Limestone Research & Consultancy Limited

Hydrogeological assessment of dewatering at Bolton Hill Quarry, Tiers Cross, Haverfordwest, Pembrokeshire 2017 – 2018 hydrometric year

A report for

Gerald D Harries & Sons Limited

Rowlands View

Narberth

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by

Professor John Gunn

LRC Report 2019/07

February 2019

COMMERCIAL IN CONFIDENCE

CONTENTS

1. BRIEF

1.1 Gerald D Harries & Sons Ltd (GDH) have appointed Professor John Gunn of Limestone Research & Consultancy Ltd (henceforth LRC Ltd) as hydrogeological advisor with respect to their quarrying operations at Bolton Hill. These comprise the original quarry (BHQ) which is dormant but has ongoing dewatering and the extension (BHQE) which is actively worked.

1.2 The brief for the present report was to assess, using data collected on site, whether the dewatering operations during the hydrometric year 2017 - 2018 have had any adverse impacts on the local and regional hydrogeology.

2. PLANNING BACKGROUND

2.1 Previous LRC monitoring reports have discussed the planning conditions under which Bolton Hill Quarry operates. On 13 July 2018 GDH applied to Pembrokeshire County Council to vary certain planning conditions and on 17 January 2019 PCC issued a Section 73 Variation or Removal of Conditions notice (decision notice reference 18/0383/MN). Condition 25 which is relevant to the present report reads:

> **25. Ground and surface water monitoring shall be carried out in accordance with the 'Groundwater and surface water monitoring scheme' dated 31/10/2018, at all times, throughout the lifetime of the development.**
> ***Reason: To protect groundwater resources and water supplies, in order to prevent pollution of the water environment and to protect the environment.***

2.2 The groundwater and surface water monitoring scheme referred to in Condition 25 is as follows:

1. Rainfall inputs are measured using a data logging tipping bucket rain gauge located close to the haul road to the extension area (Figure 1). The continuous data are used to compute meteorological day (09:00 to 09:00) totals. An additional Meteorological Office specification 5" storage gauge, emptied every few days, provides a check on totals and a back-up in case of failure.
2. Total runoff from the site is measured at the NRW permitted discharge point which is the outlet from the lowest (most northerly) of three large water settling lagoons (Figure 1). A sharp-crest rectangular weir has been constructed in the outlet channel and an Odyssey capacitive water level logger, mounted in a stilling well, records depth over the weir at 15-minute intervals. Discharge is computed from depth over the weir using standard equations. The meteorological day (09:00 to 09:00) total volume of water discharged off-site is calculated from the 15-minute data. Hourly discharge is also calculated.
3. There are three groundwater monitoring boreholes around the perimeter of the site: BHEM-1, BHEM-2 and BHEM-3 (Figure 1). The depth to water in each borehole is measured monthly using a dip meter read to the nearest 0.01m. In addition, a DIVER data logger was installed in BHEM-1 in April 2014 and this records the water depth and temperature at 30-minute intervals. The boreholes were drilled to base elevations of 45m to 37.5m aOD and GDH have agreed that should groundwater elevations fall below a trigger level of 50m aOD then new boreholes will be drilled to 0m aOD in good time to allow monitoring to continue should groundwater elevations fall below the bottom of the existing boreholes.

4. A meter records the volume of water pumped from the extension area sump and this is read every 1-4 weeks.
5. Commencing on 12 November 2018 and approximately every four months thereafter, two springs, SP2 (SM 91903 10467) and SP4 (SM 92352 10287) will be the subject of a visual inspection in order to assess flow. The respective land owners will also be contacted to establish whether any changes in the behaviour of the springs has been observed.

2.3 The data logging rain gauge, the Odyssey and the DIVER data loggers are downloaded by LRC Ltd three times per annum. The rainfall collected by the storage gauge, the dip values, and the pump readings are measured by GDH quarry staff, entered onto a spreadsheet, and provided to LRC Ltd during each site visit. All monitoring data are retained in electronic form.

2.4 Reports will be produced annually in respect of each hydrometric year describing the monitoring regime, an analysis of the data produced and providing conclusions and recommendations. Once the reports have been finalised they will be submitted to PCC for consideration. The present report, which covers the 2017-18 hydrometric year, is the first to be submitted under this new planning condition although there have been three previous reports covering the period 21 October 2014 to 2 November 2015 and the 2015-16 and 2016-17 hydrometric years.

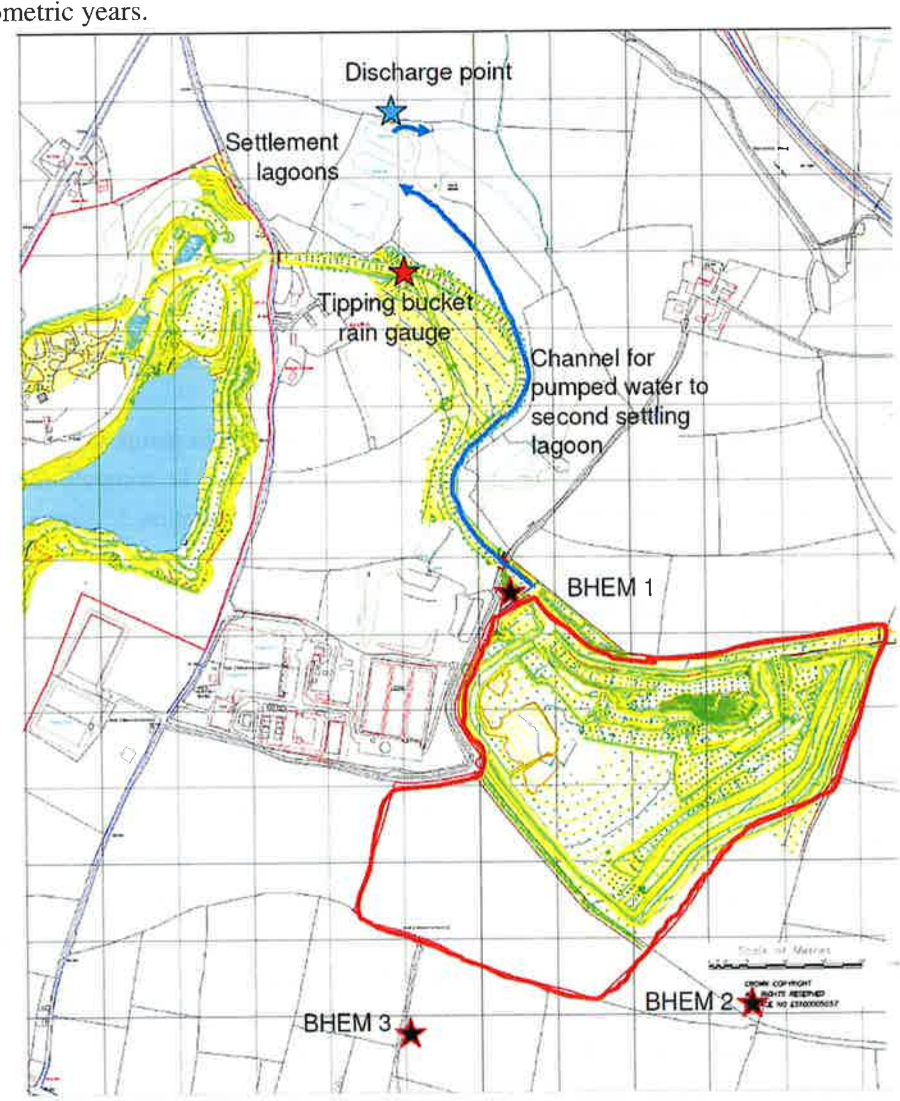

Figure 1: Monitoring Locations (extension area boundary shown in red)

