring program will report on the condition of this vegetation within the Quarry Site.

7. SITE WATER BALANCE

7.1 WATER SUPPLY

The Quarry has been designed to divert clean water around disturbed areas and towards Tinda Creek, with all runoff from within the closed water management system directed to the silt ponds and active dredge pond. As a result, the Quarry does not capture water from outside of the catchment area of the closed management system and is not required to hold a surface water access licence.

Hy-Tec holds three groundwater access licences with a total allocation of 115 share components (currently 115ML/year) for use in Quarry operations (see Section 3.5). This includes a recent allocation of 60 share components purchased through a controlled allocation order. This additional 60ML share allocation would commence from 1 July 2019. It is also noted that a maximum water allocation of 0.1 ML/unit share may be carried over from one water year to the next water year if a water meter is installed on each water supply work. An additional allocation has also been sought under a recent controlled allocation order. Historically groundwater has been used at the Quarry to top up dredge pond levels during prolonged dry periods. This water is drawn from the deep regional aquifer that lies within the underlying sandstone and is effectively added to the dredge pond from where it may enter the shallow alluvium (shallow sandy clay layer that is being extracted).

The dredge pond is generally maintained with a water level of 5m to 6m and has historically resulted in negligible impacts on the surrounding shallow groundwater aquifer and groundwater dependent ecosystems such as the sedgelands that adjoin the existing quarry to the south and north. The sandy clay that is being extracted has a relatively low permeability which is supported by the limited observed zone of influence of drawdown around the dredge pond.

On this basis, Quarry operations are unlikely to have a significant impact on the surrounding shallow groundwater aquifer during dry periods.

7.2 WATER USE AND MANAGEMENT

SSD 4978 approves an extension of the Quarry and includes a limit to annual production of 300 000tpa and development of the closed water management system of no greater than 40ha at any one time. Annual water use will vary dependent on prevailing conditions. Water use and management principally relies on maintaining a functional water level in the dredge pond (approximately 5m to 6m) while reducing reliance on top up water from the production bore. As a result, the site water balance is assessed based on water required to maintain the water level in the dredge pond.

Umwelt (Australia) Pty Ltd developed a water balance for the period from 1964 to 1992 and 2002 to 2014 that incorporated rainfall records from the following meteorological stations.

- Putty Tea Rooms 1964 to 1974 inclusive
- Putty Valley Road 1986 to 1992 and 2002 to 2006 inclusive
- Tinda Creek Quarry 2007 to 2015 inclusive.

Average annual rainfall for the available period of record (1964 to 2014) was 772 mm/year. Highest rainfall recorded for the period was 1178 mm in 1964 and lowest was 426 mm in 1966.

The groundwater setting in the vicinity of the Quarry consists of the following three layers.

- Shallow sandy clay layer associated with the Tinda Creek valley that exhibits low permeability and is the target for sand extraction.
- Weathered regional scale Hawkesbury sandstone that exhibits a higher permeability and is the regional groundwater source.
- Competent Hawkesbury sandstone that exhibits low permeability through secondary porosity and fracture flow.

The permeability of the sandy clay material is estimated to be in the order of 10^{-6}cm/s to 10^{-4}cm/s with this characteristic supported by observations of minimal seepage in dredge pond walls and the fact the walls of the dredge pond show no signs of slumping and readily sustain a batter well in excess of the angle of repose of the sandy clay material that forms the walls of the dredge pond. Groundwater inflow to the dredge pond is estimated to be less than 0.75m^3/day or less than 300kL/year. In addition, assessment of the zone of influence in the vicinity of the dredge pond indicates that the zone of influence is small (typically 50m and less than 100m). As a result, it is concluded that the groundwater inflow into the dredge pond is negligible with water from the dredge pond more likely to enter the underlying regional aquifer even during prolonged dry periods than to make a significant or measurable contribution to water volumes within the dredge pond.

Monitoring records indicate that the groundwater level in the regional sandstone aquifer is in excess of 18m below ground level. Extraction activities have been subsequently limited to a depth of 15m and therefore the regional sandstone aquifer would not be intercepted by extraction. As a result, it is anticipated that regional fluctuations in groundwater levels would not influence the water levels in the dredge pond.

For the purpose of the site water balance, it has been assumed that, groundwater inflow into and seepage from the void would have negligible impact on water levels in the dredge pond.

Hy-Tec has sealed the Quarry Access Road, subsequently removing the need to use water for dust suppression along this road (estimated to have been reduced by 10ML/year).

7.3 DREDGE POND INFLOWS

Assumptions of limited groundwater inflow to the dredge pond is supported by the following observations and assessment.

- Little observed seepage from the walls of the dredge pond.
- Limited slumping of batters in the vicinity of the dredge ponds.
- Low hydraulic conductivity of the shallow sandy clay layer that is the target for extraction.
- Records of no groundwater yield from bore GW110881 that was drilled to a depth of 10m (i.e. within the sandy clay layer).

In addition, the dredge pond is maintained above the regional groundwater level which is at depths below approximately 18m.

Umwelt (2016) undertook a preliminary assessment of the relationship between recorded groundwater levels at monitoring bores TP22, TP06, TP08, TP12, TP14 and TP23 (see **Table 11**) and proximal to the dredge pond. These bores have been deliberately constructed as pairs to assist with any future investigations.

Predicted or modelled groundwater levels were estimated using a derivation of Darcy's Law that is provided below as Equation 1.

$Q = \pi * K * (H_2^2 - H_1^2)/(\ln(r_2/r_1))$ where: **(Equation 1)**

Q = groundwater inflow (m^3/s)

$\pi = 3.1417$

K is hydraulic conductivity of the upper aquifer (K= 0.5 * e^{-8} m/s in groundwater model)

H_2 is groundwater elevation at distance r_1 from the dredge pond

H_2 is groundwater elevation at distance r_2 from the dredge pond

Hydraulic conductivity of the shallow sandy clay alluvium used in the groundwater model developed for the project (Umwelt 2014b) was $5x10^{-8}$ m/s. Umwelt (2016) reviewed available data for a dry period (December 2014) when evapotranspiration was high and only 505 mm of rainfall had been received in the previous 12 months and for a wet period (August 2015) when evapotranspiration was low and 946 mm had been received in the previous 12 months. Model predictions were checked against monitoring results to determine the validity of modelling results for the local setting.

The results are presented in **Figure 10** and demonstrate the following.

- The modelled and predicted groundwater levels match closely for the dates assessed, validating this approach for assessment of groundwater levels in surrounding sensitive areas.
- This assessment also validates the parameters assumed for the groundwater setting.
- This assessment is valid to a distance in excess of approximately 550m from the dredge pond. The Greater Blue Mountains World Heritage Areas are within 550m of the limits of the extraction area and therefore may be assessed using this method
- Drawdown due to the proximity to the dredge pond (i.e. the steeper section of the groundwater gradient) is confined to approximately 100m from the dredge pond.

On this basis, Umwelt (2016) also estimated that groundwater inflow would be less than 300kL/year which is a negligible volume for the purpose of the water balance assessment.

Once two years of data is available from the more recently installed bores (TP44, TP45, TP46, TP47, TP51 TP49, TP48 and TP50), this assessment will be repeated to incorporate the broader records of groundwater level for the site and a more accurate estimate of hydraulic conductivity. It is expected that this assessment will be completed in late 2019 or early 2020.

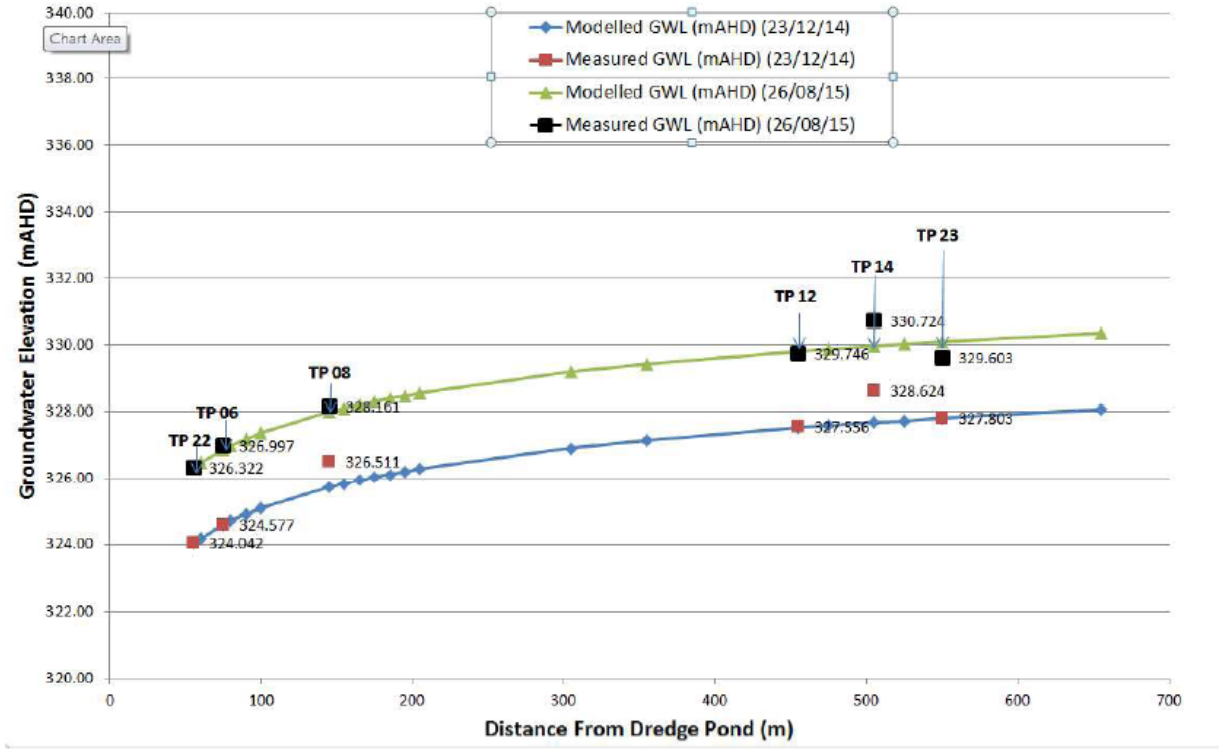


Figure 10
COMPARISON OF GROUNDWATER LEVEL MODELLING AND RECORDED LEVELS

7.4 WATER BALANCE ASSESSMENT

Water balance parameters at maximum development are as follows:

- Water management system catchment – 40ha
- Starting dredge pond volume – 400ML
- Void depth – 15m
- Dredge pond operating water depth – ~ 6m
- Dredge pond side batters – 2H:1V
- Starting dredge pond water surface area – 9.8ha
- Annual production – 300,000tpa
- Evaporation from pond surface – 1 050mm/yr
- Moisture in product – 4.5%
- Haul road (sealed) dust suppression – 0 ML/yr.

The predicted water balance for the expanded operations using rainfall for the period 1964 to 1992 and 2002 to 2014 is provided in **Table 13**. Modelled average annual runoff ranged from 20% of rainfall in dry years (400 mm/year) to 60% during wet years (900 mm/year). It is noted that this water balance was prepared in 2016 and therefore assesses the water balance against the water share component available to the Quarry at that time (55ML). From 1 July 2019, the total share allocation would be 115ML.

Table 13
Water Balance – Tinda Creek Quarry

Year	Annual Rainfall (mm)	Annual Runoff (ML)	Evaporation (ML)	Dust Suppression (ML)	Water Lost in Product (ML)	Annual Water Make (ML)	Void Volume (ML)	Pond Depth (m)	Pond Depth with 55ML GW (m)
1964	1178.3	387.7	115.5	0	13.5	258.7	758.7	8.91	9.50
1965	796.2	164.6	94.6	0	13.5	56.6	815.3	9.52	10.11
1966	426.5	37.7	96.0	0	13.5	-71.8	743.5	8.74	9.34
1967	551.2	70.8	94.2	0	13.5	-36.9	706.6	8.34	8.94
1968	722.9	132.5	93.2	0	13.5	25.8	732.5	8.62	9.22
1969	702.5	124.2	93.9	0	13.5	16.8	749.3	8.80	9.40
1970	940.1	237.7	94.3	0	13.5	129.9	879.2	10.21	10.80
1971	615.4	91.7	97.7	0	13.5	-19.5	859.6	10.00	10.59
1972	730.9	135.9	97.2	0	13.5	25.2	884.8	10.27	10.86
1973	832.7	181.9	97.8	0	13.5	70.6	955.4	11.03	11.61
1974	965.9	252.2	99.7	0	13.5	139.0	1094.4	12.51	13.09
1986	701.4	123.8	103.3	0	13.5	6.9	506.9	6.13	6.74
1987	648.6	103.5	88.0	0	13.5	2.0	509.0	6.15	6.77
1988	768.9	152.3	88.0	0	13.5	50.7	559.7	6.72	7.33
1989	1104.4	337.3	89.4	0	13.5	234.4	794.1	9.29	9.89
1990	872.8	201.9	95.5	0	13.5	92.9	887.0	10.29	10.88
1991	1039.2	295.7	97.9	0	13.5	184.3	1071.3	12.26	12.84
1992	543.2	68.3	102.7	0	13.5	-47.9	1023.5	11.75	12.34
2002	762.1	149.3	101.5	0	13.5	34.3	534.3	6.44	7.05
2003	643.1	101.5	88.7	0	13.5	-0.7	533.6	6.43	7.04
2004	514.7	60.1	88.7	0	13.5	-42.1	491.5	5.96	6.57
2005	673.3	112.7	87.6	0	13.5	11.7	503.2	6.09	6.70
2006	667.0	110.3	87.9	0	13.5	9.0	512.1	6.19	6.80
2007	977.5	258.8	88.1	0	13.5	157.2	669.4	7.93	8.53
2008	834.0	182.5	92.2	0	13.5	76.8	746.2	8.77	9.37
2009	672.5	112.4	94.2	0	13.5	4.7	750.9	8.82	9.42
2010	785.0	159.5	43.3	0	13.5	51.7	802.6	9.38	9.98
2011	933.5	234.0	95.7	0	13.5	124.9	927.4	10.73	11.32
2012	715.0	129.3	99.0	0	13.5	16.8	644.2	10.91	11.50
2013	844.0	187.4	99.4	0	13.5	74.5	1018.8	11.70	12.29
2014	627.7	96.0	101.3	0	13.5	-18.9	99.9	11.50	12.09

Source: Umwelt (2016)

Annual water make from this review would vary from year to year but remain within predictions of loss of water from the system (in dry years). During dry periods water supply would rely on licenced groundwater access (as has been experienced throughout 2018).

It should be noted that the modelled data presented in **Table 13** represents operations at maximum production and therefore the predicted water levels in the dredge pond would be expected to vary, but remain generally lower than these predictions, over the life of the Quarry dependant on extraction intensity.

The modelled water balance demonstrates that for most modelled years (all years except 2004), at an assumed maximum production level, sufficient water was available to maintain a water level of approximately 6m in the dredge pond, without the need to top up the water level using the available groundwater use allocation (now 115ML/year). The ongoing operations of the Quarry are therefore expected to continue to be managed in a manner that limits potential impacts to water availability in the surrounding area including the Greater Blue Mountains World Heritage Area.

7.5 MEASURES TO MINIMISE CLEAN WATER USE ON-SITE

Where feasible, Hy-Tec will source water for on-site activities from the dredge pond (excluding potable use in the workshop and offices). The existing water allocation may be required for dust suppression however, as the Quarry Access Road is sealed, this is expected to be required only occasionally and require negligible volumes of water.

The existing groundwater entitlement may also be required to supplement water in the dredge pond to maintain the operational water level at approximately 5m to 6m. This is only expected during prolonged dry periods.

8. SURFACE WATER MANAGEMENT PLAN

8.1 INTRODUCTION

Surface water management at the Quarry will principally involve the following components.

- Progressive development of clean water diversions in advance of the preparation and extraction of domain areas to divert clean water away from disturbed areas of the Quarry Site and preferentially towards Tinda Creek.
- The continued operation of a closed water system that has been successfully implemented throughout historic operations. The closed water system will have a limited catchment area and will continue to be designed to recycle water between operation of the dredge (extraction) and processing operations.
- Proactive implementation of erosion and sediment controls including, but not limited to hay bales, sediment fencing and rock-lined drains to limit the potential for sediment-laden water to enter Tinda Creek.

There are no water storage structures planned to be constructed outside of the closed water system.

8.2 CLEAN WATER DIVERSIONS

8.2.1 Diversion Design Objectives

The design and construction of diversions and drains will be undertaken to satisfy the following objectives.

- Diversions will be constructed with 1:3 (V:H) batters or shallower.
- Diversions will be vegetated with grass and riparian species to achieve a stable vegetative cover within three months of commencement of construction of each section of the diversion drain. Revegetation may be delayed if conditions are unfavourable to the growth of the grass and riparian species in which case additional flow management and sediment controls such as check dams, geofabric beds and silt fences will be placed in the drains to manage potential sediment movement and enable the diversions to be utilised while meeting the requirements of the Water Management Plan.
- Impacts to vegetation from native herbivores or pest species will be rectified as soon as practically possible and no later than three months after the issue is identified, subject to reasonable planting conditions.
- All diversion drains will be constructed to convey runoff from a 1 in 100 year Average Recurrence Interval event.
- The diversion drains will also be constructed to be free draining to ensure minimal change in flows in the Tinda Creek system and to the downstream Greater Blue Mountains World Heritage Area.

- Flow and sediment controls such as check dams and silt fences will be placed in the drains to assist in the establishment of a stable vegetative cover within the drain and to enable drains to convey upslope runoff from the time they are constructed.

8.2.2 Existing and Proposed Diversions

The location of existing and proposed clean water diversions are displayed in **Figure 11**. The location of clean water diversions will be modified during the progressive development of the Quarry as the extraction domains are developed. The locations of diversions at any one point in time will reflect the requirements of the active extraction domain and Hy-Tec's objective to divert clean water towards Tinda Creek.

Existing diversions have been constructed to ensure that clean water is diverted around Domain 4 (former extraction area) and around the currently active extraction activities in Domain 6. The diversions typically have a trapezoidal cross-section with a base width of two to three metres and 1:3 (Vertical:Horizontal) side batters. The drains are typically 1 to 1.5 m deep.

The location of proposed diversions will be generally consistent with those displayed in **Figure 11**. However, additional interim diversions may be constructed to temporarily divert runoff around active areas.

All new diversions will be constructed and vegetation planted/seeded with the aim that it would have established prior to development of the extraction domain downslope of the diversion. However, vegetation establishment may be delayed until conditions are suitable for growth. In these cases, Hy-Tec will utilise silt traps, hay bales, geofabric and other techniques, as needed to ensure the proper function of the diversion. In addition, all diversions will be maintained until extraction has ceased in the downslope extraction domain and a suitable cover of vegetation has been established in that area to limit sediment movement. All diversions would be removed prior to Quarry closure unless their retention is approved in a Quarry Closure Plan.

