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Aggregates Express

Forest Wood Quarry

Pontyclun, Vale of Glamorgan

Hydrogeological Impact Appraisal

March 2024

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BCL CONSULTANT HYDROGEOLOGISTS' EXPERIENCE & QUALIFICATIONS

BCL is an independent consultancy specialising in all aspects of hydrogeology and hydrology as they relate to minerals extraction, waste disposal, water supply and related industries.

Gavinder Meetca (the author of this report) holds an honours degree (B.Sc. Exploration and Resource Geology) conferred by Cardiff University, 2017 and a Master of Science Degree (M.Sc. Hydrogeology), conferred by the University of Birmingham, in 2018. Gavinder has worked as a hydrogeologist since 2018.

BCL has provided specialist services, advice and reporting to the extractive, waste and related industries since 1990. During this time a collective 100+ years of experienced has been earned from involvement with wide variety of assignments. BCL's work has included:

- Installation and management of information collection systems;
- Data interpretation;
- Conceptualisation of hydrogeological systems;
- Identification of potential impacts;
- Formulation of mitigation measures;
- Management and undertaking of operational impact monitoring and impact assessment;
- Review and auditing of contingency mitigation schemes;

1. INTRODUCTION

1.1 Background

1.1.1 Forest Wood Quarry (the Site) is an existing limestone quarry operated by Aggregates Express Ltd (AE), located south of Llanharry, Pontyclun, South Wales (*figure 1*).

1.1.2 The Site has been in operation for over 30 years under previous operators, with dewatering taking place throughout this time to allow for limestone extraction at depth. Under new regulations, dewatering operations such as that previously undertaken at the Site require an abstraction licence.

1.1.3 BCL Hydro (BCL), agents of AE, have been in discussions with Natural Resources Wales (NRW) and have been requested to undertake a Hydrogeological Impact Appraisal (HIA) in support of an application for an abstraction licence for dewatering (transfer licence) at the Site.

1.2 Scope of Assessment

1.2.1 The scope of the HIA has been informed by national and local planning policies and associated guidance which all reinforce the need to pay due regard to the likely effect of the Proposed Development upon various aspects of the water environment.

1.2.1 National Policy & Guidance

1.2.1.1 Relevant current national policy documents and associated guidance that have been consulted include:

- “Hydrogeological impact appraisal for dewatering abstractions – SC040020/SR1”, Environment Agency (EA), May 2007.
- “Minerals Planning Policy (Wales), Minerals Technical Advice Note (Wales), 1: Aggregates”, Welsh Assembly Government (WAG), March 2004;
- “Planning Policy Wales, Technical Advice Note 15: Development and Flood Risk” (TAN15), WAG, July 2004,
- "Rainfall Runoff Management for Developments”, Kellagher R, joint DEFRA / Environment Agency (EA) Flood and Coastal Erosion Risk Management R&D Programme, Report SC030219, October 2013;
- “The SUDS Manual v5”, Construction Industry Research and Information Association (CIRIA): report no. c753, 2015, and;
- "The Environment Agency’s Approach to Groundwater Protection”, EA, v1.1, February 2018.

1.3 Methodology & Outcomes

1.3.1 Approach and calculation methodologies referenced as part of the Assessment are listed at appendix 1.

1.3.2 The impact assessment procedure adopted is summarised below:

- Baseline characterisation of the local water environment, leading to the development of a conceptual hydrogeological model (the Conceptual Model)

describing the nature of (and interactions between) groundwater and surface-water systems operating within and around the Site;

- Application of the Conceptual Model to assist Impact assessment of the Proposed Development upon that environment. The assessment process is iterative; initial study aiming to identify significant potential impacts associated with early-draft project design;
- Where significant potential impacts have been identified, alterations to the project design and / or specific mitigation measures have been adopted to eliminate, reduce or compensate for those potential impacts,
- Description of residual impacts and;
- Development of monitoring strategy

1.4 Site Reconnaissance

1.4.1 A site visit was conducted by BCL on 31/05/23 to inspect the water management system whilst noting any updates to historic practices / layout, assess the status of historic groundwater monitoring points and to undertake the water features survey.