3. QUALITY OF DATA COLLECTED IN THE 2017-18 HYDROMETRIC YEAR

3.1 As noted in LRC Report 2017/22, when the data-logging rain gauge was downloaded on 8 November 2017 some of the data after 28 July 2017 were clearly spurious. A replacement Hobo rain gauge was installed and when the problem gauge was removed and checked it was found that one of the wires had broken. A regression equation was established between the rain gauge in Blaencilgoed Quarry and the rain gauge in Bolton Hill Quarry using data from 1 October 2016 to 15 July 2017 and this was applied to predict the Bolton Hill to fill in the suspect data. Finally, the logger data were compared with the rainfall collected by the storage gauge and as in previous years it was found that the tipping bucket gauge was underestimating the catch of the storage gauge. Hence, a correction factor (0.92) was applied to bring the total annual rainfall at the data-logging rain gauge up to the total annual rainfall in the storage gauge. The same correction factor was applied to the missing data between 1 October 2017 and 7 November 2017 was estimated from the Blaencilgoed rain gauge using regression analysis. The Hobo gauge required a different correction factor which was based on the ratio between the total rainfall in the storage gauge and the total rainfall recorded by the Hobo over the period 8 November 2017 to 21 March 2018. The Davis gauge and logger were repaired and replaced on 22 March 2018 and the ratio between the total rainfall in the storage gauge and the total rainfall recorded by the Davis gauge over the period 22 March to 30 September 2018 was 0.90.

3.2 The Odyssey data logger on the outlet weir functioned satisfactorily throughout the monitoring period with no gaps in the record. The quality of the data was checked by comparing spot readings of a ruler attached to the side of the stilling well with logged data. There were 44 readings and the average depth from the ruler was 551.6mm and the average depth from the closest logger reading was 556.8mm, a difference of 5.2mm. Given the difficulty of reading the ruler to better than +/-3mm this is an acceptable result. However, there were differences of up to 120mm between individual spot and logger readings and these are of concern. As there is no evidence of problems with the logger it seems more likely that the ruler has from time to time been read incorrectly. Hence, it is recommended that a digital photograph be taken of the ruler and sent to LRC Ltd after each visit. The images will be stored and as they have a date/time stamp it will be possible to make a more accurate comparison with the logged data.

3.3 The data from the DIVER logger in BHEM-1 was compared with manual dip values (Table 1). There were 34 manual dips in 2017-18, a marked improvement on the 2016-17 year, and there was only one occasion when the dip elevation differed from the logged elevation by more than 5cm which is again a marked improvement. The dip elevations are plotted alongside the logged elevations on Figure 8 and it is clear that the aberrant dip lies off the data trend making it likely that there was an error in the manual measurement rather than with the logger.

Table 1: Groundwater elevations at BHEM-1 from manual dip measurements and the DIVER logger
(the date when the difference between observed and logged elevation was > 5cm is in bold red font)

	dip	logger	difference (m)
20/10/17 12:00	70.140	70.140	0.000
02/11/17 08:00	70.150	70.129	0.021
08/11/17 11:30	70.130	70.110	0.020
25/11/17 09:30	70.32	70.322	-0.002
01/12/17 16:00	70.47	70.449	0.021
15/12/17 09:30	70.48	70.506	-0.026
05/01/18 13:00	70.83	70.830	0.000
12/01/18 10:30	70.68	70.685	-0.005
19/01/18 09:00	70.67	70.671	-0.001
26/01/18 08:30	70.85	70.841	0.009
02/02/18 12:30	70.74	70.768	-0.028
09/02/18 09:30	70.66	70.658	0.002
16/02/18 12:00	70.64	70.689	-0.049
23/02/18 15:00	70.58	70.593	-0.013
01/03/18 09:00	70.52	70.490	0.030
10/03/18 15:00	70.59	70.550	0.040
16/03/18 11:30	70.68	70.690	-0.010
22/03/18 09:30	70.63	70.647	-0.017
29/03/18 09:00	70.550	70.544	0.006
06/04/18 09:00	70.620	70.623	-0.003
13/04/18 09:00	**70.470**	**70.576**	**-0.106**
27/04/18 08:30	70.330	70.360	-0.030
04/05/18 16:00	70.260	70.299	-0.039
18/05/18 08:30	70.160	70.199	-0.039
08/06/18 08:00	70.010	70.004	0.006
22/06/18 15:00	69.880	69.881	-0.001
04/07/18 10:30	69.780	69.775	0.005
06/07/18 08:00	69.770	69.772	-0.002
19/07/18 13:00	69.680	69.670	0.010
03/08/18 08:00	69.600	69.580	0.020
17/08/18 07:00	69.540	69.544	-0.004
31/08/18 07:30	69.570	69.562	0.008
14/09/18 08:00	69.510	69.502	0.008
28/09/18 07:30	69.660	69.664	-0.004

4. DATA ANALYSIS

4.1 The monthly rainfall totals from October 2017 to September 2018, as recorded by the tipping bucket rain gauge (with interpolated data and adjusted to storage gauge), are shown on Figure 2. The total rainfall was 1164mm, 87mm higher than in the previous hydrometric year. The wettest month was March 2018 (155.6mm) and the driest months were May and June both of which had 32mm of rain.

