Technical Note:

Hendy Quarry - Assessment of discharge 2018

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Contents

1 Introduction

1.1 Background

Surface water run-off at Hendy Quarry (the Site) is discharged via a soakaway located at the northern end of the Site immediately adjacent to School Road (B4264) (Figure 2.1). All runoff within the main quarry catchment drains into the quarry sump and is then discharged to the soakaway location. A topographical survey is included in Appendix A and photos of the sump and soakaway are included in Appendix B.

Tarmac currently hold an Environmental Permit (EPR/BT1088ID/V003) for inert landfill, with the Directly Associated Activity (DAA) to discharge, predominately rainfall runoff to a soakaway, with a daily limit of 750 m^3. An informal agreement between Tarmac and NRW exists, which permits the reporting of the monthly average discharge values to account for the fluctuations in discharge requirements caused by the variation in receiving rainfall. Despite this allowance, the mean daily discharge regularly exceeds the consented volumetric limit.

A technical assessment was undertaken by ESI (2014) to investigate the likely rainfall runoff rates from at the Site and therefore inform an application to revise the volumetric discharge limit. This report concluded that rainfall runoff was the primary component of the discharge water and that the receiving geological stratum at the soakaway location (fractured Carboniferous Limestone) was capable of receiving the quantities of water which have been discharged to the feature in recent years.

Natural Resources Wales (NRW) has subsequently requested further information as to the makeup of water being discharged to the soakaway (NRW, date unknown) and how much of this, if any, is groundwater derived (as opposed to surface water runoff). Further to this, if there is a groundwater component to the discharge water, what impact is this having on the surrounding groundwater and is there an element of water recycling occurring i.e. water being discharged to the soakaway and abstracted again from the sump.

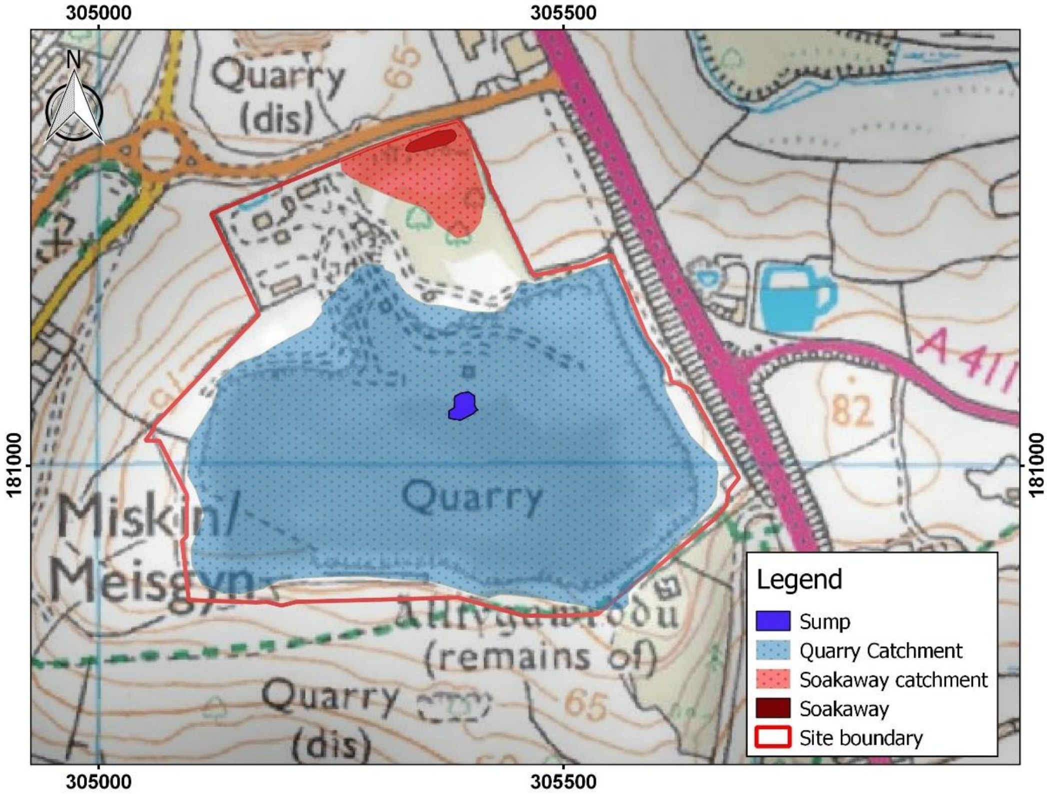
This technical note provides further analysis and information to provide answers to NRW's question above.

2 Site details

2.1 Current Conceptual Model

Mineral extraction at Hendy Quarry has created a sub-catchment across much of the Site which drains to the quarry sump. The soakaway in the north of the Site also has a separate sub-catchment. A site plan is included in Figure 2.1.

Figure 2.1 Site plan



The main quarry catchment is principally covered with bare rock with some areas of inert fill. ESI (2014) estimated the proportion of runoff from incoming rainfall (the runoff coefficient) using the established Coal Board (1982) nomogram method as being 0.67. Linear Regression of daily pumping and rainfall data yielded a coefficient of 0.71 which appeared to validate the high proportion of rainfall being diverted to runoff which may be expected in a heavily modified quarry catchment.