2. BASELINE CONDITIONS

2.1 Site Setting and Study Area

2.1.1 Site Location

2.1.1.1 The Site is situated approximately 3 kilometres (km) southwest of Pontyclun, Mid Glamorgan and 750 metres (m) south of the M4 Motorway, centred upon NGR: 301684, 179711. A Site location plan is provided at *figure 1*.

2.1.1.2 The Site is bound by various parcels of farmland to south, Fforest Road to the west and a straight track originating from Cowbridge Road to the east. This track acts as the main access route to the Site.

2.1.2 Topography and Landform

2.1.2.1 The topography surrounding the Site is typical of the Welsh countryside, characterised by rolling hills, valleys, and scattered woodlands.

2.1.2.2 The Site itself is situated in an area of grassy hills generally sloping towards the southeast, farmland and scattered woodlands. In the immediate vicinity of the Site, historic quarrying workings create a bowl-like depression in a hill sloping east towards a valley.

2.1.2.3 Topographical cross-sections are provided at *figure 2.*

2.1.2.4 To the west of the Site, elevation gently falls from *circa* (*c.*) 90 metres above Ordnance Datum (maOD) to c. 55 maOD to the east. Within the extraction area, ground elevations steeply fall from 80-90 maOD to the historical base of workings of c. 4 maOD. It is of note that no deepening of workings has been undertaken since at least 2012.

2.1.2.5 The closest residential properties are located adjacent to the western Site boundary on Fforest Road, or approximately 90 m north of the perimeter of current workings.

2.1.3 Land Use

2.1.1 In addition to the limestone quarry itself, the Site comprises a processing plant, settlement ponds, a small quarry office, complete with weighbridge, wheelwash and parking area.

2.1.2 The Site is host to multiple operators who manage other facilities within the quarry.

2.1.4 Ecological Designations

Statutorily Protected Sites of Ecological Importance

2.1.4.1 Details of statutorily protected ecological sites within a 4 km radius of the Site have been obtained from the NRW.

2.1.4.2 The identified sites are located as shown at *figure 3*, with summary detail below at *table 1*.

2.1.4.3 The Breigam Moor Site of Special Scientific Interest (SSSI) lies some 2.6 km to the west of the Site boundary at the closest approach. The northern section of the Ely Valley SSSI also partially extends into the area of search, located some 3.4 km to the east of the Site.

2.1.4.4 There are no wetlands of international importance (RAMSAR), Special Protection Areas (SPAs) nor National Nature Reserves (NNRs) recorded within the local area.

Table 1 Statutorily Protected Sites			
Site Name	**Distance* and Direction from Proposed Development**	**Designation**	**Summary Description**
Breigam Moor	2.6 km West	SSSI	Wet grassland habitat of biological interest.
Ely Valley	3.4 km East	SSSI	Woodlands and grassland of biological interest.
*-at shortest distance from the Proposed Development SSSI –Site of Special Scientific Interest			

Non-Designated Sites of Ecological Importance

2.1.4.5 *Table 2* provides details of non-statutorily protected ecological sites within a 4 km radius of the Site, as shown at *figure 3.*

2.1.4.6 All sites identified fall within the Regionally Important Geodiversity Sites (RIGS) classification, selected for their geological, geomorphological and soil interest.

Table 2 Non-Statutorily Protected Sites			
Site Name	**Distance* and Direction from Proposed Development**	**Designation**	**Summary Description**
Argoed Isha Quarry	1.8 km West	RIGS	Geological exposures of interest.
Bute Iron Mine	3.2 km Northeast	RIGS	Iron mine of geological and historical interest.
Llantristant: Cefn Parc	3.5 km Northeast	RIGS	Mining infrastructure of geological and historical interest.
*-at shortest distance from the Proposed Development RIGS - Regionally Important Geodiversity Sites			

2.2 Geological Setting

2.2.1 Background

2.2.1.1 Information concerning the geology of the Study Area has been obtained from:

- British Geological Survey (BGS): Geological Survey of England and Wales, New Series 1:63 360/1:50 000 geological map series.
- BGS Geoindex, well details and borehole logs.