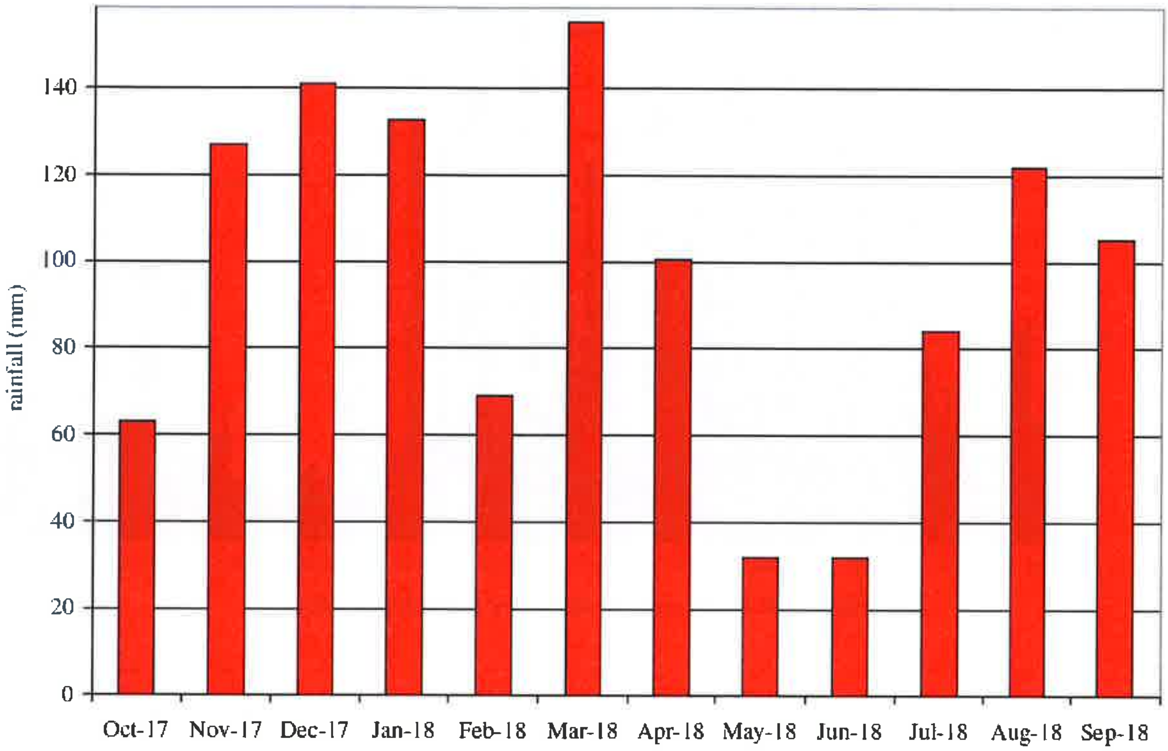

Figure 2: Monthly total rainfall at Bolton Hill Quarry, 2017 - 2018

4.2 Figure 3 shows the total daily volumes of water discharged off-site during the 2017 – 2018 hydrometric year. These were calculated using 15-minute data from the weir. The highest daily volume was 3882 cubic metres over the period 09:01 24 April - 09:00 25 April 2018. This was the only occasion when the permitted daily maximum of 3800 cubic metres was exceeded and the most likely reason is that during April there was a high pumping rate from the original quarry to control water depth (see Figure 5). It is notable that just five days later the volume discharged had dropped below 600m3/d.

4.3 Figure 4 shows the hourly average discharge off-site, calculated from the 15-minute weir data, for the 2017 – 2018 hydrometric year. The highest discharge was 50.2 L/s, well below the 60 L/s permitted maximum.

4.4 Figure 5 provides monthly totals for the volume of water pumped from the BHQE (extension area) sump, the volume of water derived from the remainder of the site (pumping from BHQ, the original quarry, and site runoff) and rainfall during the 2017 - 2018 hydrometric year. The combined total volume of water derived from BHQ and from site runoff was obtained by subtracting the measured amount pumped from BHQE from the total volume discharged off-site as measured at the outlet weir. Daily cumulative volumes are shown on Figure 7. During the 2017-2018 year 29% of the water discharged from the site came from BHQE and the remainder from BHQ and site drainage. The contribution from BHQE is above 2016-17 (23%) but down on 2015-2016 (39%) and 2014-2015 (31%).