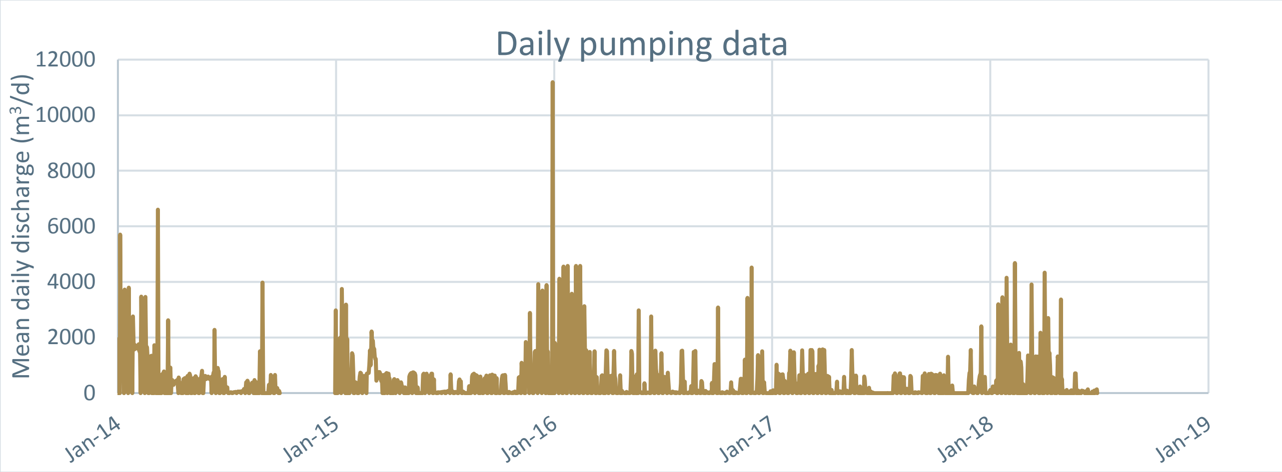
The sump is at an elevation of around 45 mAOD (Appendix A). Water levels are not regularly recorded in this feature although historic site topographical surveys put the sump water level at between 44.5 and 46.0 mAOD. Water level in the sump was noted to be 44.7 mAOD in June 2018. The sump level is controlled by submersible pump which is engaged manually by quarry staff.

The Site's 2017 Hydrogeological Risk Assessment Review (HRAR) (Caulmert, 2018) provided an updated hydrogeological conceptual model for the Site – Appendix C provides an excerpt of the figures which graphically show the conceptual model and groundwater contours across the Site. In general, the base of the quarry is inferred to be very close to the ambient groundwater level, with no significant unsaturated zone (<1 m). However, there is no evidence of groundwater flooding over the base of the void. Water in the sump is considered by Caulmert to be in continuity with groundwater. During a site visit in August 2018 water was observed in the sump following a period of very dry weather. The Quarry Manager (2018) stated at this time that following the occasional pumping that was undertaken over the 2018 summer, water levels in the sump would recover, confirming the connection with groundwater. A comparison of groundwater and sump levels is presented in Section 4.

2.2 Pumping Data

Raw daily pumping data was provided by Tarmac for the period January 2014 to June 2018 inclusive and is presented in Figure 2.2 below. An electronic copy of this data is provided as Appendix D. This shows the high variability of the pumping rate on a daily basis. Note that the high recorded value in December 2015 is likely a summed value over several days and should be discounted.

Figure 2.2 Raw daily discharge data



Over the observed period, the monthly discharge totals (expressed as a daily average) exceeded the consented volumetric limit on 8 occasions – this represents 16% of the data record.

The discharge record is highly variable. The pump capacity is currently unknown although values in excess of 6,000 m^3/d (69 l/s) seem unlikely to be accurate and are probably a result of accrued totals. The maximum daily totals are considered likely to be in the order of 4,000 m^3/d – 5,000 m^3/d. The Site has confirmed the pump runs for 24 hrs following periods of heavy rainfall and that no flooding of the soakaway occurs during these times.

3 Rainfall runoff analysis

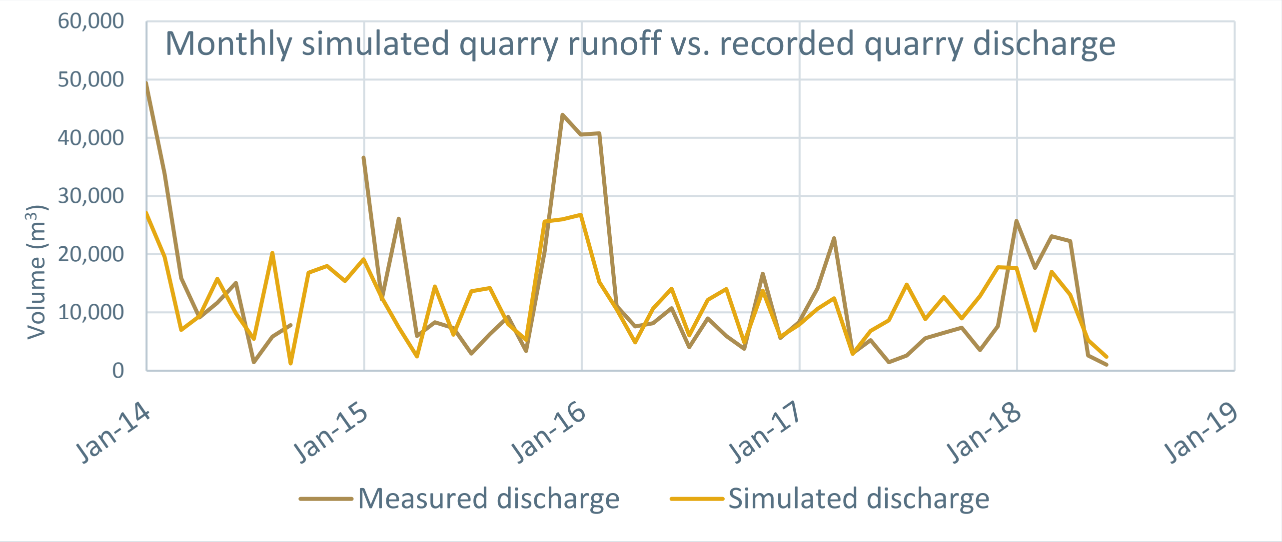
This work builds upon that undertaken in ESI (2014). Using rainfall data obtained from the gauge at the Rhiwsaeson sewage treatment works, 2.25 km northeast of the Site, monthly runoff totals were calculated based upon the runoff coefficient previously established through Linear Regression (0.71). Monthly simulated runoff totals were compared with monthly sum discharge figures, which have previously been used as a proxy for total site runoff, to gauge the relative proportion of total discharge which is likely to be sourced from runoff alone. The latest quarry topographic survey was reviewed as part of this work to assess any change in the catchment area.