2.2.2 Regional Geology

2.2.2.1 The Site lies on the northern limb of an east-west striking anticlinal antiform. The strata in the locality generally dip between 15° and 24° to the north.

2.2.2.2 The locality is characterised by a number of northwest-southeast and east-west oriented sub-vertical faults, some of which run through the Site itself.

2.2.2.3 An extract of the British Geological Survey (BGS) mapping data for the locality is provided at *figure 4* with summary stratigraphic sequence below at *table 3.*

Table 3 Stratigraphic Sequence			
Age	Group	Formation	Lithological Description
Quaternary		Head – Clay, Silt, Sand and Gravel	Poorly sorted and poorly stratified, angular rock debris and/or clayey hillwash and soil creep, mantling a hillslope and deposited by solifluction and gelifluction processes
		Devensian Till	Diamicton – Unsorted to poorly sorted particles ranging in size from clay to boulders, suspended in an unconsolidated matrix of mud and/or sand.
Carboniferous	South Wales Coal Measures Group	South Wales Upper Coal Measures (UCM)	Grey coal-bearing mudstones/siltstones with minor grey, quartz-rich sandstones, coals and ironstones. Thickness 100 m+.
		South Wales Middle Coal Measures (MCM)	Grey coal-bearing mudstones/siltstones with minor sandstones. Thickness 120m-240m.
		South Wales Lower Coal Measures (LCM)	Grey coal-bearing mudstones/siltstones with minor sandstones. Thickness 80m-300m.
	Marros Group (MG)		Fissile dark grey siliceous mudstones and cherts (Aberkenfig Formation); grey, commonly fossiliferous mudstones (Bishopston Formation); quartzitic sandstones and conglomerates (Twrch Sandstone Formation), occupying the basal half of the Group on the northeastern crops and eastern crops of the South Wales Coalfield, and quartzitic sandstones (Telpyn Point Sandstone Formation) occupying the highest part of the Group locally. Thickness 20m-750m.
	Pembroke Limestone Group	Oxwich Head Limestone Formation (OHL)	Thick bedded fine- to coarse-grained, recrystalised, bioturbated skeletal packstones with distinctive pale to dark grey mottling and pseudobrecciation and ooidal limestones. Units of dark grey, irregularly bedded skeletal packstones with shaly partings are developed at intervals. Thickness 125m-183m.
		Stormy Limestone Formation (SrL)	Interbedded cryptalgal and fenestral, calcite mudstones, coquinoid limestones, skeletal, peloid, intraclast, ooid packstone/grainstones, ooid grainstones and the characteristic oncolitic grainstones. Scattered algal bioherms. Thickness 55m-65m.
		Cornelly Oolite Formation (CoO)	Thick bedded, cross bedded, pale grey ooid grainstones with scattered beds of medium grey fine-grained skeletal packstone including porcelaneous limestones. Compound ooids of pisolitic proportions common. Thickness 135m-180m.
		High Tor Limestone Formation (HTL)	Mid grey, predominantly thick-bedded, fine- to coarse-grained, burrowed, skeletal packstones, with thin beds and partings of shaly dolomite mudstone and siltstone. Some thin-bedded dark grey bituminous skeletal packstones interbedded with thin argillaceous wackestones and mudstones. Coarse, locally cross bedded, peloidal/skeletal/oolitic packstones/grainstones. Thickness 55m-133m.
		Caswell Bay Mudstone Formation (CBM)	Thinly interbedded grey and green-grey peloidal and bioclastic micrites, wackestones and packstones, and cryptalgal laminites. Dolomitisation is locally common on the southeast and east crop of the South Wales Coalfield. Thickness up to c.15m.
		Gully Oolite Formation (GuO)	Medium- to thick-bedded, pale grey, oolitic grainstone with subordinate beds of fine-grained skeletal packstones. Cross-laminated and cross-bedded, some burrowing. Locally dolomitized, especially on the southeast and east crop of the South Wales Coalfield. Thickness 19m-83m.