Dispersive soils have not been identified within the Quarry Site. However, if dispersive soils are encountered within disturbed areas they will be treated in-situ with gypsum or lime, if possible. If they need to be excavated, gypsum or lime will be added and the treated material will be stockpiled away from overland flow paths and drainage lines. Dispersive soils will not be used in the construction of roads or bunds.

8.3 CLOSED WATER MANAGEMENT SYSTEM

All runoff within the disturbed areas of the Quarry Site is considered as being sediment-laden and will drain to the dredge pond or silt ponds that form part of the closed water system. By operating the Quarry Site as a closed system, Hy-Tec will limit potential impacts to downstream aquatic and terrestrial ecosystems within the Greater Blue Mountains World Heritage Area.

Figure 12 presents a schematic of the closed water system at the Quarry Site that has been based on the system presented in the EIS for the Quarry (Umwelt, 2014a) and updated to incorporate active areas in Domain 6. The closed water system would be progressively.

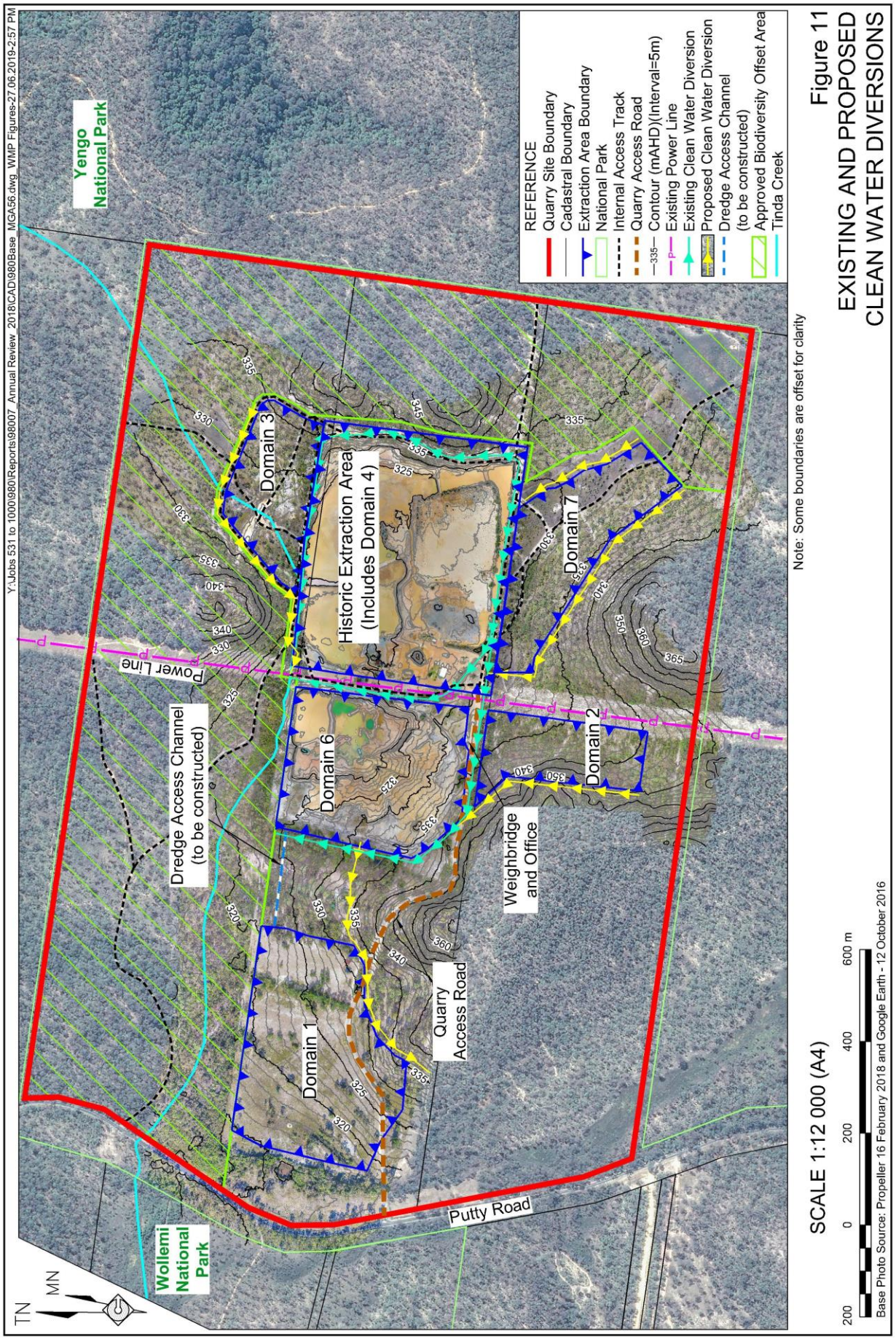


Figure 11
EXISTING AND PROPOSED CLEAN WATER DIVERSIONS

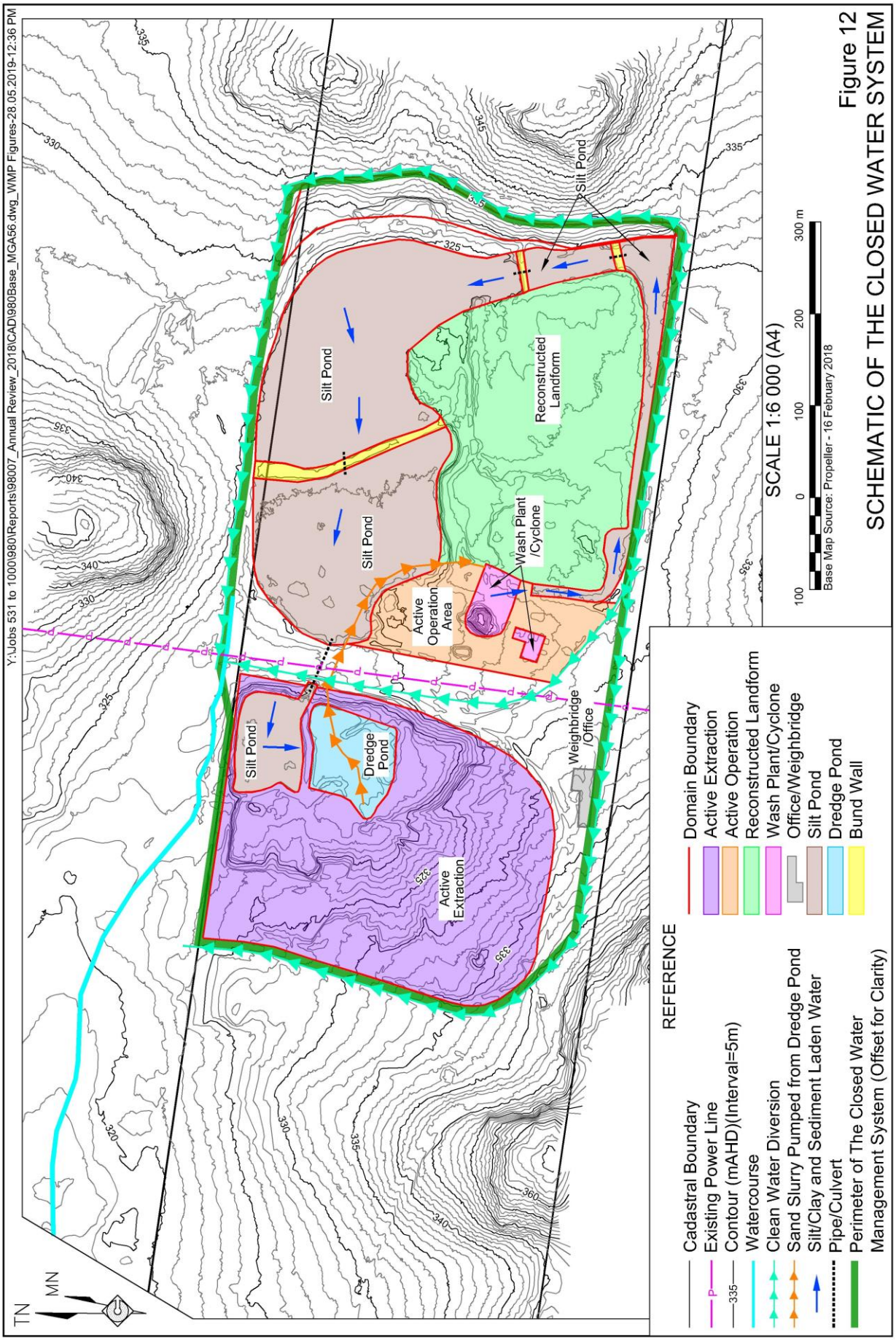


Figure 12
SCHEMATIC OF THE CLOSED WATER SYSTEM

developed as extraction domains are developed and former extraction domains are completed. Hy-Tec will progressively reconstruct landforms using silt and clay washed from the sand slurry and imported virgin excavated neutral material (VENM) and excavated neutral material (ENM) (as needed). The catchment of the closed water system will not exceed 40ha at any one time, unless the Secretary of DPE agrees otherwise (in accordance with Condition 12 of Schedule 3 of SSD 4978).

The catchment will be delineated by clean water diversions with reconstructed landforms progressively removed from the system as vegetation is established and the areas are rehabilitated.