The results are presented below as mean totals per quarter, with the first quarter being January to March and so on. This is to show the variability over the year. Monthly totals are also presented in Figure 3.1.

Table 3.1 Recorded discharge vs simulated runoff at the Site (mean values for period Jan 2014 to June 2018)

Quarter	Average of recorded discharge (m^3)	Average of simulated runoff (m^3)	Difference (m^3)
Q1	25,216	13,959	11,257
Q2	7,966	8,452	-486
Q3	5,603	10,948	-5,344
Q4	12,485	14,264	-1,779
Sum	**51,271**	**47,623**	**3,648**

Figure 3.1 Monthly simulated runoff vs recorded site discharge



The results in Table 3.1 suggest that overall runoff is expected to represent the majority of all site discharge, with total simulated flow being 93% of the total recorded discharge (when comparing the summed values). Over the year there is a lot of variation, with recorded discharge being significantly above the simulated flows in the first quarter – this is also clear to see in Figure 3.1. This possibly indicates that the contribution of groundwater to total discharge increases at this time of year, when the water table is at its maximum elevation.

It was noted during a site visit in August 2018 that off-site discharge has been minimal over the dry summer of 2018. Over May and June 2018, recorded rainfall at the Rhiwsaeson rain gauge totalled just 50.0 mm and 22.6 mm, with recorded discharge averages being just 86 m^3/d and 34 m^3/d respectively. The maximum daily simulated runoff, as calculated for the period 2014-2018, was 5,281 m^3 which was as a result of 47.4 mm of rainfall on 21st July 2017 (Appendix D).

Based on an assessment of the data provided in Figure 2.2 and the maximum daily simulated runoff for the Site (5,281m^3), it is considered that it would be appropriate to increase the discharge limit, which is currently being exceeded due to a gross underestimate of rainfall to the Site, to **5,000 m^3**/day.

4 Groundwater levels

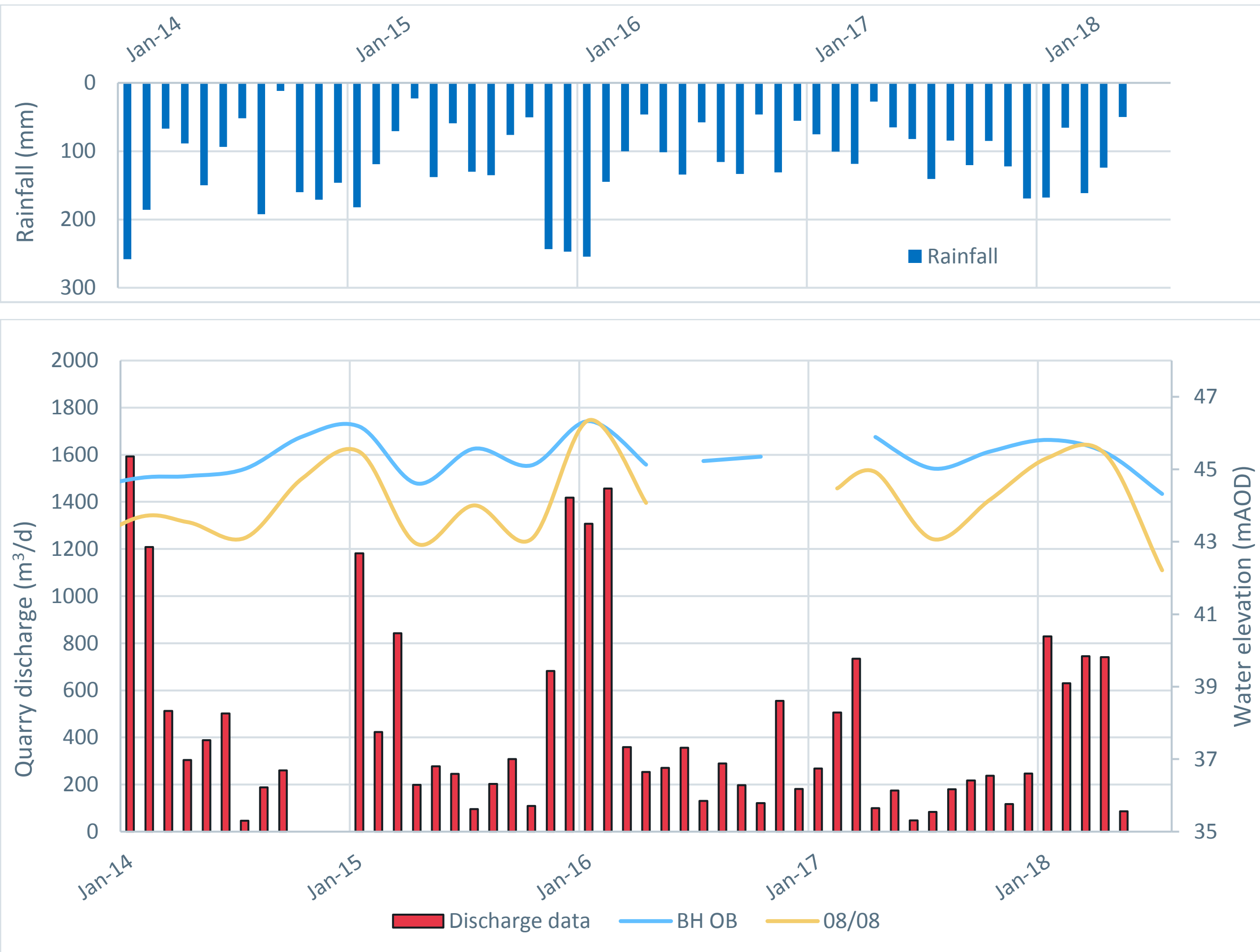
Groundwater monitoring is undertaken at ten locations around the Site. Locations of the monitoring locations are shown on Figure 4.2 and Figure 4.3. In general, the groundwater gradient is from east to west across the Site.