Table 3 Stratigraphic Sequence			
Age	Group	Formation	Lithological Description
		Friars Point Limestone Formation (FPL)	Thin- to thick-bedded, dark grey to black, fine- to coarse-grained skeletal [mainly crinoid] packstones with subordinate thin beds of shaly argillaceous skeletal packstones and mudstone. Dolomotised along the southern and eastern crop of the South Wales Coalfield. Thickness 76m-410m+.
		Brofiscin Oolite Formation (BFO)	Pale to purplish grey, thick-bedded to massive, cross-bedded, ooidal grainstone. Thickness 13m-17m.
		Barry Harbour Limestone Formation (BHL)	Thin- to medium-bedded, dark grey, coarse- to fine-grained, commonly graded, skeletal packstones with thin beds of calcareous mudstone. Thickness 32m-80m.
		Cwmyniscoy Mudstone Formation (CCM)	Interbedded grey mudstones and thin- to medium-bedded skeletal packstones deposited in a mid-shelf environment. Thickness 10m-60m.
		Castell Coch Limestone Formation (CCL)	Grey, locally reddened, medium- to thick-bedded, cross-bedded, oolitic and skeletal grainstones. Thin units of grey mudstone, calcite mudstone and calcisiltite are locally present in the uppermost part of the Formation. conglomerates, calcareous sandstones and sandy limestones are present in the lowermost part. Thickness 9m-30m.
		Tongwynlais Formation (TGW)	Lower part comprises thin- to thick-bedded skeletal, peloidal, ooidal and sandy grainstones and packstones with subordinate grey mudstones, calcite mudstones, calcretes and ironstones. Upper part comprises thin- to medium-bedded skeletal packstones and grey mudstones. Thickness up to 50m.
Devonian	Quartz Conglomerate Group (QCG)		An upper portion of sandstones with alternations of marl, and a lower portion of lenticular quartz-conglomerate beds with sandstones, grits and quartzites. Thickness c.77m.
	Daugleddau Group	Brownstones Formation (BRS)	Red, brown and purple fluvial sandstones with red mudstone interbeds. Thickness up to 1200m.
Jurassic	Lias Group	Blue Lias Formation (BLI)	Also known as Porthkerry Formation. Thinly interbedded limestone (laminated, nodular, or massive and persistent) and calcareous mudstone or siltstone (locally laminated). Thickness up to c.140m.
Triassic	Penarth Group	Westbury Formation (WBY)	Dark grey mudstones or shales with subordinate thin limestones, sandstones and fossiliferous arenaceous units ('bone beds'). Thickness 5m-10m.
	Mercia Mudstone Group (MMG)	Blue Anchor Formation (BAN)	Pale green-grey, dolomitic silty mudstones and siltstones with thin argillaceous or arenaceous laminae and lenses and a few thin, commonly discontinuous beds of hard, dolomitic, pale-cream to buff, porcelaneous mudstone and siltstone. Thickness up to c. 20m.
	Mercia Mudstone Group (MMG)		Dominantly red, less commonly green-grey, mudstones and subordinate siltstones with thick halite-bearing units in some basinal areas. Thin beds of gypsum/anhydrite are widespread; thin sandstones are also present. Thickness up to c.1350m.

2.2.3 Solid Geology

2.2.3.1 Bedrock geology local to the Site comprises of Carboniferous limestones of the CoO, HTL, GuO, FPL and CBM. These formations constitute the economic mineral at the Site, and record a combined pre-quarry thickness over 100 m.

2.2.4 Superficial Geology

2.2.4.1 The existing Site is largely stripped of all superficial geology, with hardstanding covering the eastern portion of the Site.