As Domain 6 is currently in the mid-stages of development, sand, silt and clay is currently being pushed towards the dredge pond using a Front-end Loader from where it is drawn to the dredge and pumped through a pipeline to the wash plant. The sand is washed to separate the silt and clay materials and passed through a cyclone before being stockpiled. The separated silt and clay is directed to an open drain to the south of the sand processing area which directs the silt and clay around the reconstructed landform (within the former Domain 4 extraction area) to the silt ponds and eventually towards the Domain 6 dredge pond.

Rainfall runoff or drainage within disturbed areas of the Quarry not used for active water management, such as the sand processing or workshop areas, is directed towards the silt ponds.

The dredge pond and silt ponds are constructed below ground level and therefore cannot discharge to the surrounding environment unless they completely fill and overtop. The closed water management system including, transfer pipes is fully contained within a bunded perimeter as shown on **Figure 12**.

The ponds have and will maintain sufficient capacity greater than that required to contain the rainfall captured within the catchment area of the system. That is, from back to back (i.e. on consecutive days) 1 in 100 year Average Recurrence Interval 18 hour rainfall events. Therefore, there would be negligible risk of discharge from the system. It should be noted that the storage capacity of the system will increase over the life of the Quarry, however the catchment area would be limited to no greater than 40ha.

Provided that the closed water management system is maintained, quarry operations will continue to present negligible risk to water quality in the downstream Greater Blue Mountains World Heritage Area.

8.4 EROSION AND SEDIMENT CONTROLS

Various erosion and sediment controls have been implemented at the Quarry to limit the potential for sediment-laden water to enter Tinda Creek. These controls are principally intended to limit sediment movement within clean water diversions (that is, for sediment in clean water flowing from outside operational areas that is diverted towards Tinda Creek), and therefore capture sediment from areas of the property that are vegetated but feature sandy surface materials. Examples of existing controls are shown in **Plate 1** and **Plate 2**. Erosion and sediment controls will continue to be used at the Quarry as a proactive tool or in response to conditions at the Quarry.

8.5 REHABILITATION

The approved final landform for the Quarry incorporates a series of water storage areas. It is anticipated that the final landform would reflect the adjacent landscape, however, would in places be several metres below the pre-quarrying landform. As a result the potential for water to be stored on the property would be increased. It would be expected that these water storages would provide a natural water source for native fauna or for fire-fighting needs.

Retained water storages would be preferentially located in the vicinity of Domain 1 to aid access for fire-fighting purposes.

Plate 1 Hay bales and sediment fencing within the ephemeral drainage at the head of Tinda Creek
(REF: E980A_065)

Plate 2 Sediment trap, hay bales and sediment fencing within a clean water diversion
(REF: E980A_046)

9. SURFACE WATER MONITORING

Tinda Creek in the vicinity of the Quarry flows intermittently and only for short durations. These flows typically occur during or following intense or prolonged rainfall events. As a result, collecting surface water samples while Tinda Creek is flowing is very difficult to achieve due to the short duration that there is flowing water in the creek. This is particularly the case upstream of Quarry operations where flows typically occur as overland flow over the relatively flat sedgelands. There are no well-defined flow paths in this area. As flows are intermittent it is also very difficult to record flows in the system or make an assessable and reasonable estimate of flow volumes in the creek.

9.1 SURFACE WATER QUALITY

Surface water sampling, if water is available to be sampled, will be undertaken immediately upstream of the Quarry disturbance area (SW1 – in the vicinity of Domain 7), at the farm dam on Tinda Creek (SW2) and immediately downstream at the culvert under Putty Road (SW3). The trigger for surface water sampling will be rainfall greater than 50mm or where there is water observed to be flowing at monitoring locations during monthly observations. Sampling locations are displayed on **Figure 13**. Water samples will be analysed for the following parameters in order to gather information required under Condition M2.1 of EPL 12007.

- Electrical conductivity.
- pH.
- Turbidity.

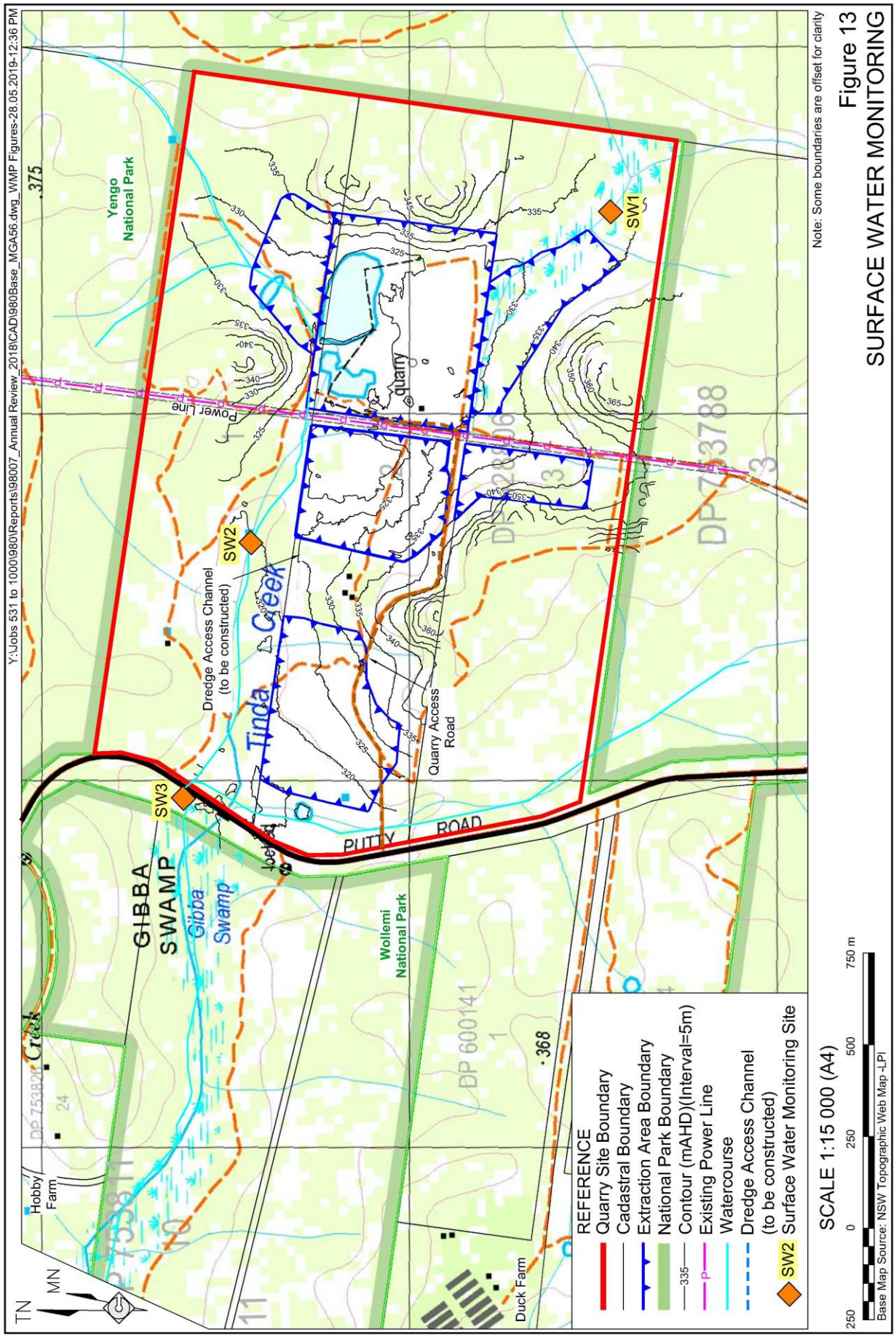
All samples will be collected by a suitably trained person, placed in appropriately treated sample bottles, placed on ice in a cooler and delivered to a NATA registered laboratory on the same day as they are collected. Limited historic monitoring results are available given the difficultly in monitoring water over short periods following rainfall.

9.2 CONDITIONS AND MAINTENANCE

It is proposed to undertake monthly inspections of the surface water management system. These inspections will include sampling of any water that is flowing in Tinda Creek at the time the monthly inspection is undertaken. Additional event based inspections including sampling where water is flowing, will be undertaken after rainfall events where greater than 50mm is received in 24 hours.

In addition, if Bureau of Meteorology issues a severe rainfall event warning for Tinda Creek area, an inspection of the water management system will be undertaken to make sure the system is well maintained provided that the Quarry Manager considers that the inspection can be undertaken safely.

During the monthly inspections, observations on the general condition of Tinda Creek will also be recorded. This will include inspections for litter, oil and grease and sedimentation.


Y:\Jobs 531 to 1000\980\Reports\98007_Annual Review_2018\CAD\980Base_MGA56.dwg_WMP Figures-28.05.2019-12:36 PM
Yengo National Park
Power Line
Quarry
SW1
SW2
SW3
Dredge Access Channel (to be constructed)
Tinda Creek
Quarry Access Road
PUTTY ROAD
GIBBA SWAMP
Gibba Swamp
Wollemi National Park
Hobby Farm
Duck Farm
DP 753811
DP 600141
DP 753788
REFERENCE
Quarry Site Boundary
Cadastral Boundary
Extraction Area Boundary
National Park Boundary
Contour (mAHD)(Interval=5m)
Existing Power Line
Watercourse
Dredge Access Channel (to be constructed)
SW2 Surface Water Monitoring Site
SCALE 1:15 000 (A4)
250 0 250 500 750 m
Base Map Source: NSW Topographic Web Map -LPI
TN MN
Note: Some boundaries are offset for clarity
Figure 13
SURFACE WATER MONITORING

The condition of the diversion channels in terms of sand build up and erosion from the farm dam will also be recorded each time the monthly inspection is undertaken. Following the inspection, it will be determined if sediment is required to be removed from any of the diversion drains or if any maintenance of the closed water management system is required.