The most proximal borehole to the sump is BH OB, located 70 m to the northwest. Groundwater levels at BH OB and PZ08-08 (a more remote location from the sump) have been plotted below along with pumping rates (monthly average data) and rainfall (monthly sums). The data show that groundwater levels and pumping rates both appear to correlate well with total rainfall i.e. in wetter periods there is more runoff to the sump and the groundwater levels rise such that there is also likely to be an increased groundwater discharge to the sump.

Whilst there are no groundwater monitoring wells very close to the sump, there is no evidence that pumping from the sump actually draws groundwater in i.e. there is unlikely to be any zone of depression in groundwater forming due to pumping. The pumping simply removes excess groundwater which has discharged into the sump due to the prevailing hydraulic gradient.

What is also evident in the Figure 4.1 is the BH OB has a smaller amplitude than PZ08/08. This is most likely due to variations in storage which might well be related to the relative degree of fissuring at the locations.

Figure 4.1 Comparisons of rainfall, discharge and groundwater elevation at the Site



Summer and winter groundwater contours have been calculated for the Site using data collected in July 2017 and January 2018 respectively. These are presented in Figure 4.2 and Figure 4.3 along with an east-west profile through the Site showing topography data (LiDAR) and interpolated groundwater levels.

The profiles confirm that the summer groundwater level is similar to or below the sump level, whilst the winter groundwater level is higher than it. This confirms that there is likely to be a component of groundwater discharge to the sump in the winter months with a reduced or absence of discharge in the summer months. Winter groundwater levels do not show any influence from sump pumping.