2.3 Hydrological Setting

2.3.1 Background

2.3.1.1 Information concerning the hydrology of the Study Area has been obtained from:

- BCL Water features survey – 31/05/23 and 13/09/23
- Natural Resources Wales – Main Rivers dataset

2.3.2 Water Framework Directive (WFD) River Waterbody Catchments

2.3.2.1 The Site is located in the Ely Operational Catchment of the South East Valleys Management Catchment of the Severn River Basin District.

2.3.2.2 The overall waterbody and ecological classification of the Ely Operational Catchment is 'Poor' with 'Moderate' chemical status as assessed by WFD River Waterbodies Cycle 3 (2021).

2.3.3 Surface Watercourses

2.3.3.1 There are two main watercourses in near proximity to the Site, these being the Nant Rhydhalog and Nant Felin-Fach.

2.3.3.2 The Nant Rhydhalog is situated c.20 m east of the eastern Site boundary or c.520 m east of the centre of workings and flows southeast before adjoining the Nant Dyfrgi.

2.3.3.3 The Nant Felin-Fach is situated c.650 m northeast of the north-eastern corner of the Site boundary or c. 980 m from the centre of workings and flows east before adjoining the River Ely.

2.3.3.4 The NRW hold no data of surface water level or flow for these watercourses.

2.3.4 Water Features Survey

2.3.4.1 A water features survey was conducted within a 4 km radius of the Site, identifying and noting the status of springs, wells, streams, rivers, reservoirs and lakes. The locations of these features are presented at *figure 5* with summary detail below at *table 4*.

2.3.4.2 The majority of water features identified are situated on the Carboniferous limestone bedrock (CLB) with the exception of Nant Craean stream and a spring northwest of Trescastell which lie within the LCM and MMG.

Table 4 Water Features Survey Summary

ID	Title	Name	Distance (m)*	Easting	Northing	Notes
1	Stream	Nant Rhydhalog	520	302058	179802	Receiving quarry water
2	Spring	S of Tynewydd	530	302053	179862	Discharges on to edge of grazing farmland
3	Stream	Nant Felin-fach	980	301878	180687	
4	Well	W of Tymaen	1090	300873	178867	
5	Well	Elm Cottage	1100	301850	178600	In use
6	Well	Crofta Farm	1110	301368	178627	Not in use
7	Water Body	Disused Mine	1150	301698	180987	Stagnant Pond
8	Water Body	S of Ash Hall	1340	301013	178492	Pond
9	Lake & Well	S of Llwyn-nwydog Wood	1380	301928	178402	
10	Spring	W of reservoir	1410	301708	178322	
11	Spring	S of Trecastell	1430	301833	181122	
12	Spring	W of Ash Hall	1490	300813	178427	
13	Spring	SW of Trecastell	1550	301383	181267	
14	Lake	From Nant Dyfrgi	1550	303088	179622	
15	Spring	N of Ty-chwith	1550	302008	178247	
16	Spring	S of Coed Wern Fawr	1830	302763	178362	
17	Spring	E of Hillside Farm	1850	299698	179772	
18	Spring	NW of Trecastell	1870	301528	181587	
19	Water Body	N of Llwyndu	1920	302023	177862	
20	River	Ely River	1950	303123	180872	
21	Spring	S of Ty-chwith	1980	301683	177747	
22	Spring	E of Enclosure	1980	300908	177852	
23	Water Body	SE of Wern Fawr	2170	302583	177817	
24	Water Body	Briggan Farm	2180	299363	179817	
25	Spring	S of Pantaquesta Farm	2200	303738	179902	
26	Water Body	Argoed-ganol Farm	2280	299288	179372	
27	Stream	Nant Creaean	2310	301183	182002	
28	Well	S of Pantaquesta Farm	2500	304033	179877	
29	Well	E of Cefn Llys	2580	304123	179677	
30	Water Body	Lllwyn-yoy	2580	303885	178935	Pond
31	Spring	S of Llwynddu	2600	303097	177502	
32	Stream	Coed y Marlau	2896	303318	177318	Dry Stream
33	Lake	Hensol Lake	3010	304580	178946	