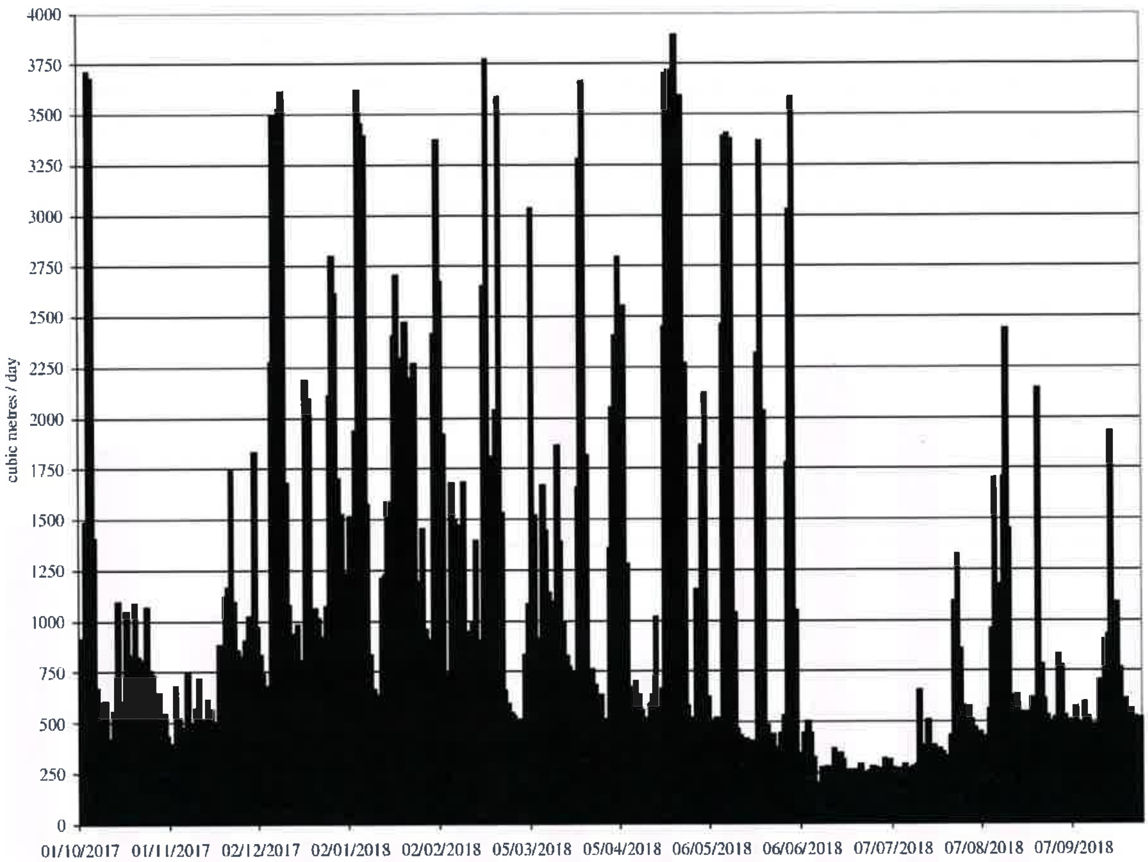

Figure 3: Daily volume of water discharged off-site

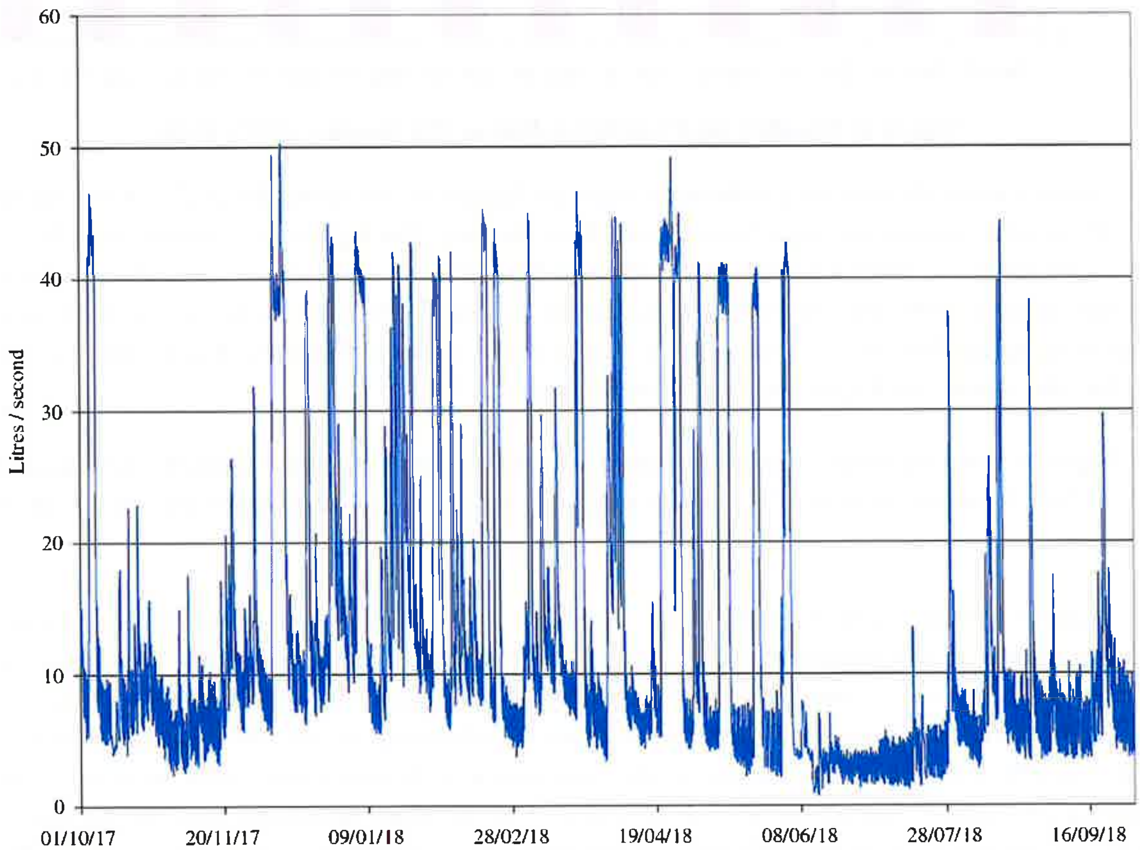

Figure 4: Average hourly discharge of water off-site

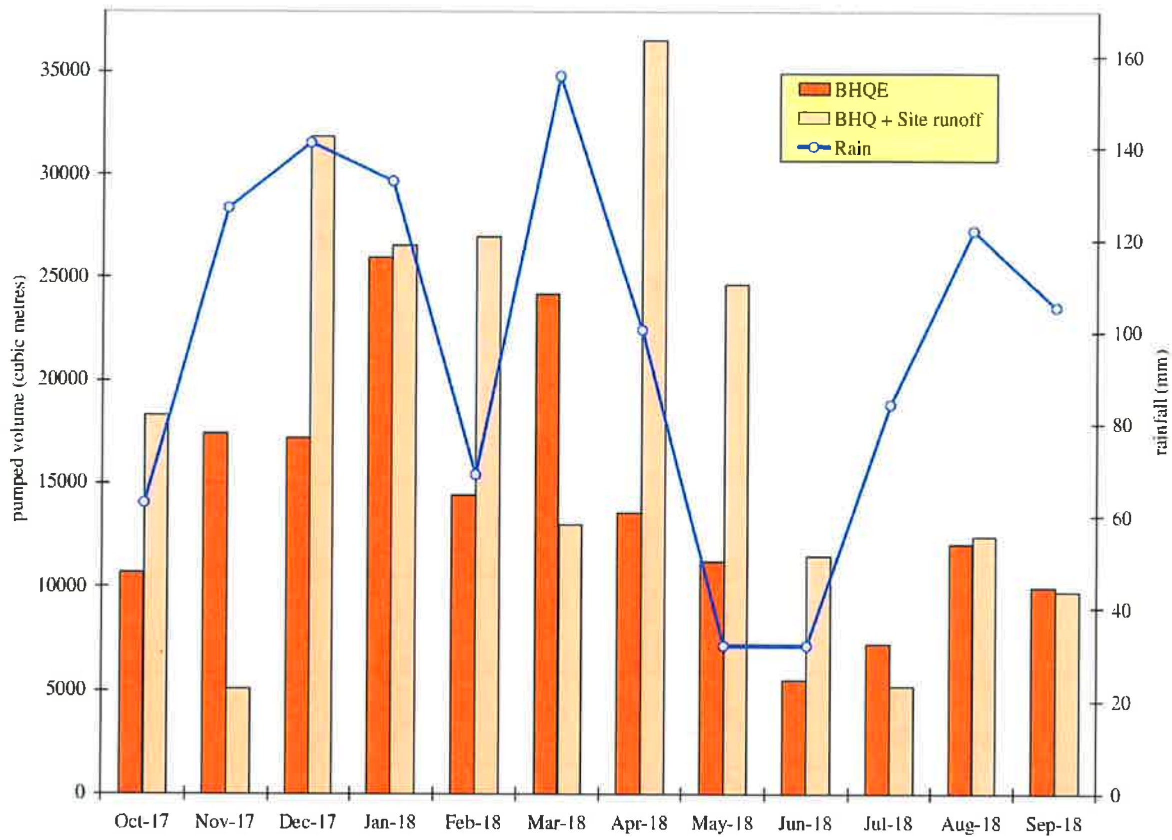

Figure 5: Monthly rainfall and total volumes pumped from BHQ+site and from BHQE

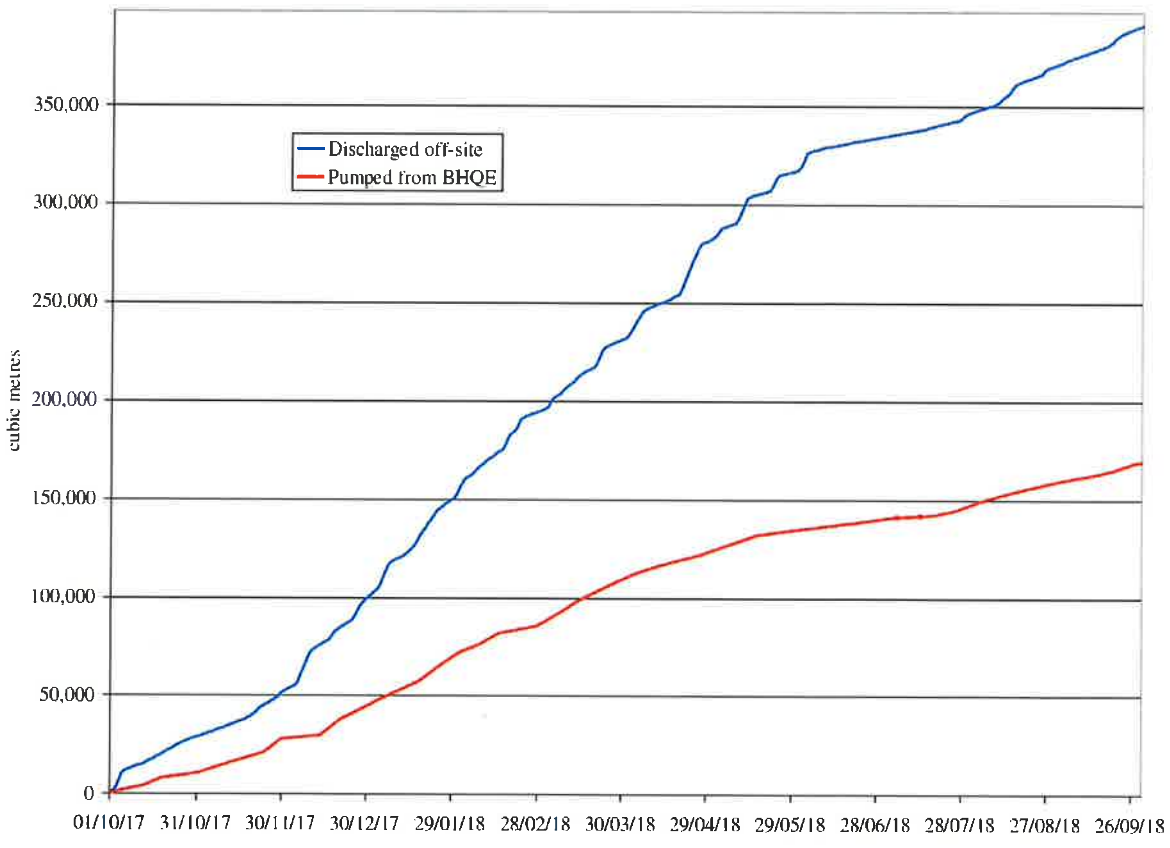

Figure 6: Cumulative volumes of water discharged off site and pumped from BHQE based on daily data (2017-2018 hydrometric year).

4.5 Figure 7 shows the water surface elevation in the three monitoring boreholes for the whole monitoring period, May 2009 - September 2018 and Table 2 provides descriptive statistics, between-site correlations and the lowest elevation in each hydrometric year. There is a very strong correlation between borehole groundwater elevations (r>0.90) which are lowest in late summer and early autumn and highest in winter, broadly reflecting seasonal rainfall patterns. The range and average are both (BHEM-3) > (BHEM-2) > (BHEM-1), suggesting a hydraulic gradient towards the north. The lowest groundwater elevations over the monitoring period were in 2010-11 (BHEM-1 and 2) and 2014-15 (BHEM-1) and it is clear that to date pumping has not had any impact on groundwater elevations.