Figure 4.2 Summer groundwater contours at the Site – data recorded in July 2017

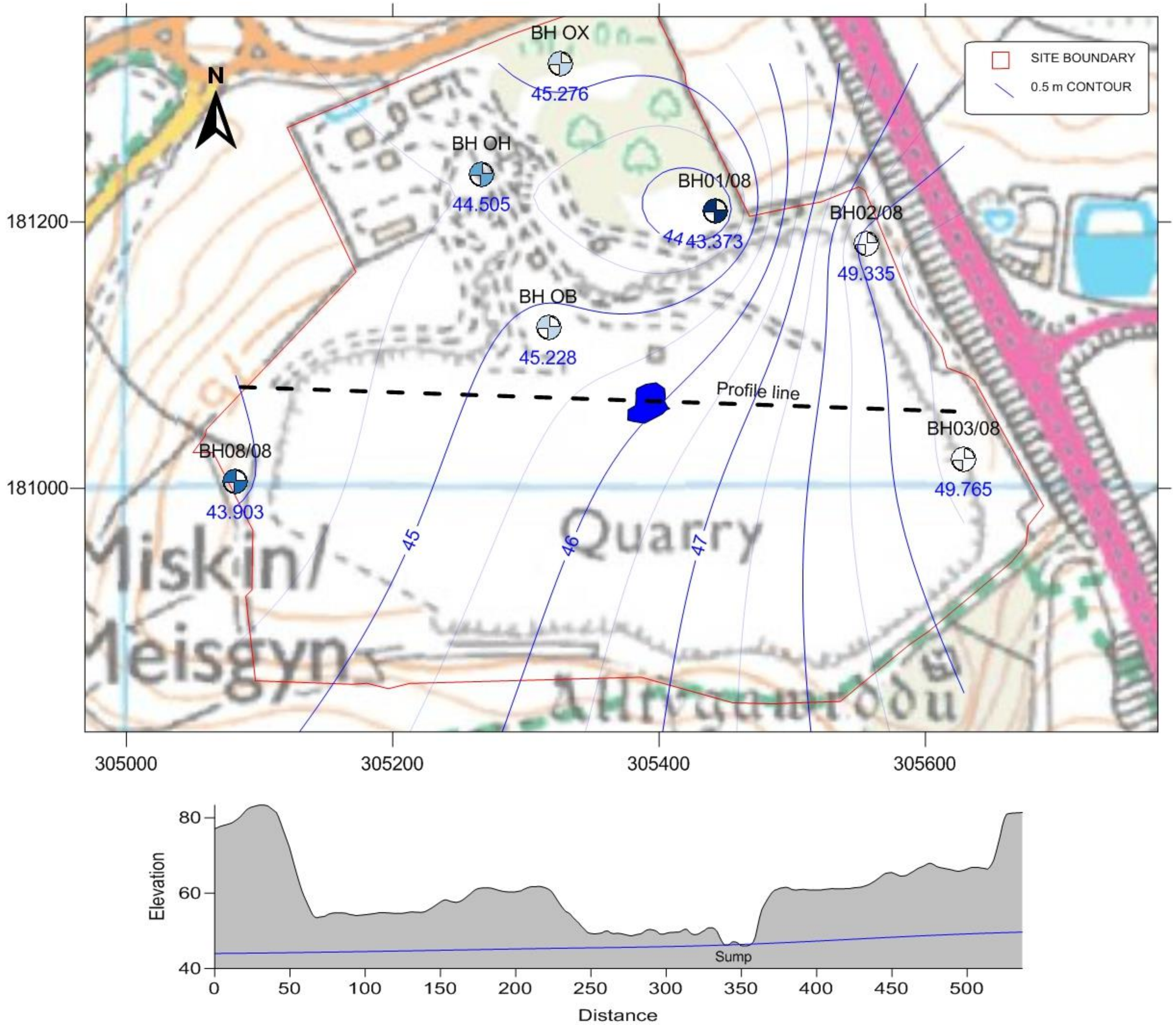
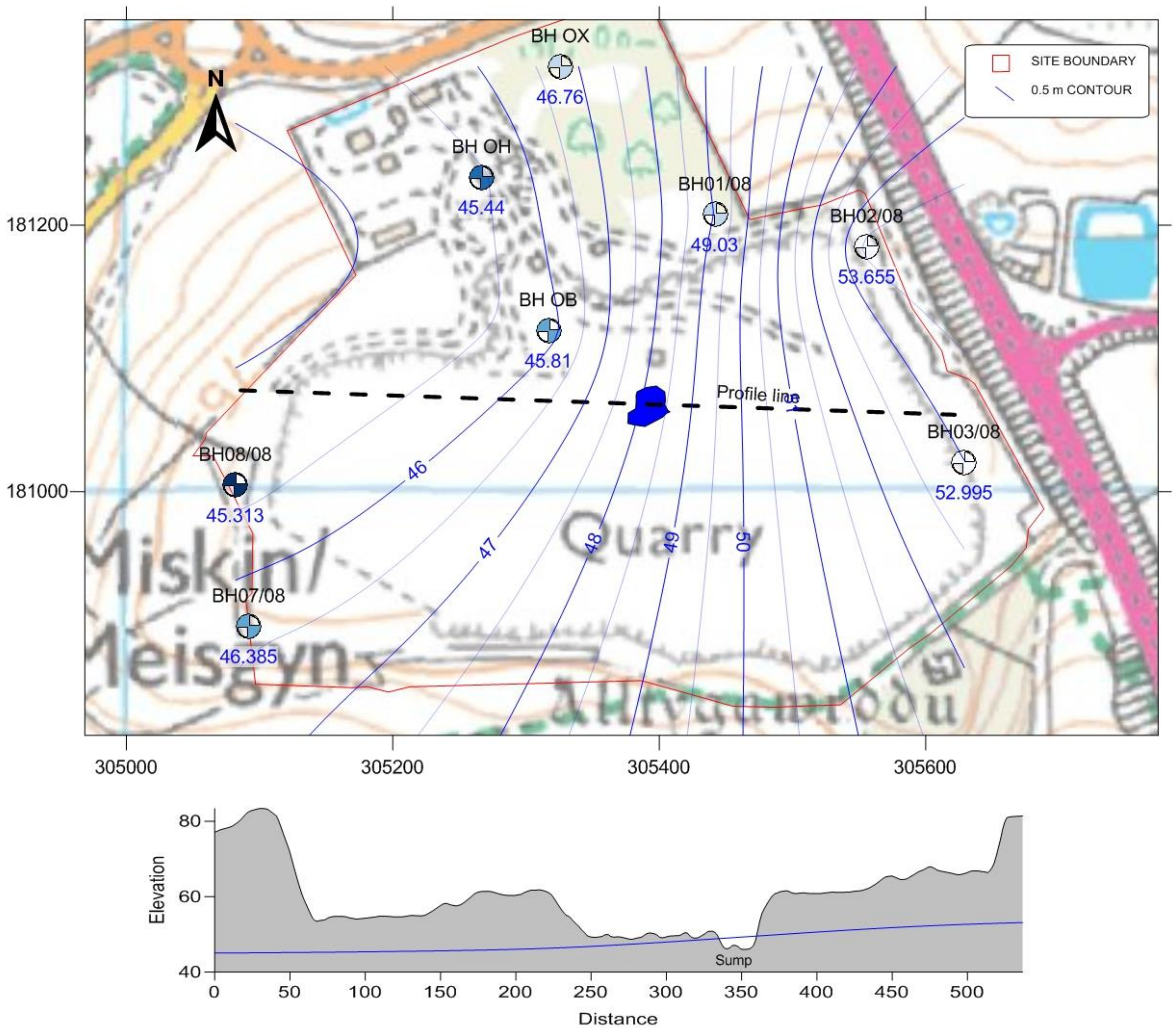


Figure 4.3 Winter groundwater contours at the Site – data recorded in January 2018



5 Conclusions

The Hendy quarry sump is at an approximately equal elevation to the local groundwater table (within the Carboniferous Limestone). Water within the sump is likely to be in hydraulic continuity with groundwater, at least during the wetter winter months. When groundwater levels are high, groundwater discharges to the sump and this water, along with runoff, is pumped out to the soakaway. During the drier, summer months, the groundwater level falls below the base of the sump and the only contribution to the sump is runoff.

There is no evidence that removal of excess groundwater that discharges into the sump has any significant effect on groundwater flow rate or direction. There will be a very small effect as a volume of groundwater is being removed at one location and returned to ground in another location, but this does not appear to affect overall flow rates or directions.

The proportion of rainfall diverted to runoff in the quarry catchment is relatively high, being in the order of 71% as demonstrated in previous work (ESI, 2014). Calculated rainfall runoff on a monthly basis using the established coefficient gives volumes which approach the total magnitude of the recorded discharge totals. In general, pumping rates correlate very well with rainfall totals which would not be expected if the major component of abstracted water was derived from groundwater. This suggests that the majority of pumped water in any given year from the sump is derived from surface water runoff.

The degree of any recycling of water between the soakaway and the sump is likely to be negligible. This is due to the distance between the sump and soakaway and the absence of a hydraulic gradient between the sump and the soakaway.

REFERENCES

Caulmert, 2018. Hendy Landfill Site - Hydrogeological Risk Assessment Review 2017. Doc ref: 3145-CAU-XX-XX-RP-O-0301.S0.C1

ESI, 2014. Hendy Quarry - Assessment of run-off. 62847TN03.