9.3 SUMMARY OF SURFACE WATER MONITORING PROGRAM

Table 14 provides a summary of the proposed ongoing surface water monitoring program.

Table 14
Surface Water Monitoring

Monitoring Type	Location	Parameters Monitored	Frequency of Monitoring	Monitoring Method
Dredge Pond Level	Dredge Pond	Level (depth below ground)	Monthly	Observation or dip
Surface Water Quality	Upstream and downstream of Quarry	pH, EC, turbidity	Monthly if water is flowing in Tinda Creek. Samples will also be taken after more than 50mm of rain in 24 hours if water is flowing.	Grab Sample
Drainage Lines and Diversion Drains	Upstream and downstream of quarry	Stability, erosion, and sediment build up	Monthly and event based	Observation and photography
Closed Water Management System	Quarry	Stability, erosion, and sediment build up	Monthly and event based	Observation and photograph

No surface water other than water recycled within the closed water management system is harvested for use in the Quarry and therefore there will be no surface water usage to report on.

All activities will be the responsibility of the Quarry Manager or their delegate.

The outcomes of surface water monitoring will be reviewed and reported on as part of annual reporting and compliance reporting.

10. GROUNDWATER MONITORING

10.1 GROUNDWATER LEVEL MONITORING

Groundwater level monitoring results will be reviewed monthly once they are collected and will be reported annually unless trigger levels set out in Section 11.2 are exceeded. If trigger levels are exceeded relevant authorities will be notified and the reason for the exceedance determined and reported. Appropriate mitigation or contingency measures will be implemented.

Hy-Tec is currently also collecting data from automatic data loggers placed within each of the bores. This data is downloaded and reviewed on a quarterly basis for all bores, and a six monthly data analysis and interpretation is completed. High frequency datalogger monitoring is undertaken to support the monthly manual groundwater level reading.

Dredge pond levels will also be recorded on a monthly basis along with estimates of the perimeter length and area of the dredge pond. These will be reviewed monthly at the time of collection and reported annually unless trigger levels set out in Section 11 are exceeded.

10.2 GROUNDWATER QUALITY MONITORING

Groundwater quality has historically been monitored on a six-monthly basis with all samples collected by a suitably qualified person, placed in appropriately treated sample bottles, placed on ice in a cooler and delivered to a NATA registered laboratory on the same day as they are collected. This monitoring program will continue for all monitoring bores within the Quarry Site. Groundwater quality monitoring data is presented in **Appendix 2**.

Water quality parameters that are currently being monitored and will continue to be monitored include pH, Conductivity, Nitrate, Ammonia and TPH (now Total Recoverable Hydrocarbon – Silica).

Historically the Quarry has analysed for Total Petroleum Hydrocarbons (TPH). In 2013 NEPM changed analysis requirements to Total Recoverable Hydrocarbon (TRH). TRH results can be affected by significant levels of non-petroleum based interferences such as high organic content and under these circumstances the Total Recoverable Hydrocarbon – Silica analysis (TRH – Silica) should be used. Monitoring for TRH has been undertaken on a six-monthly basis. Minor quantities of hydrocarbons have been identified in some historic samples (**Appendix 2**) however, all but one sample was below 5.0mg/L which is the standard trigger applied to environment protection licences in NSW. Historically, elevated Total Petroleum Hydrocarbons (TPH) have been investigated with the laboratory indicating that the elevated levels recorded were likely to be a result of organic matter in the groundwater samples. Trigger levels for investigation (Section 11.3) will be established based on a level of 5.0mg/L.

Groundwater quality monitoring results will be reviewed six monthly following receipt of results from the laboratory and will be reported annually unless trigger levels set out in Section 11.3 are exceeded. If trigger levels are exceeded, relevant agencies will be notified, and the cause of the exceedance determined and reported. Appropriate mitigation and contingency measures will be identified, reported and implemented.

10.3 GROUNDWATER QUANTITY

The volume of groundwater drawn from the on-site production bores is monitored using a meter on the pump used to draw the groundwater from the aquifer.

Records of groundwater take from the on-site groundwater production bores will be retained for a period of five years and updated after each use of the pump. The logbook will record the following details.

- Before water is taken, confirmation will be recorded in the logbook that cease to take conditions do not apply and water may be taken. The method of confirmation will also be recorded (visual inspection or internet search).
- The purpose for which water is taken.
- The date, volume of water, start and end time when water was taken as well as the pump capacity per unit of time.
- The access licence number under which the water is taken.
- The approval number under which the water is taken.
- The meter reading before taking water and after taking water.
- The volume of water taken.

The volume of water taken in each water year (that is, consistent with each financial year) will be recorded in the logbook at the end of each water year.

10.4 GROUNDWATER MONITORING SUMMARY

Table 15 presents a summary of the groundwater monitoring program at the Quarry.

Table 15
Groundwater Monitoring Program

Monitoring Type	Location	Parameters Monitored	Frequency of Monitoring	Monitoring Method
Groundwater Quantity	Production Bore	Usage (KL)	Monthly	Meter Reading
Groundwater Levels	Monitoring Bores (Table 11)	Level (mbgl)	Monthly	Manual or electric dipper
Groundwater Quality	Monitoring Bores (Table 11)	pH, EC, Nitrate, Ammonia and TRH	Six-monthly	Grad sample following bore purge

All activities will be the responsibility of the Quarry Manager or their delegate.

The recorded monthly rainfall and dredge pond depth will also be used in reviewing groundwater monitoring results.

The outcomes of groundwater monitoring will be reviewed and reported on as part of annual reporting and compliance reporting.

11. PERFORMANCE CRITERIA INCLUDING TRIGGER LEVELS FOR INVESTIGATION

11.1 SURFACE WATER TRIGGERS

Surface water management at the Quarry principally relates to the ongoing management and development of the closed water system that will be progressively constructed through establishing clean water diversions around the Quarry. Hy-Tec will report on the status of the closed water management system in each Annual Review and accompany this with photographs and aerial photography. Triggers for action or investigation of the surface water management system are presented in **Table 16**.

Table 16
Surface Water Investigation Triggers and Actions

Trigger	How Identified	Action / Remedial Response
Exceedance of the 40ha limit to the closed water system	Annual aerial photography	Review site planning and investigate reduction of catchment area using diversions or other measures. Notify DPE and report on investigation and response
Failure of clean water diversions. This includes geotechnical failure, functional issue or failure of stabilising vegetation cover.	Monthly inspections or inspection after a rainfall event that exceeds 50mm.	Remediate failure and/or seek geotechnical advice. Notify DPE and report on investigation and response
Excess sedimentation of the clean water diversions	Monthly inspections or inspection after a rainfall event that exceeds 50mm.	Investigate source of sediment and remove from drainage. If sediment has escaped drainage and entered environment notify DPE and report on investigation and response
Failure of erosion and sediment controls	Monthly inspections or inspection after a rainfall event that exceeds 50mm.	Repair erosion and sediment controls as soon as practical. If inspection identifies sediment-laden water flowing to Tinda Creek, notify DPE and report on investigation and response
Surface water monitoring records outside the range specified in **Table 7** and which are consistent with historic monitoring records in **Table 7**	Review of monitoring records when received.	Investigate cause of anomalous result and remediate, where necessary. Notify DPE and report on investigation and response
The depth of water in the dredge pond is below 5m.	Monthly monitoring	Top up dredge pond with water sourced from production bore. Where feasible, reduce the size of the dredge pond by backfilling with VENM/ENM
Erosion, oil and grease or litter from the Quarry is observed in or adjacent to Tinda Creek	Monthly inspections or inspection after a rainfall event that exceeds 50mm.	Investigate source of pollution and remediate. Photograph and record outcomes for reporting in Annual Review.

11.2 GROUNDWATER LEVEL TRIGGERS

It is acknowledged that groundwater levels in close proximity to the dredge pond (typically 50m and less than 100m) can be drawn down as a result of dredging.

If groundwater levels in monitoring bores greater than 100 m from the dredge pond decrease below records outside of the trigger levels in **Table 17**, the Quarry will initiate an investigation that will review the groundwater level in relation to the following.

- Monthly rainfall levels.
- Dredge pond depth.
- Proximity of monitoring bore to dredge pond and likely impact from dredging.
- Proximity to the Greater Blue Mountains World Heritage Area and consideration of potential impact to groundwater availability to these areas.
- Proximity to neighbouring registered bores and consideration of potential impact to groundwater availability in these bores.

Table 17
Groundwater Level Investigation Triggers

Bore	Drilled Depth (m)	Trigger Level (1m below 90th Percentile of historic records[1]) mBGL
TP22	12	4.43
TP06	18	5.91
TP12	15	6.67
TP23	15	6.77
TP14	20	9.08
TP08	18	6.76
TP05	15	8.75
TP18*	18	3.30
TP19*	12	4.79
TP20	12	5.84
TP21	12	5.84
TP44	18.5	3.11
TP45	9	3.36
TP46	20	1.71
TP47	12	0.69
TP48	18	5.85
TP49	10	5.80
TP50	20	7.67
TP51	16	2.49

[1] Historic records are summarised in **Table 11**

It is noted that due to their recent installation the records for bores TP44, TP45, TP46. TP47, TP48, TP49, TP50 and TP51 are limited (less than two years) and do not yet provide an understanding of the potential range in seasonal variation.