* From centre of workings

2.3.5 Flooding

2.3.5.1 The NRW Flood Risk Assessment Wales Map for River and Surface Water and Small Watercourses defines prevailing flood risk through application of 4 no. bands as below:

- 'High' risk means that each year, this area has a chance of flooding of greater than 1 in 30 (3.3%)

- 'Medium' risk means that each year, an area has a chance of flooding of between 1 in 100 (1%) and 1 in 30 (3.3%).
- 'Low' risk means that each year, an area has a chance of flooding of between 1 in 1000 (0.1%) and 1 in 100 (1%).
- 'Very low' risk means that each year, this area has a chance of flooding of less than 1 in 1000 (0.1%)

2.3.5.2 The Site is situated entirely within 'Very low' risk band for flooding by Rivers, the closest 'High' risk area being confined along the banks of the Nant Rhydalog.

2.3.5.3 The Site is situated entirely within Zone A of the NRW Development Advice Map – considered to be at little or no risk of fluvial or coastal/tidal flooding.

2.4 Meteorological Setting

2.4.1 Long Term Area Averages

2.4.1.1 Long-term monthly average data (MAFF[1]) indicates an annual average rainfall depth for the area of 1172 millimetres (mm; MAFF Rainfall Area 52), as at *table 5*.

Table 5 Area Long Term Average Monthly Rainfall and Potential Transpiration

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Tot
Area Average Rainfall	121	84	77	73	80	71	80	102	110	116	129	129	1172
Potential Evaporation	1	9	32	55	83	90	90	75	46	22	6	1	510

2.4.1.2 The closest telemetered rain gauge to the Site with long-term data is at Cardiff Bute Park, situated some 16 km east of the Site.

2.4.1.3 The Standard Average Annual Rainfall for the Site area in the period 1941 to 1970 derived from the Flood Studies Report[2] is 1223 mm.

2.4.2 Local Data

2.4.2.1 Data has been obtained from the Met Office operated Cardiff Bute Park Raingauge located 16 km east of the Site. Monthly data is presented below at *Table 6.*

Table 6 Met Office Cardiff Bute Park Rain Gauge

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2000	47.8	168.4	59.5	155.4	95.1	37.1	74.5	73.9	156.8	90.3	60.5	231.0	1250.3
2001	84.0	96.5	147.5	119.1	31.6	34.8	144.6	134.3	36.5	267.6	180.4	187.7	1464.6
2002	142.0	187.6	65.1	84.7	129.8	66.0	65.9	55.9	30.5	183.4	86.6	36.1	1133.6
2003	90.6	39.9	47.1	70.3	93.0	68.4	93.9	16.2	23.1	47.8	175.6	151.1	917
2004	162.2	67.3	85.6	73.8	40.0	65.9	82.5	141.7	107.4	65.4	105.3	138.1	1135.2
2005	75.0	49.5	65.2	87.6	51.6	76.6	69.9	55.6	82.8	182.5	65.6	84.5	946.4
2006	36.0	59.0	121.8	35.1	159.2	47.4	65.6	58.9	43.4	160.0	106.1	114.7	1007.2
2007	178.9	152.3	89.5	21.8	128.5	104.7	173.8	71.3	53.1	178.1	178.1	147.1	1477.2

1 "Climate & Drainage", Technical Bulletin No.34, Ministry of Agriculture Fisheries & Food (MAFF), September 1976.
2 Centre for Ecology & Hydrology Flood Estimation Handbook Web Service, FEH13 Rainfall Model (https://fehweb.ceh.ac.uk/), October 2023.