National Coal Board, 1982. Technical Management of Water in the Coal Mining Industry. National Coal Board, Mining Department. Brighton

Natural Resources Wales, date unknown. Letter from Natural Resources Wales to Tarmac – exact date unknown although assumed to be early 2017. Subject of letter: Response to SLR/Tarmac request to vary volumetric discharge limit and ESI's technical note 6284TN03.

Quarry Manager, 2018. Conversation between Henry Kelly (ESI) and Hendy Quarry Manager (Owen Llewellyn) during site visit, 02 August 2018.

APPENDICES

Appendix A

Topographical survey

NOTE: Certain information on this plan has been digitised and therefore its accuracy cannot be guaranteed. Do not scale off plant/building locations.

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Tel +44(0)1275 465714
e-mail: stuart.blackhurst@tarmac.com

H074 - HENDY

TOPOGRAPHIC PLAN
4th JUNE 2018

LSS Models Used To Create Plot

H074 HENDY QU 2018-06-04

Drawn By	Date
SJB	JUNE 2018
Scale	**Drawing No.**
1 : 1250	H074 QU 2018-06-04_A1L.pdf

Appendix B

Site photos

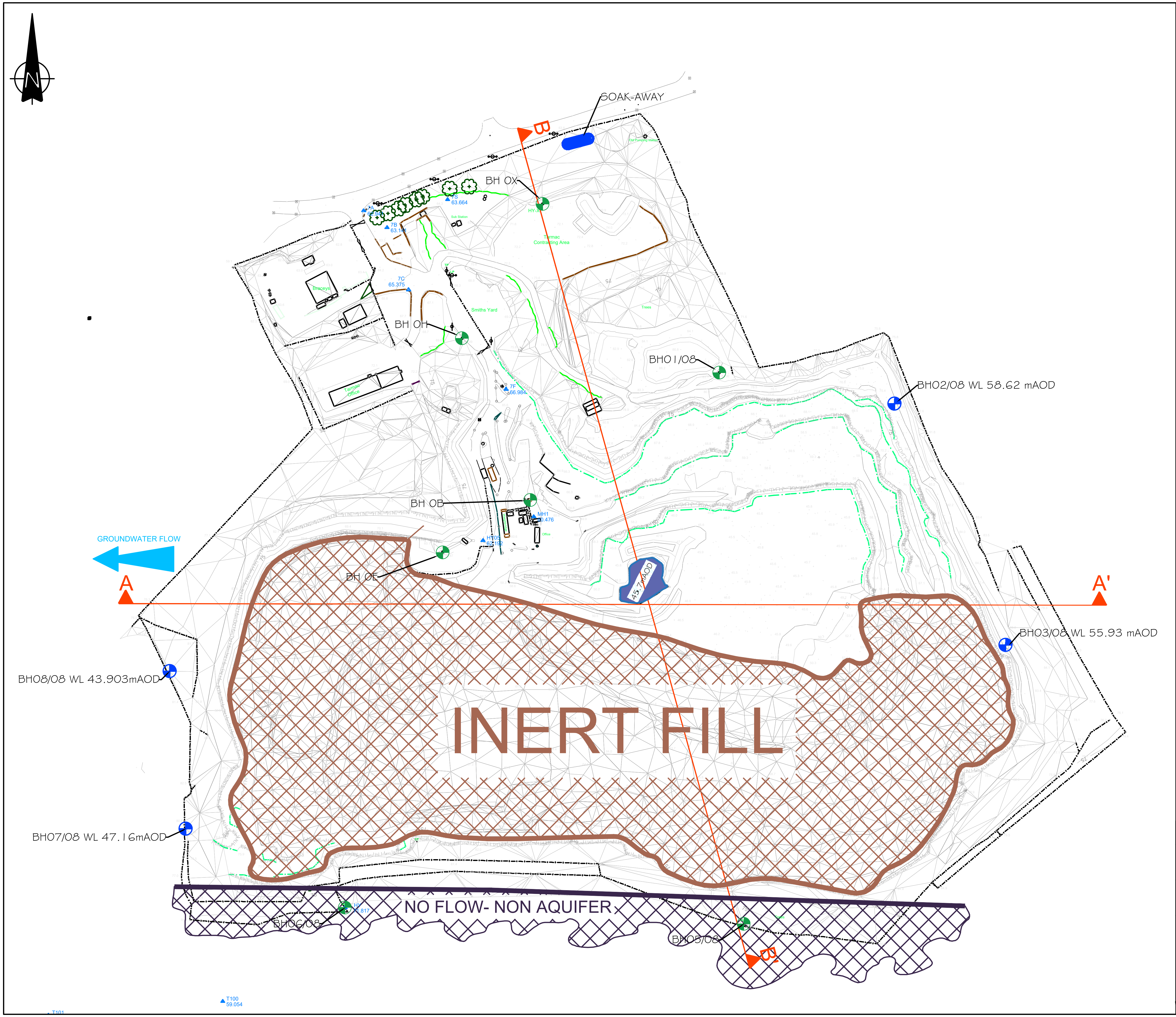
Site photos – 02/08/2018

Hendy sump

Hendy soakaway

Appendix C

Hydrogeological conceptual model drawings (Caulmert, 2018)