DPE will be notified of records outside of the trigger levels in **Table 17** and provided with the outcomes of the investigation into the likely causes and impacts.

Should it be suspected that changes to the groundwater levels are impacting biodiversity values in the vicinity of the Quarry, ecological surveys of surrounding sedgelands and groundwater dependant ecosystems would be commissioned to explore if reduced water levels in dredge ponds has adversely impacted on surrounding ecosystems. This would only be necessary if the groundwater level in the dredge pond was reduced for a prolonged period.

Potential remedial actions will be determined through investigation of the monitoring records but may include the following.

- Raising the water level in the dredge pond.
- Reducing the size of the dredge pond by backfilling with VENM/ENM.
- Modifying operations to avoid impacts to biodiversity values.

11.3 GROUNDWATER QUALITY TRIGGERS

Historic groundwater monitoring data (see Section 5.8 and **Table 12**) has been used to develop the site-wide groundwater quality triggers presented in **Table 18**.

Table 18
Groundwater Quality Trigger Levels

Analyte	Trigger Value
pH (range)	4.5 - 7.0
Conductivity (µS/cm)	900
Nitrate (mg/L)	7.50
Ammonia (mg/L)	0.20
TPH (C6-C9) (mg/L)	5.0
TPH (C10-C14) (mg/L)	5.0
TPH (C15-C28) (mg/L)	5.0
TPH (C29-C36) (mg/L)	5.0

Exceedance of the trigger levels in **Table 18** will trigger an investigation of the likely cause of the anomalous records. The investigation will commence with re-sampling of relevant bores to determine if the results are in error.

If the results are confirmed, DPE will be notified of the results and an investigation into groundwater quality in the relevant bores will commence that will consider the following.

- Monthly rainfall levels.
- Proximity of monitoring bore to operational areas.

- Investigation of potential Quarry-related sources of the result.
- Proximity to the Greater Blue Mountains World Heritage Area and consideration of potential impact to groundwater quality in these areas.
- Proximity to neighbouring registered bores and consideration of potential impact to groundwater quality in these bores.

DPE will be notified of records outside of the trigger levels in **Table 18** and provided with the outcomes of the investigation into the likely causes and impacts.

Potential remedial actions will be determined through investigation of the monitoring records but may include modifying Quarry operations to reduce the total disturbed area (i.e. rehabilitation) or the use of flocculants or additives to modify pH or turbidity levels.

12. SURFACE WATER AND GROUNDWATER CONTINGENCY STRATEGY

12.1 PRIVATELY-OWNED LAND

There are no private landholders within the proximity to the Quarry that have surface water resources they rely on and that would potentially be affected by Quarry operations. Private landholders that are downstream of the Quarry are generally located on side tributaries of Tinda Creek and would not be impacted by changes to the flow regime of Tinda Creek should such a change occur.

Similarly, three licensed groundwater bores are located in excess of 1km west of the Quarry operations and are located within the valley of a tributary of Tinda Creek. These bores are hydro-geologically separated from the shallow clayey sand layer, that is the target for extraction at the Quarry, by intervening sandstone ridges.

If for some unforeseen reason surface water or groundwater resources on these private land holdings are impacted and it is reasonably suspected that this is as a result of Quarry operations, Hy-Tec will investigate the identified impact and prepare a report on the potential reasons for the identified impact. The report will be submitted to relevant agencies for comment. If it is reasonably suspected that the identified impacts are a result of Quarry operations, the Quarry will develop appropriate contingency measures or make-good provision to prevent further impact and offset the impact that has been identified as being caused by Quarry operations.

12.2 GREATER BLUE MOUNTAINS WORLD HERITAGE AREA

Outside of the surface and groundwater trigger levels identified in Section 11, the Quarry is considered to have negligible potential to adversely impact on surface or groundwater quality or groundwater levels in the Greater Blue Mountains World Heritage Area.

If for some unforeseen reason monitoring on-site indicates that surface or groundwater resources in Greater Blue Mountains World Heritage Area may be impacted, Hy-Tec will investigate the identified impact and prepare a report on the potential reasons for the identified impact, notify relevant agencies the cause of the identified impact. The report will be submitted to relevant agencies for comment.

If it is reasonably expected that the identified impacts are a result of Quarry operations, Hy-Tec will develop appropriate contingency measures to prevent further impact in accordance with this Plan and remediate any identified impacts, where possible.

13. COMPLAINTS HANDLING AND RESPONSE

Complaints will be managed in accordance with the procedure described in 3.1 of the Environmental Management Strategy (Umwelt, 2017) and involve the following key steps.

- Responding to the complainant within one working day of receiving the complaint, acknowledging the complaint has been received.
- Recording the details of the complaint (date, time, matter raised and contact details of complainant so feedback may be provided).
- Investigation of the matter subject to complaint.
- Implementing measures to remediate the matter.
- Responding to the complainant notifying them of the outcomes of the investigation.

Records of all complaints are published on the Hy-Tec website, reviewed in the Annual Review and discussed with the Community Consultative Committee.

14. INCIDENT MANAGEMENT, NOTIFICATION AND REPORTING

SSD 4978 defines an incident as "*a set of circumstances that:*

- causes or threatens to cause material harm to the environment; and/or
- breaches or exceeds the limits or performance measures/criteria".

In accordance with the definition provided by Section 147 of the POEO Act, harm to the environment is deemed to be material if:

i) it involves actual or potential harm to the health or safety of human beings or to ecosystems that is not trivial; or

ii) it results in actual or potential loss or property damage of an amount, or amounts in aggregate, exceeding $10,000 (or such other amount as is prescribed by the regulations).

An incident which causes or threatens to cause material harm to the environment (and may or may not result in an exceedance of noise criteria) is referred to as a Pollution Incident.

In the event of a water-related incident which is deemed a Pollution Incident, the Quarry Manager will be notified and the event will be reported to the EPA immediately and subsequently to the DPE. Notification will occur at the first practical opportunity (and preferably within 24 hours of the incident).

An investigation into the source of the incident will be immediately commenced and once identified the Quarry Manager or delegate will implement remedial measures.

Within 7 days of the incident, the Company will submit a report to DPE and the EPA confirming the source of the incident, actions taken and ongoing management to prevent future incidents.

15. DOCUMENTATION AND PUBLICATION OF MONITORING INFORMATION AND REPORTING

Hy-Tec will retain records of all monitoring for a minimum period of four years. Historic monitoring records will be made available to relevant government authorities following a written request. Hy-Tec will include all monitoring records as appendices to the Annual Review. That document, once approved by the relevant government agencies, would be published on the Company's website.

16. ROLES AND RESPONSIBILITIES

Table 19 outlines the roles and responsibilities of personnel with reference to management of water resources and water management structures.

Table 19
Roles and Responsibilities of Personnel with Respect to Management of Noise

Role	Responsibilities
NSW Quarry Operations Manager	Ensure compliance with the Water Management Plan. Ensure adequate resources are available to implement the Water Management Plan. Ensure suitably trained personnel are available to implement the responsibilities of the Quarry Manager during any time of the Quarry Manager's absence from site. Coordinate the review of the Plan.
Quarry Manager, or his/her nominee	Ensure the implementation of the Water Management Plan. Undertake monthly investigations including review of water management structures and record any anomalies or failures (written or photo). Ensure monitoring results are regularly reviewed/evaluated and entered into the environmental database. Ensure reviews of meteorological forecasts are undertaken on a daily basis prior to the commencement of operations. Provide primary contact for complaints and supply follow-up information to any complainant. Initiate investigations of complaints as received from the public or government agency. Prepare a report to government agencies or neighbours following a notifiable pollution incident Ensure employees are competent through training and awareness programs.
All On-site Personnel	Operate in manner that minimises risks of incidents to themselves, fellow workers or the surrounding environment. Fully implement the relevant control measures within the Water Management Plan. Report any identified failures of water management structures to the Quarry Manager. Follow any instructions provided by the Quarry Manager.

17. COMPETENCE TRAINING AND AWARENESS

All personnel and contractors working at the Quarry undergo an induction. This induction includes information on the management of water resources while working on site.

After completing the induction, workers will sign a statement of attendance and records of this are kept in the administration office.

Monthly toolbox meetings are held to discuss whole-of-site production, management, safety and environmental issues. Matters relating to water resources are raised during these meetings, when necessary.

18. PLAN REVIEW AND CONTINUAL IMPROVEMENT PROTOCOL

In accordance with Condition 5 of Schedule 5 of SSD 4978, the Plan will be internally reviewed within 3 months of submission of an Annual Review, an incident report resulting from a notifiable incident, each independent environmental audit and any modification to SSD-4978 to address feedback from these processes. Should changes to the Plan be required, approval for the modified plan would be sought from DPE. A comprehensive review of all management plans will take place every three years and include review of all management measures to ensure these remain within best practice management. This will ensure the adequacy of the Plan and allow for opportunities of adaptive management and continual improvement. This will include a review of all trigger levels. Each review will also evaluate the effectiveness of the groundwater and surface water monitoring programs and whether they should be modified or scaled back.

19. REFERENCES

Fetter, C.W. (1980). Applied Hydrogeology.