Table 6 Met Office Cardiff Bute Park Rain Gauge													
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2008	170.6	44.5	98.7	59.9	95.3	63.8	138.4	170.2	197.8	57.0	88.4	171.5	1356.1
2009	153.5	43.6	51.8	53.5	68.0	114.8	194.1	76.0	34.7	113.0	93.3	64.6	1060.9
2010	73.5	72.1	72.6	28.7	28.5	21.9	88.0	144.6	94.8	73.6	220.4	114.9	1033.6
2011	122.2	80.4	22.6	5.1	56.7	88.9	80.6	64.4	97.8	82.8	101.0	39.8	842.3
2012	140.4	35.8	27.2	160.0	66.8	180.8	123.2	117.4	94.6	81.6	84.0	145.2	1257
2013	145.0	56.6	107.0	46.2	89.2	39.2	25.9	74.2	68.2	158.2	162.6	229.4	1201.7
2014	234.6	161.4	61.6	100.0	135.6	76.8	39.8	185.1	14.2	230.6	93.8	159.6	1493.1
2015	158.2	124.2	55.8	9.8	155.6	50.4	107.6	129.0	57.0	122.6	155.8	109.8	1235.8
2016	221.0	129.2	96.0	46.6	109.6	109.8	25.2	95.2	109.0	47.4	223.8	191.4	1404.2
2017	76.0	81.0	114.6	14.2	76.2	84.8	116.8	69.4	102.8	49.6	82.2	152.9	1020.5
2018	153.2	50.0	163.4	129.4	56.2	8.4	46.0	129.8	89.8	48.0	121.0	196.4	1191.6
2019	48.0	72.8	139.6	99.2	37.0	84.6	83.6	137.4	159.8	235.8	158.2	171.4	1427.4
2020	111.4	242.8	104.0	42.0	15.4	147.4	98.4	154.6	39.4	175.0	90.0	265.6	1486.0
2021	162.8	100.6	92.6	19.6	202.0	39.0	101.8	62.8	29.0	227.0	26.4	125.6	1189.2
2022	65.4	116.8	62.4	44.4	53.4	82.2	13.0	27.8	78.6	128.6	179.4	165.2	1017.2

2.4.3 Effective Rainfall

2.4.3.1 Long-term monthly average rainfall and potential evaporation statistics have been used to derive estimates of monthly average effective rainfall[3].

2.4.3.2 Effective rainfall is the amount of precipitation available for infiltration to the watertable and for surface water run-off, after satisfying any soil moisture deficit and actual evapotranspiration. The latter two parameters are dependent upon vegetation cover. Therefore, effective rainfall rates have been calculated for bare ground and crops, as encountered at the application area.

2.4.3.3 Calculation has been performed to provide estimates for bare earth[4], crop cover and open water using methods described by Grindley[5] and EA R&D Handbook W6-043/HB[6].

2.4.3.4 The derived monthly average data is presented below at *table 7*. The derived average annual effective rainfall at the Site ranges from 611 mm/year for areas of bare ground to 662 mm/year for areas of permanent grassland.

3 The proportion of rainfall available for runoff and groundwater recharge after accounting for evapotranspiration and satisfaction of soil moisture deficit.
4 Which may be taken to represent a quarried surface.
5 "The Calculation of Actual Evaporation and Soil Moisture Deficit over Specified Catchment Areas", Grindley J, November 1969, Hydrological Memorandum 38, Meteorological Office, Bracknell, UK.
6 "Estimation of Open Water Evaporation, Guidance for Environment Agency Practitioners", R&D Handbook W6-043/HB, J W Finch and R L Hall, October 2001.