LEGEND

PZ02/0 PERMIT BOREHOLE LOCATION

PZ ADDITIONAL BOREHOLE LOCATIONS

SOAK-AWAY

PROJECT HENDY	
REPORT TITLE BOREHOLE LOCATION PLAN	
HRA 01	REPORT REF 3145

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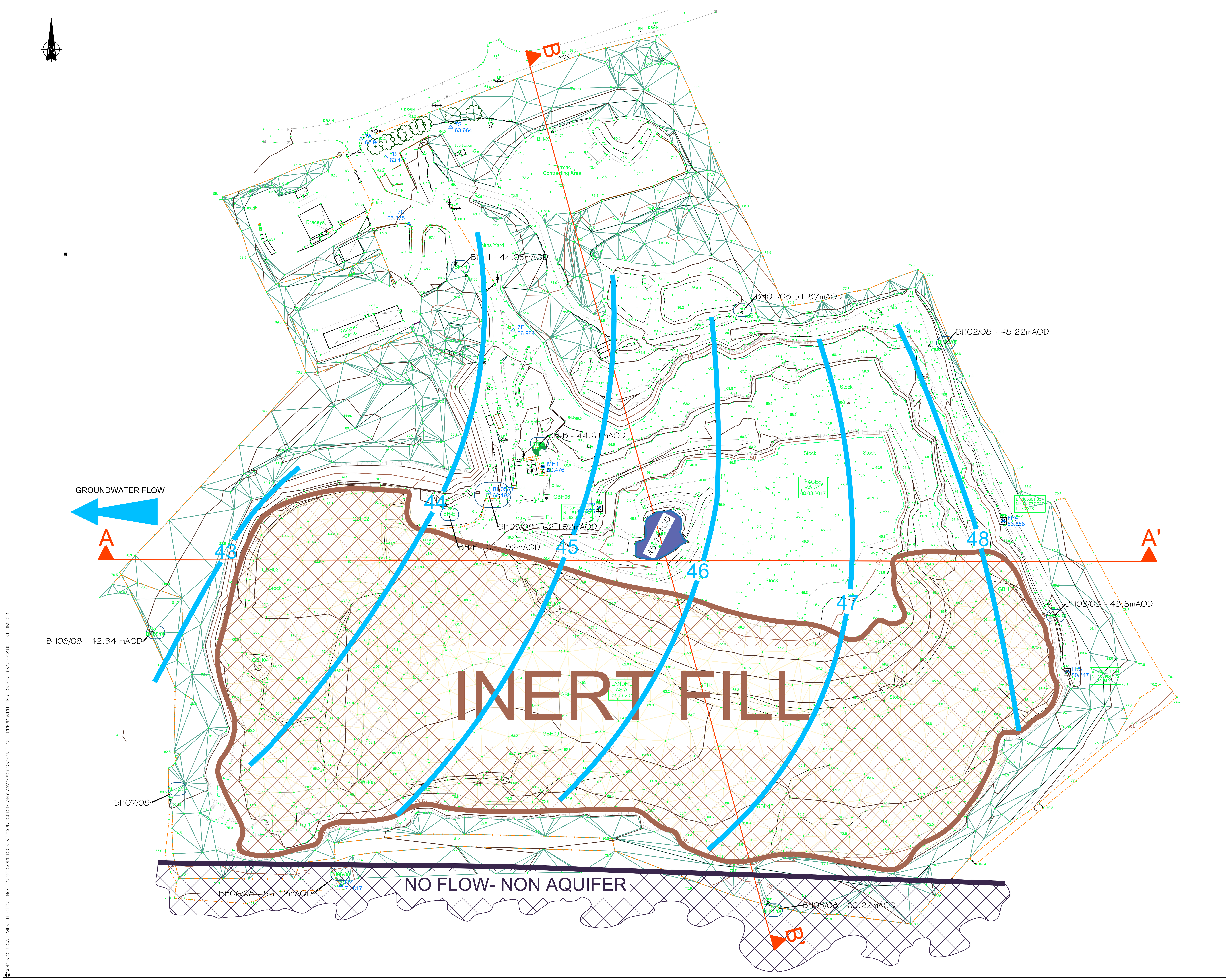

NOTE

1. DO NOT SCALE FROM THIS DRAWING, WORK FROM FIGURED DIMENSIONS ONLY. ALL DIMENSIONS ARE IN MILLIMETRES AND ALL LEVELS ARE IN METRES ABOVE ORDNANCE DATUM U.N.O.

2. NO DEVIATION FROM THE DETAILS SHOWN ON THIS DRAWING WILL BE ALLOWED WITHOUT THE PRIOR PERMISSION IN WRITING.

3. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS, ENGINEERS AND SPECIALIST DRAWINGS AND SPECIFICATIONS.