Stitt, P.H. & Associates, (2010). The Tinda creek sand deposit near Colo Heights NSW, Drilling- Resource estimates – Comments. Report No 2010-01 prepared for Hy-Tec Industries Pty Ltd

Umwelt (Australia) Pty Limited (2014a). Environmental Impact Statement for Proposed Expansion of Tinda Creek Sand Quarry. Prepared on behalf of Aus-10 Rhyolite Pty Ltd.

Umwelt (Australia) Pty Limited (2014b). Groundwater Assessment for Proposed Expansion of Tinda Creek Sand Quarry. Prepared on behalf of Aus-10 Rhyolite Pty Ltd.

Umwelt (Australia) Pty Limited (2016). Tinda Creek Quarry Landscape Management Plan. Prepared on behalf of Aus-10 Rhyolite Pty Ltd.

Umwelt (Australia) Pty Limited (2017). Environmental Management Strategy for the Tinda Creek Sand Quarry. Prepared on behalf of Aus-10 Rhyolite Pty Ltd.

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Appendices

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Appendix 1

Hydrographs of Groundwater Levels 2010 to 2018

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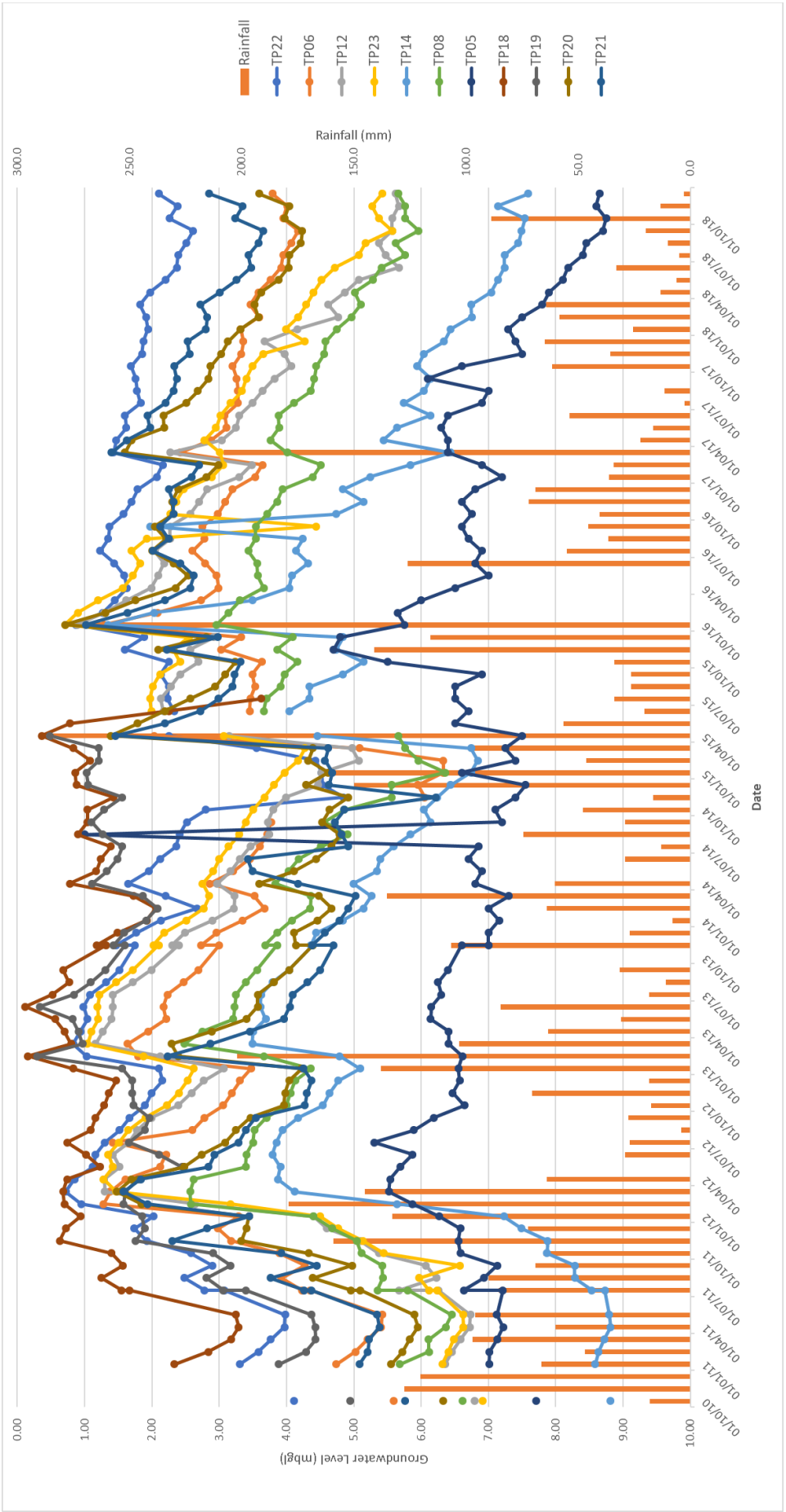
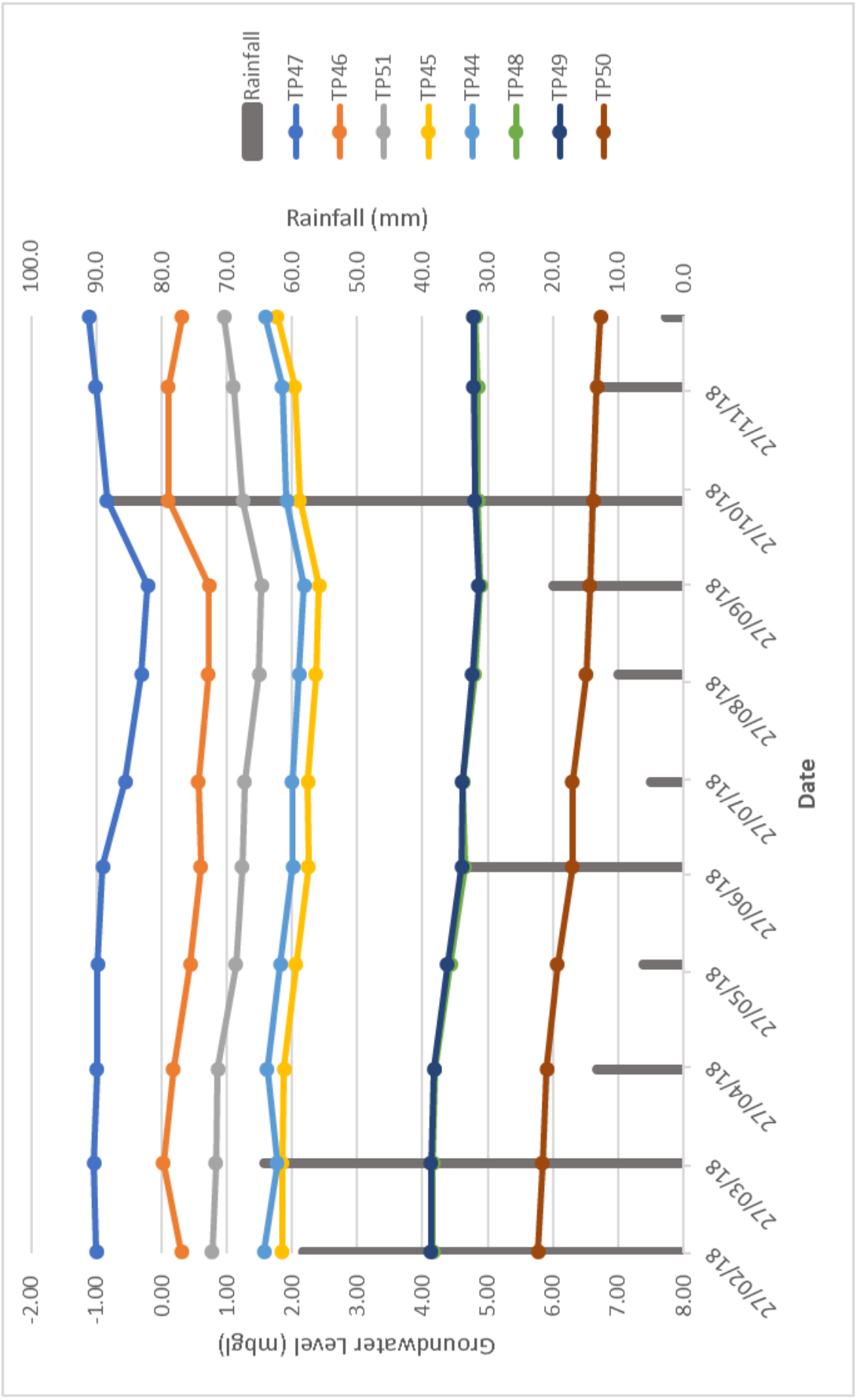

Rainfall
TP22
TP06
TP12
TP23
TP14
TP08
TP05
TP18
TP19
TP20
TP21
Rainfall (mm)
300.0
250.0
200.0
150.0
100.0
50.0
0.0
Date
Groundwater Level (mbgl)
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
9.00
10.00


Rainfall
TP47
TP46
TP51
TP45
TP44
TP48
TP49
TP50
Rainfall (mm)
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Groundwater Level (mbgl)
-2.00
-1.00
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
Date
27/11/18
27/10/18
27/09/18
27/08/18
27/07/18
27/06/18
27/05/18
27/04/18
27/03/18
27/02/18