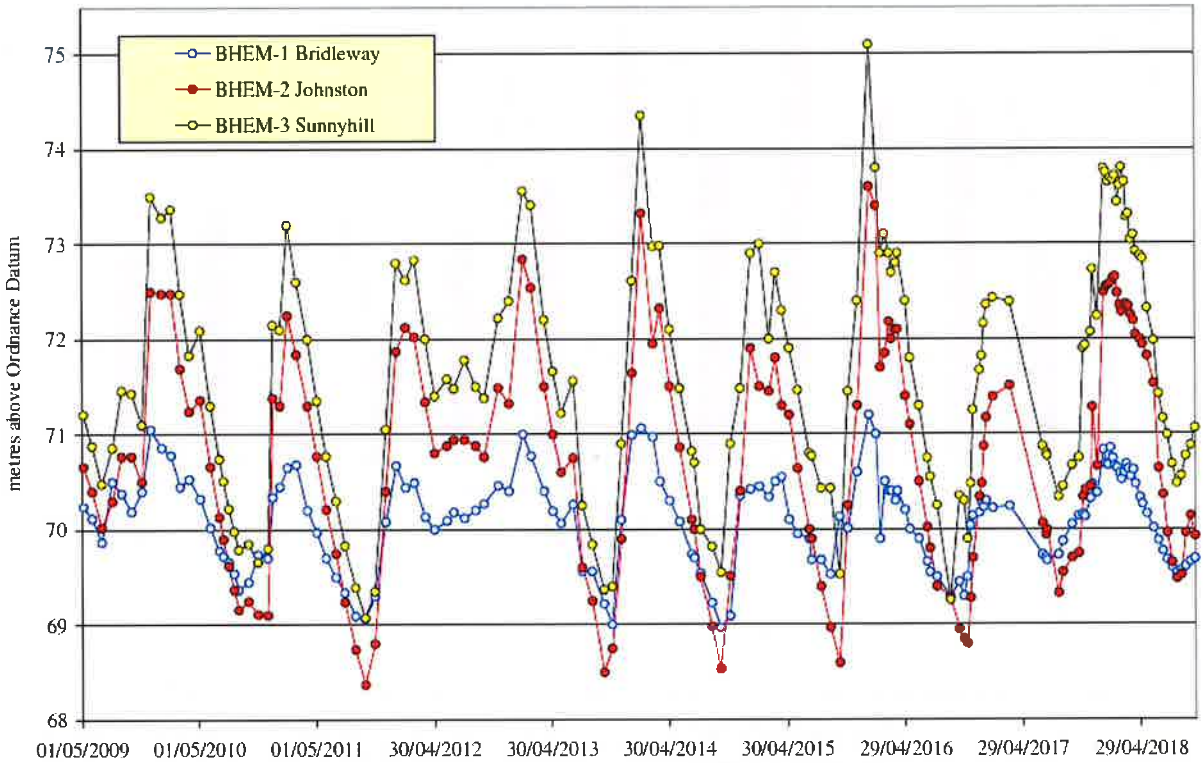

Figure 7: Groundwater elevations in the monitoring boreholes

Table 2: Groundwater elevation (m, aOD) descriptive statistics, correlation and minima
(**red bold font** is the lowest elevation over the 2009-2018 monitoring period)

	BHEM-1 Bridleway	BHEM-2 Johnston	BHEM-3 Sunnyhill
max	71.20	73.60	75.10
min	68.97	68.37	69.07
range	2.23	5.23	6.03
average	70.11	70.80	71.67
Minimum			
2009 - 2010	69.37	69.16	69.79
2010 - 2011	69.06	**68.37**	**69.07**
2011 - 2012	69.30	68.80	69.35
2012 - 2013	69.56	69.25	69.84
2013 - 2014	69.00	68.50	69.37
2014 - 2015	**68.97**	68.54	69.55
2015 - 2016	69.29	69.33	70.34
2016 - 2017	69.30	71.94	72.84
2017 - 2018	69.54	69.48	70.48

CORRELATION MATRIX		
	BHEM-1	BHEM-2
BHEM-2	0.902	
BHEM-3	0.905	0.974

4.6 In LRC Report 2017/22 it was noted that the manual dips were not being recorded at sufficiently frequent intervals. The situation was markedly better in 2017-18 with all three readings 21 days apart and the remainder at 14 day intervals or less.