LEGEND

- INERT FILL
- NON FLOW, NON AQUIFER
- GROUNDWATER CONTOUR- 28.04.2015

PRELIMINARY DRAWING FOR INFORMATION PURPOSES ONLY

REV	MODIFICATIONS	BY	RE	AP	DATE
B	BOREHOLES ID AMENDED	EJD	SV	SV	09.01.18
A	GROUNDWATER CONTOURS	RP	SV	SV	18.09.17

TARMAC

PROJECT: HENDY

TITLE: CONCEPTUAL MODEL

DRAWN BY: RP	DATE: 04.07.2017	
REVIEWED BY: SV	SCALE @ A1: N.T.S.	JOB REF: 3145
AUTHORISED BY: SV	ISSUE: -	REVISION: B

DRAWING NUMBER: 3145.02

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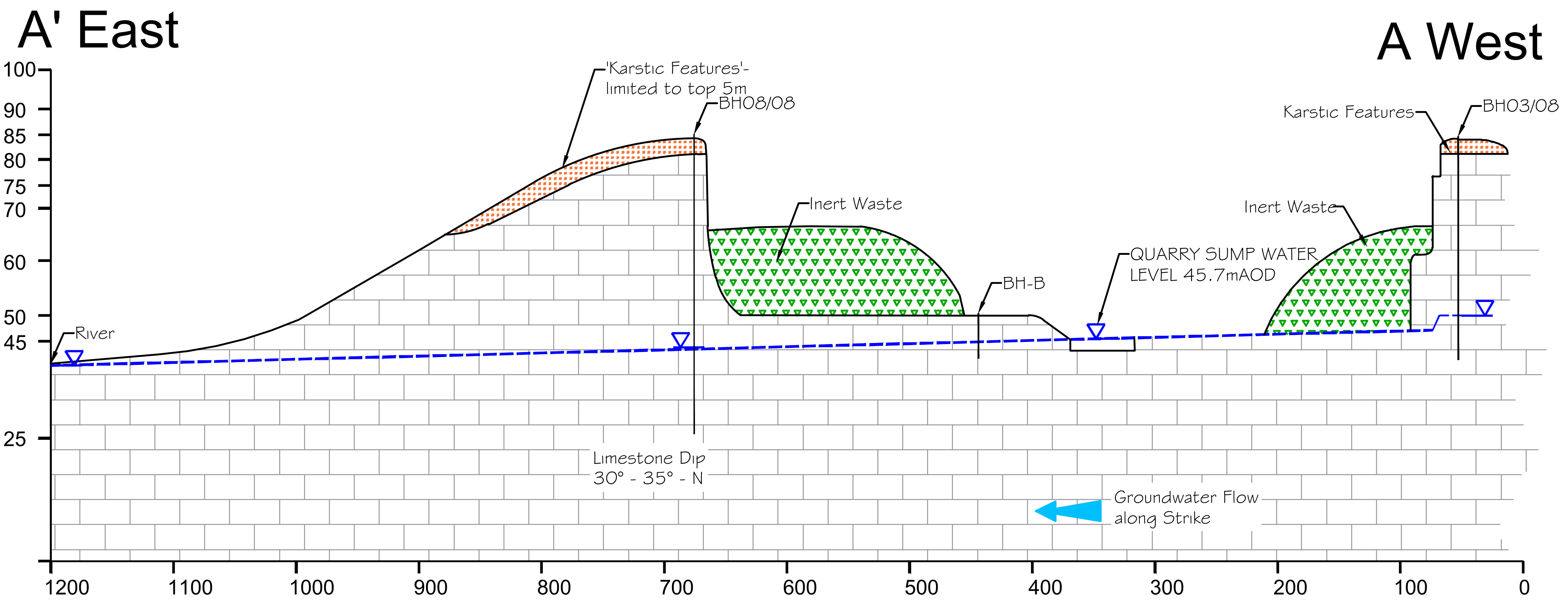

PROJECT	
HENDY	
REPORT TITLE	
CONCEPTUAL MODEL	
CROSS SECTION A-A	REPORT REF 3145.03

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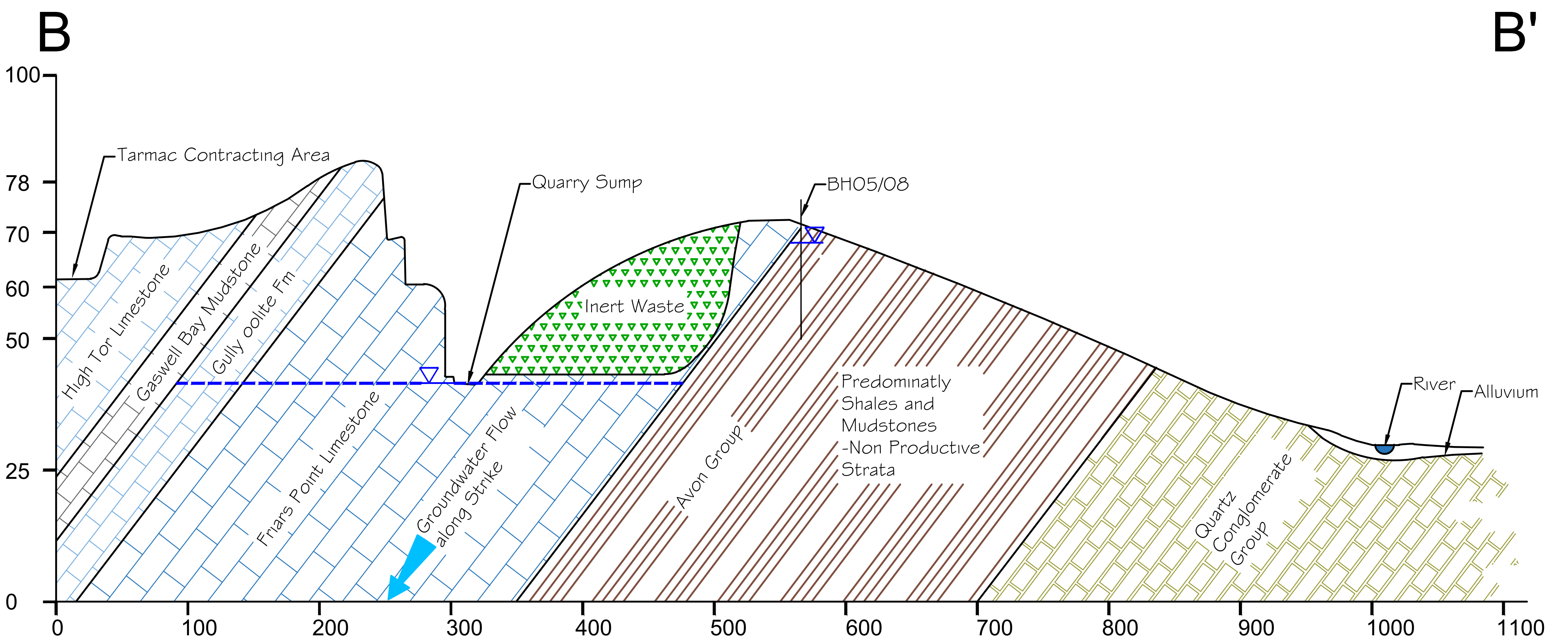

PROJECT	
HENDY	
REPORT TITLE	
CONCEPTUAL MODEL	
CROSS SECTION B-B	REPORT REF 3145.04

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Appendix D

Raw data calculation worksheet (electronic)