Appendix 2

Groundwater Quality Monitoring Data

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pH	TP05	TP06	TP08	TP12	TP14	TP18	TP19	TP20	TP21	TP22	TP23	TP44	TP45	TP46	TP47	TP48	TP49	TP50	TP51
01/10/10	5.5	6.6	5.0	5.0	5.0		5.6	5.5	5.7	4.6	5.5								
29/04/11	5.2	6.5	6.7	5.3	4.9	5.2	5.3	5.3	5.5	5.3	5.4								
31/10/11	5.1	6.2	6.3	5.2	4.8	5.3	5.2	5.3	5.5	5.3	5.4								
30/05/12	4.9	5.3	5.0	5.3	5.2	4.9	4.9	5	5.3	5.3	5.2								
27/11/12	5.2	5.6	5.2	5.5	5.1	5.2	5.3	5.3	5.5	5.4	5.4								
29/05/13	5.2	5.4	5	5.5	5.9	5.2	5.2	5.2	5.5	5.3	5.2								
03/12/13	4.1	5	4.7	4.7	4.7	4.6	4.6	4.6	4.7	4.6	4.5								
28/05/14	4.9	5.4	5.1	5.2	5.1	5.1	5.1	5.2	5.3	5.2	5.1								
25/11/14	4.9	5.6	5.1	5.1	5	5.2	5.2	5.2	5.4	5.1	5.1								
27/05/15	5.2					5.7		5.4	5.7										
24/09/15	5.2	5.8	5.1	5.5	5.6			5.2	5.3		5.2								
26/05/16	5.1	5.5	4.9	5.4	5.6			5.4	5.6		5.6								
29/11/16	5.1	5.3	5	5.3	5.7			5.4	5.3		5.3								
25/05/17	5.2	5.5	5.1	5.2	5.6			5.3	5.4		5.2								
23/11/17	5.3	5.9	5.2	5.4	5.6			5.4	5.7		5.3								
27/03/18	5.3	5.8	5.2	5.3	5.5			5.4	5.4		5.2	5.7	5.7	4.5	4.8	5.9	5.5	5.4	6.2
26/07/18	5.1	5.7	5.2	5.2	5.4			5.3	5.3		5.1	5.5	5.7	5.7	5.7	6.2	5.3	5.1	6.3
Minimum	**4.1**	**5.0**	**4.7**	**4.7**	**4.7**	**4.6**	**4.6**	**4.6**	**4.7**	**4.6**	**4.5**	**5.5**	**5.7**	**4.5**	**4.8**	**5.9**	**5.3**	**5.1**	**6.2**
Average	**5.1**	**5.7**	**5.2**	**5.3**	**5.3**	**5.2**	**5.2**	**5.3**	**5.4**	**5.1**	**5.2**	**5.6**	**5.7**	**5.1**	**5.3**	**6.1**	**5.4**	**5.3**	**6.3**
Maximum	**5.5**	**6.6**	**6.7**	**5.5**	**5.9**	**5.7**	**5.6**	**5.5**	**5.7**	**5.4**	**5.6**	**5.7**	**5.7**	**5.7**	**5.7**	**6.2**	**5.5**	**5.4**	**6.3**
Standard Deviation	**0.3**	**0.4**	**0.5**	**0.2**	**0.4**	**0.3**	**0.3**	**0.2**	**0.2**	**0.3**	**0.2**	**0.1**	**0.0**	**0.8**	**0.6**	**0.2**	**0.1**	**0.2**	**0.1**

Conductivity	TP05	TP06	TP08	TP12	TP14	TP18	TP19	TP20	TP21	TP22	TP23	TP44	TP45	TP46	TP47	TP48	TP49	TP50	TP51
01/10/10	170		180	73	104		94	97	73	74	77								
29/04/11	165	270	200	60	145	130	80	80	55	60	60								
31/10/11	150	100	68	68	170	130	89	90	55	62	56								
30/05/12	105	75	95	60	90	120	90	90	55	50	55								
27/11/12	100	95	90	60	65	115	95	75	50	55	50								
29/05/13	80	65	85	55	100	120	80	80	45	60	55								
03/12/13	100	110	45	50	80	120	90	80	55	60	50								
28/05/14	105	80	80	65	75	115	90	75	50	60	55								
25/11/14	140	90	85	80	110	110	80	70	50	65	50								
27/05/15	100					130		75	50										
24/09/15	90	85	85	70	60			80	60		55								
26/05/16	100	80	95	70	60			75	60		60								
29/11/16	90	60	80	60	75			70	65		55								
25/05/17	80	70	70	70	50			70	50		50								
23/11/17	90	95	80	75	70			65	50		50								
27/03/18	95	90	95	60	70			65	55		50	205	240	160	130	310	260	400	110
26/07/18	85	80	60	50	85			80	60		50	200	230	100	110	280	260	380	100
Minimum	**80**	**60**	**45**	**50**	**50**	**110**	**80**	**65**	**45**	**50**	**50**	**200**	**230**	**100**	**110**	**280**	**260**	**380**	**100**
Average	**109**	**96**	**93**	**64**	**88**	**121**	**88**	**77**	**55**	**61**	**55**	**203**	**235**	**130**	**120**	**295**	**260**	**390**	**105**
Maximum	**170**	**270**	**200**	**80**	**170**	**130**	**95**	**97**	**73**	**74**	**77**	**205**	**240**	**160**	**130**	**310**	**260**	**400**	**110**
Standard Deviation	**28.9**	**49.9**	**40.2**	**8.7**	**32.1**	**7.4**	**6.0**	**8.8**	**6.8**	**6.6**	**6.9**	**3.5**	**7.1**	**42.4**	**14.1**	**21.2**	**0.0**	**14.1**	**7.1**

Nitrate NO3	TP05	TP06	TP08	TP12	TP14	TP18	TP19	TP20	TP21	TP22	TP23	TP44	TP45	TP46	TP47	TP48	TP49	TP50	TP51
01/10/10	<0.1	<0.1	6.7	<0.1	1.1		<0.1	7.4	6.3	0.18	5.5								
29/04/11	<0.1	<0.1	8.9	<0.1	0.53	2.4	0.89	0.31	5.6	<0.1	0.8								
31/10/11	<0.1	<0.1	<0.1	<0.1	<0.1	1.6	7	<0.1	6.4	<0.1	0.22								
30/05/12	0.22	<0.1	0.18	<0.1	<0.1	1.9	9.3	<0.1	4.3	<0.1	1.4								
27/11/12	<0.1	<0.1	<0.1	<0.1	<0.1	2.3	7.5	<0.1	1.6	<0.1	0.53								
29/05/13	<0.1	<0.1	0.4	<0.1	<0.1	0.75	4.5	<0.1	1.5	<0.1	1.2								
03/12/13	<0.1	<0.1	0.2	<0.1	<0.1	0.62	5.4	<0.1	0.71	<0.1	0.84								
28/05/14	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	5.4	<0.1	2.5	<0.1	0.49								
25/11/14	<0.1	<0.1	<0.1	<0.1	<0.1	0.35	5	<0.1	0.97	<0.1	0.75								
27/05/15	<0.1					<0.1		1.2	2.4										
24/09/15	<0.1	<0.1	0.4	<0.1	<0.1			1.2	1		0.66								
26/05/16	<0.1	<0.1	<0.1	1.5	<0.1			0.8	0.3		1.1								
29/11/16	<0.1	<0.1	<0.1	<0.1	<0.1			1.1	0.4		0.9								
25/05/17	<0.1	<0.1	<0.1	<0.1	<0.1			3.7	2.0		1.2								
23/11/17	0.1	<0.1	<0.1	<0.1	<0.1			1.2	3.6		0.7								
27/03/18	0.13	<0.1	<0.1	0.22	<0.1			1.1	9.3		0.93	0.13	0.13	33	25	0.71	0.66	0.4	1.2
26/07/18				0.18				1.9	4.9		0.89	0.09	0.13	5.5	12	0.49	0.35	0.14	0.31

Ammonia	TP05	TP06	TP08	TP12	TP14	TP18	TP19	TP20	TP21	TP22	TP23	TP44	TP45	TP46	TP47	TP48	TP49	TP50	TP51
01/10/10	0.1	0.2	0.4	0.3	0.2		<0.1	0.2	<0.1	<0.1	0.2								
29/04/11	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1								
31/10/11	<0.1	<0.1	0.1	0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1								
30/05/12	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1								
27/11/12	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1								
29/05/13	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1								
03/12/13	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1								
28/05/14	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1								
25/11/14	<0.1	0.3	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1								
27/05/15	<0.1					0.6		<0.1	<0.1										
24/09/15	<0.1	<0.1	<0.1	<0.1	<0.1			<0.1	<0.1		<0.1								
26/05/16	<0.1	<0.1	<0.1	<0.1	<0.1			<0.1	<0.1		<0.1								
29/11/16	0.1	<0.1	<0.1	0.2	<0.1			<0.1	0.3		<0.1								
25/05/17	<0.1	<0.1	<0.1	<0.1	<0.1			<0.1	<0.1		<0.1								
23/11/17	<0.1	<0.1	<0.1	<0.1	<0.1			<0.1	<0.1		<0.1								
27/03/18	0.1	<0.1	<0.1	<0.1	<0.1			<0.1	<0.1		<0.1	<0.1	<0.1	2.1	0.4	<0.1	<0.1	<0.1	<0.1
26/07/18	0.02	0.05	0.04	0.06	<0.1			0.04	0.04		0.05	<0.1	0.01	0.01	0.03	0.02	0.01	<0.1	0.02