4.7 The 30-minute groundwater elevation and water temperature in BHEM-1 are shown on Figure 8 and it can be seen that there is a very good match with the manual dips with only one aberrant value. The elevation data show a long seasonal recession from April to August but there is a 'saw-tooth' pattern with increasing amplitude that ends abruptly on 23 June. This type of pattern is commonly caused by pumping but careful examination of the data revealed that in this case there was a problem with the BaroLogger used to compensate the data. The Baro location was experiencing temperatures of up to 30°C which were causing the apparent pressure to rise by up to 8mb (Figure 9). On Figure 9 the pressure recorded by the Diver in BHEM-1 shows small changes but the Baro-logger records large increases in pressure during the day due to high temperature. Subtraction of the baro-logger pressure from the Diver pressure yields a pattern that has marked changes in groundwater elevation. After 23 June the barometric pressure was recorded in a location with a stable temperature and there was no further saw-tooth variability.

4.8 The water temperature in BHEM-1 exhibits only a very small seasonal change which is typical of groundwater that has a long residence-time and has come to equilibrium with the rock temperature.

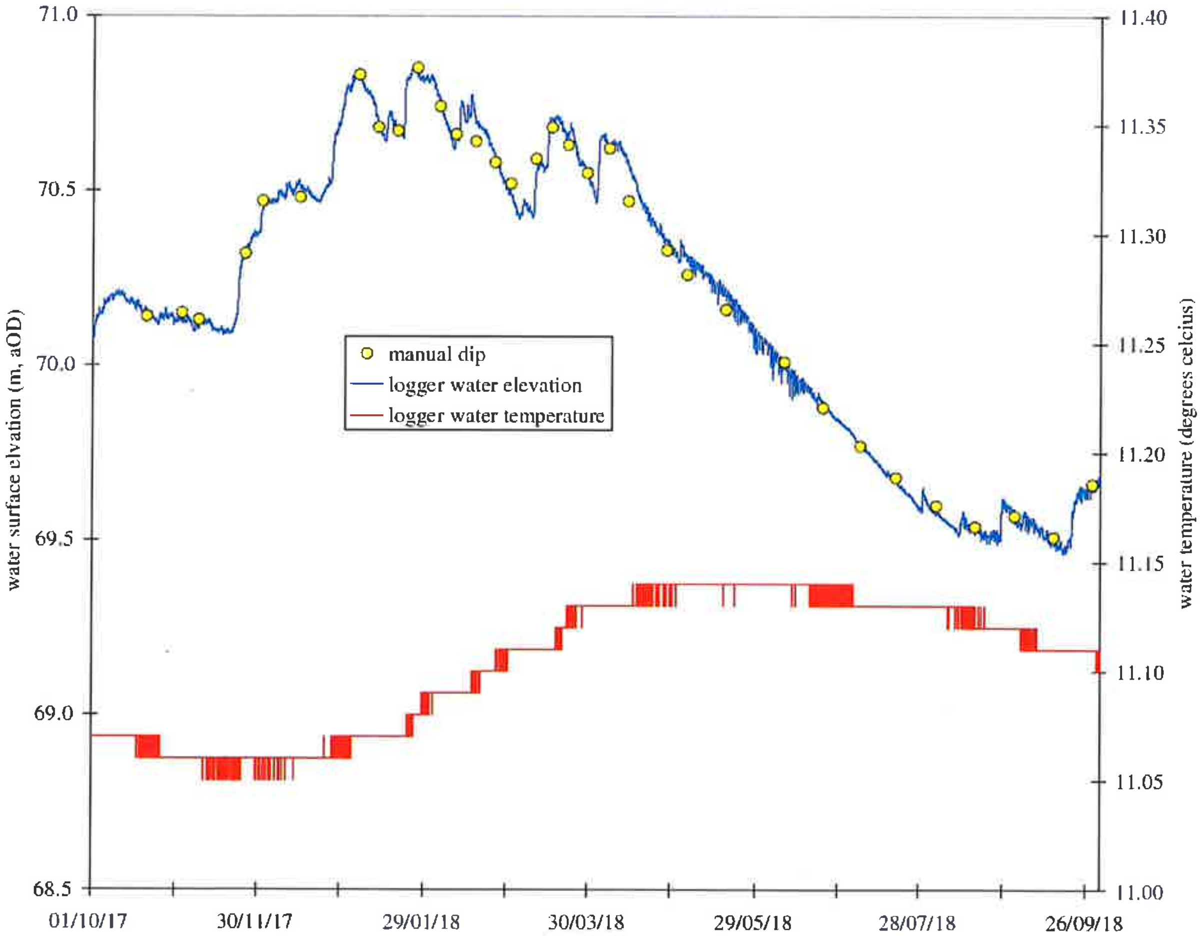

Figure 8: Groundwater elevation and temperature data for BHEM-1
(30-minute data logging and manual dip measurements)

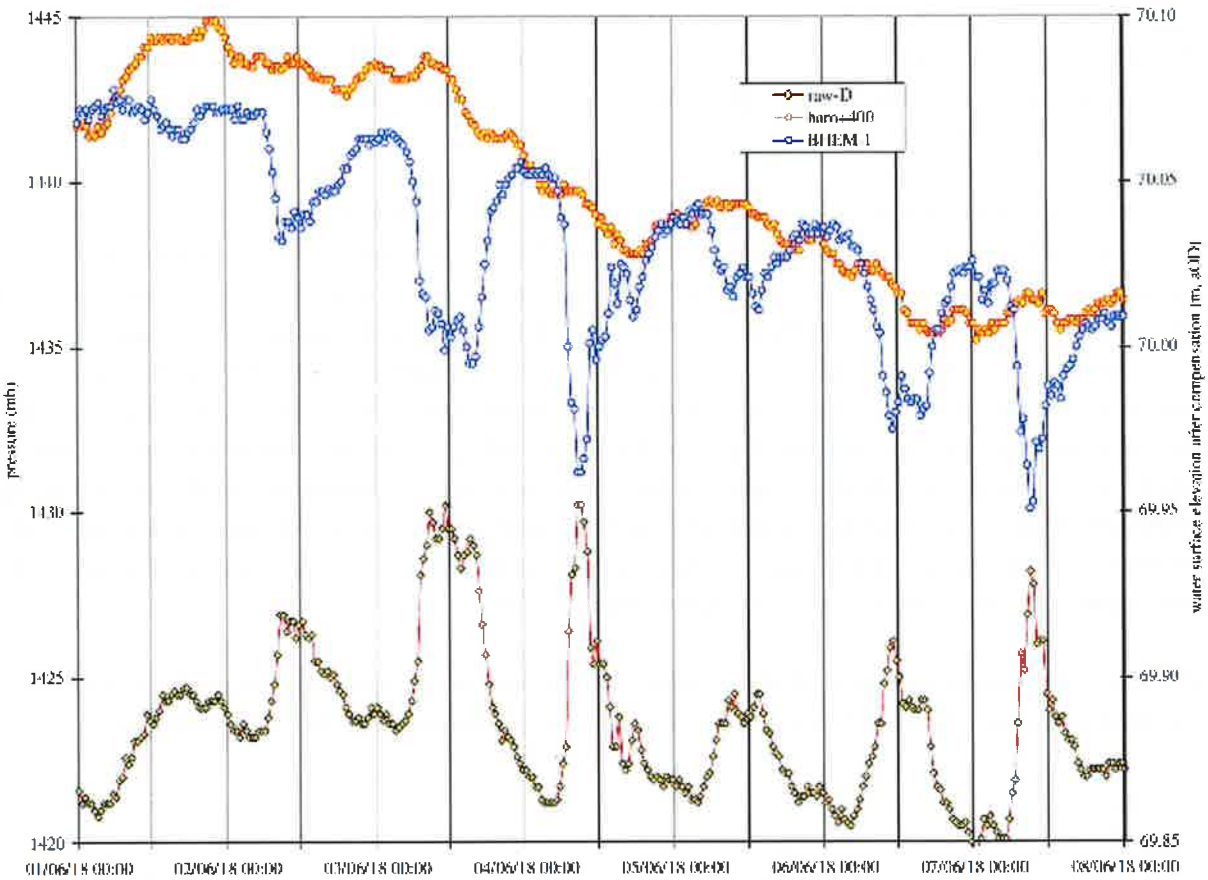

Figure 9: Data to illustrate the influence of aberrant barometric pressure on apparent groundwater elevation in BHEM-1

4.9 To assess the likely provenance of the water discharged off-site approximate monthly water balances during the 2017 - 18 hydrometric year have been constructed for BHQ and for BHQE using the equation:

Input [CA * EP] = Output [PU] ± ΔS

where

CA = catchment area (m^2)

EP = effective precipitation (m)

PU = volume of water pumped from the site (m^3)

ΔS = change in water stored on site (m^3)

CA

4.10 The catchment for BHQ is approximately 26ha of which about 14.6ha drains directly into the sump. In addition an area of about 1.6ha drains into the settlement lagoons giving a total catchment of 27.6 ha (276,000m^2). The catchment for BHQE is approximately 18.2ha (182,000 m^2) most of which drains directly into the sump.

EP

4.11 The effective precipitation input to a site is commonly obtained by subtracting evapotranspiration outputs from the precipitation inputs. At Bolton Hill the centrally located rain gauge provides a representative measure of rainfall inputs although any periods of snowfall are likely to be under-recorded. Evapotranspiration outputs are particularly difficult to assess due to the varied nature of the site. Evaporation from open water bodies (the quarry sumps and the settlement lagoons) could be estimated using data from the evaporation pan at the GDH Blaencilgoed Quarry. However, in BHQ the sump and settlement lagoons occupy only 12.5% of the catchment area and in BHQE the sump, and areas of standing water on the quarry floor, occupy less than 5% of the catchment. There is some scrubby vegetation, particularly in the area around the settlement lagoons, and these areas will be subject to evapotranspiration losses. However, more than 75% of the BHQ area and more than 90% of the BHQE area has no vegetation and rainfall will either infiltrate or run-off towards the quarry sumps from which there are only evaporative losses. Given the uncertainties, a simplifying assumption has been made that over the whole site 15% of precipitation inputs are lost to evapotranspiration.

PU

4.12 The volume of water discharged off-site is measured at 15-minute intervals and these values were summed to obtain monthly volumes. The total volume of water pumped from BHQE is recorded by a meter and an average daily volume is obtained by dividing the difference between successive readings by the number of days between those readings. However, the actual pumping rate is likely to be much more variable, as can be seen in the site discharge graphs (Figures 3 and 4). During the 2017 - 18 hydrometric year the meter was read at intervals of 1 to 14 days. The difference between the volume of water discharged off-site and the volume of water pumped from BHQE is assumed to be equivalent to net pumping from BHQ and any site drainage.

ΔS

4.13 Water is stored in the quarry sumps, in the settlement lagoons, in the soil (where present) and in the rock as groundwater. Over a hydrometric year it is commonly assumed that there is no significant change in soil and groundwater storage and the same assumption can be made for the sumps and settlement lagoons (that is $\Delta S = 0$). However, the storage term may be significant on a month by month basis. For example, for operational reasons water may be allowed to accumulate in the quarry sumps for a period near the end of one month and pumped out during the next month.

The water balances

4.14 Table 3 shows the monthly water balances and the annual balance for BHQE and for the remainder of the site. The volume of water pumped from BHQE exceeded the estimated recharge in five months but in the other seven months and over the hydrometric year there was a surplus of 10,649m^3. There were also five months when the volume of water pumped from the remainder of the site exceeded the estimated recharge but there was a surplus of 51,265m^{3}over the hydrometric year. The month to month variability can be explained by rainfall intensity and the relatively low rock permeability. When rain falls at a high intensity it generates site runoff which goes directly into the quarry sumps. The same amount of rain falling at a lower intensity will generate less site runoff with more water infiltrating into the superficial deposits (where present) and rock. Water that has infiltrated moves slowly downwards towards the water table and this is the groundwater component of water pumped from the quarry sumps. As a consequence, rain falling in one month and infiltrating to bedrock is not pumped out until a later month. The effects can be seen when comparing BHQ data for October and November. October has half the rainfall of November but three times more pumping. Similarly, the rainfall in July 2018 was 2.6 times higher than in June but the pumping from BHQE only increased by a factor of 1.3. Changes in storage in the BHQ sump provide an additional complication. The area of the sump in BHQ is approximately 27,500m^2 so that a change in water depth of 30cm is equivalent to a change of volume of 8250m^3. These issues notwithstanding, over the hydrometric year as a whole there was continued recharge to groundwater making it highly unlikely that dewatering is having any adverse impacts on local or regional groundwater levels.

Table 3: Water balance for BHQ and BHQE

(months when water output exceeded input are highlighted in bold red font)

		BHQ (including site drainage)			BHQE		
	Rainfall (mm)	[CA * EP] (m^3)	PU (m^3)	[(CA*EP) - PU] (m^3)	[CA * EP] (m^3)	PU (m^3)	[(CA*EP) - PU] (m^3)
Oct-17	62.9	14,762	18,305	**-3,542**	9,735	10,681	**-947**
Nov-17	127.0	29,793	5,098	24,694	19,646	17,399	2,247
Dec-17	141.1	33,107	31,866	1,241	21,831	17,206	4,625
Jan-18	132.7	31,134	26,529	4,604	20,530	25,955	**-5,425**
Feb-18	69.0	16,181	26,959	**-10,779**	10,670	14,425	**-3,755**
Mar-18	155.6	36,514	13,010	23,505	24,078	24,204	**-125**
Apr-18	100.4	23,564	36,576	**-13,012**	15,539	13,592	1,946
May-18	32.0	7,507	24,679	**-17,172**	4,950	11,238	**-6,288**
Jun-18	32.0	7,507	11,492	**-3,984**	4,950	5,528	-577
Jul-18	84.2	19,759	5,172	14,587	13,029	7,215	5,815
Aug-18	122.0	28,621	12,435	16,186	18,873	12,052	6,822
Sep-18	105.3	24,711	9,775	14,936	16,295	9,983	6,312
Year	**1164.4**	**273,161**	**221,896**	**51,265**	**180,128**	**169,478**	**10,649**

Notes:

CA (catchment area) = 276,000m^2 (BHQ) and 182,000m^2 (BHQE).

EP (effective precipitation) = 0.85 * rainfall.

PU (volume of water pumped from the site) of BHQE is from meter readings.

PU of BHQ is by subtraction of PU(BHQE) from the total volume of water discharged off-site.

5. CONCLUSIONS

5.1 A robust monitoring regime is in place to record the data needed to evaluate any hydrogeological impacts from (1) the dewatering operations at BHQE and (2) the ongoing pumping of water from BHQ required to maintain a safe water depth in the quarry sump.

5.2 The monitoring data confirm that the quarry has complied with the hourly volume limits set in the NRW permit although there was one day when the volume discharged was slightly above the daily limit.

5.3 On the basis of the water balance calculations it is highly unlikely that the dewatering operations have produced any adverse impacts on local or regional groundwater levels. This is consistent with groundwater depth measurements at the three observation boreholes which have shown the same trend since 2009.

5.4 In addition to the monitoring that has been ongoing since 2009 the 2018 groundwater and surface water monitoring scheme introduced a requirement to visually monitor two springs, SP2 (SM 91903 10467) and SP4 (SM 92352 10287). The springs are shown on Figure 2.05 in a report by White Young Green (WYG) that formed part of a 2007 planning application (Figure 10). On page 33 of the report WYG state that:

- At the time of the field visit it was not possible to access any of the springs due to thick, overgrown vegetation and lack of permission where these were located on private property. As a result, it was not possible to quantify their flow regime and assess whether they were flowing at the time of the visit.

BOLTON HILL QUARRY
Chapter 2

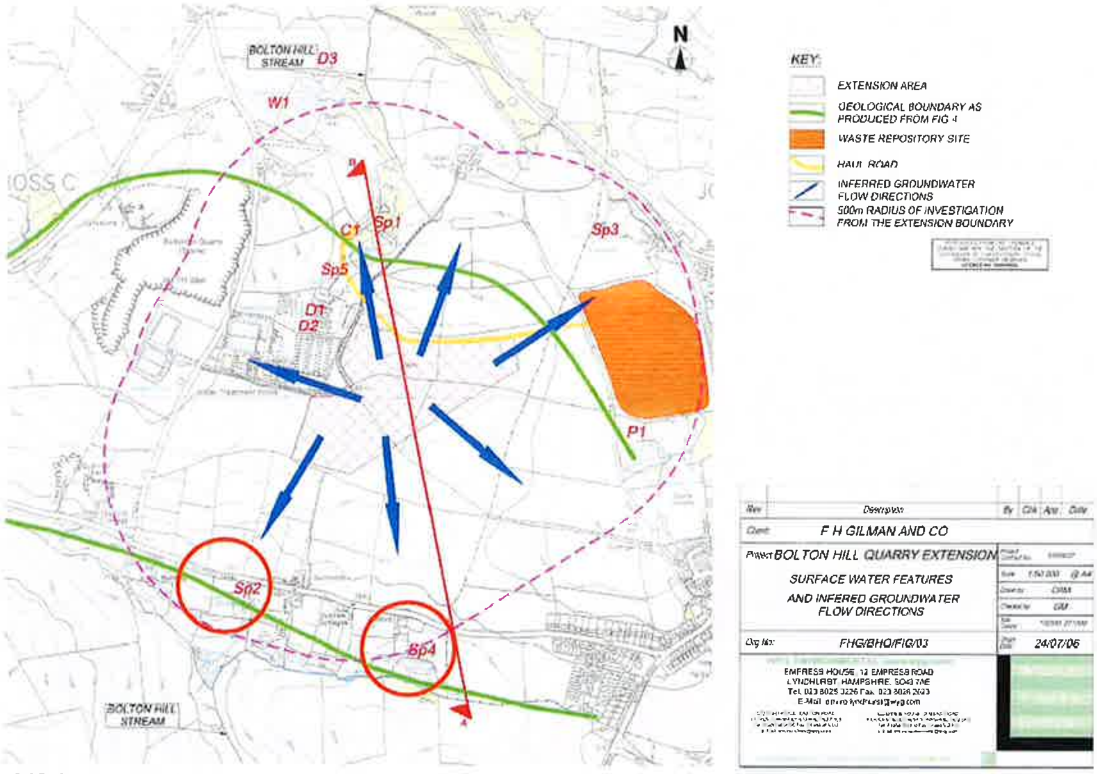

Figure 2.05: Surface Water Features

Figure 10: Reproduction of Figure 2.05 from the White Young Green (2006) Environmental Impact Assessment for the proposed extension to Bolton Hill Quarry. Springs Sp2 and Sp4 are circled.

5.5 The lack of any form of description or baseline is unfortunate because when the sites identified as having springs were visited on 15 November 2018 it was difficult to ascertain which features were to be visually monitored. The only water feature at the location labelled as SP2 is a large pond with no obvious outlet (Figure 11). An aerial image shows no obvious springs in this area although springs are shown in the area to the west of the pond on an early Ordnance Survey map. LRC ltd suggest that there may have been small ephemeral seeps in this area the past that were recorded by the Ordnance Survey and that it was on this basis that WYG recorded them in their EIA. The fields have subsequently been drained to improve the land for agriculture and the springs have been lost.

Figure 11: Aerial image from 'Bing Maps' of location shown as "Sp2" by WYG and photograph of pond (arrow on aerial image) taken by LRC on 15 November 2018.

5.6 Similar problems were encountered at "Sp4" where there are two ponds used for fishing. The owners stated that the ponds were thought to be sustained in part by groundwater but there were no obvious orifices in the area. However, a small spring was identified to the west of the ponds (Figure 12). This feature clearly has a very low flow and appears to emerge on the top of a clay layer suggesting it comprises local drainage.

Figure 12: Ponds and small spring in the location shown as Sp4 by WYG.
(The aerial image is from Bing Maps)

5.7 To comply with planning requirements Sp2 and Sp4 sites will be visited in March 2019 and at approximately four-monthly intervals thereafter.

6. RECOMMENDATIONS

6.1 It is recommended that the present on-site monitoring network is maintained, viz:

1. Storage rain-gauge to be emptied on the first day of each month (or as close to that day as possible if the first is not a working day) and every 5-7 days during the month with an increased frequency at times of heavy rainfall. Data logging rain-gauge to be downloaded three times per annum.
2. Manual readings of stage (water depth) at the outlet weir to be made at approximately weekly intervals to coincide with sampling that is undertaken to check compliance with water quality conditions on the NRW consent. Whenever possible a digital photograph should be taken of the ruler and sent to LRC Ltd. The images will be stored and as they have a date/time stamp it will be possible to make a more accurate comparison with the logged data
3. Data logging water depth recorder to be downloaded three times per annum.
4. Meter on the pump from BHQE to be read at least once a week from November to February and at least once every two weeks in other months.
5. Water depth in the three monitoring boreholes to be recorded by manual dipping once a month.
6. Data logging water depth recorder in BHEM-1 to be downloaded three times per annum.

6.2 The monitoring data should be analysed to determine trends and to assess the likelihood of any impacts on the water environment and an annual monitoring report should be compiled.

6.3 To comply with planning conditions the areas named by WYG as Sp2 and Sp4 should be visited in March 2019 and at approximately four-monthly intervals thereafter.