Table 7 Derivation of Effective Rainfall for Differing Surfaces													
Bare Earth (rc = 0mm)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Rf	121	84	77	73	80	71	80	102	110	116	129	129	1172
Pe	1	9	32	55	83	90	90	75	46	22	6	1	510
rf-Pe	120	75	45	18	-3	-19	-10	27	64	94	123	128	662
dPsmd	0	0	0	0	3	19	10	-27	-5	0	0	0	
dAsmd	0	0	0	0	3	19	6	-27	-5	4	0	0	
Asmd	0	0	0	0	3	22	32	5	0	0	0	0	62
Psmd	0	0	0	0	3	22	28	1	-4	0	0	0	50
Ae	1	9	32	55	83	90	86	75	105	22	6	1	565
ERF	120	75	45	18	0	0	0	0	4	98	123	128	611
Permanent Grassland (rc = 75mm)													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Rf	121	84	77	73	80	71	80	102	110	116	129	129	1172
Pe	1	9	32	55	83	90	90	75	46	22	6	1	510
rf-Pe	120	75	45	18	-3	-19	-10	27	64	94	123	128	662
dPsmd	0	0	0	0	3	19	10	-27	-5	0	0	0	
dAsmd	0	0	0	0	3	19	10	-27	-5	0	0	0	
Asmd	0	0	0	0	3	22	32	5	0	0	0	0	62
Psmd	0	0	0	0	3	22	32	5	0	0	0	0	62
Ae	1	9	32	55	83	90	90	75	46	22	6	1	510
ERF	120	75	45	18	0	0	0	0	59	94	123	128	662
Open Water													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Correction Constants	1.4	1.1	0.9	1.0	0.9	1.0	1.2	1.4	1.5	2.0	2.3	2.0	
Ae	1.4	10.3	29.4	52.3	75.5	91.8	111.6	102.8	67.6	43.8	13.7	2.0	602.2
ERF	119.6	73.7	47.6	20.8	4.5	-20.8	-31.6	-0.8	42.4	72.2	115.3	127.1	569.9
rc: Root Constant, Rf: Rainfall, Pe: Potential Evaporation, Psmd: Potential Soil Moisture Deficit. Asmd: Actual Soil Moisture Deficit, Ae: Actual Evaporation, ERF: Effective Rainfall. All units other than correction constants are millimetres.													

2.5 Hydrogeological Setting

2.5.1 Aquifer Classification

2.5.1.1 The Hunts Bay Oolite Group together with limestones of the Pembroke Limestone Group comprise the Carboniferous limestone bedrock (CLB) aquifer at the Site. This is defined by the NRW as a ''Principal'' aquifer and reflects capability to store and transmit groundwater at a strategic scale, where present in sufficient areal extent and suitable geological setting.

2.5.1.2 The South Wales Coal Measures Group is present north of Llanharry is defined as 'Secondary A' aquifer and reflects some potential to support local water supplies, and may form an important source of base flow to rivers.

2.5.1.3 Superficial deposits although largely stripped from the Site are defined by the NRW as a Secondary (undifferentiated) aquifer. This is reflecting of the aquifer's ability to store and transmit groundwater at a local scale rather than a strategic scale.

2.5.2 Groundwater Flow Mechanism

2.5.2.1 The CLB features negligible primary (intergranular) permeability, with groundwater storage and movement being dependent on the development of secondary permeability (weathering / fracturing) within the aquifer.

2.5.3 Aquifer Boundaries

Lateral Aquifer Boundaries

2.5.3.1 The lateral boundaries of the CLB aquifer to the north, east, south and west are determined by the limit of distribution.

2.5.3.2 The lateral CLB aquifer boundary south of the Site is assumed to be along the coast at Limpert Bay, where formations of the CLB are cut off by the MMG owing to erosional contact along a synform fold. The coastline also acts as a no-flow boundary to the west of the Site.

2.5.3.3 The northern lateral CLB aquifer boundary is assumed to be along the contact with the LCM north of Llanharry. The eastern lateral CLB aquifer boundary is assumed as a constant head boundary with the River Ely.

Aquifer Upper and Lower Boundaries

2.5.3.4 The CLB aquifer is unconfined and assumed to be c.350 m thick at the Site - the depth between the top of the FPL and the lower boundary of the aquifer, assumed to be the base of the BHL.

Aquifer Internal Boundaries

2.5.3.5 As mentioned in *section 2.2*, BGS mapping at the Site indicate that the CLB is cut by a succession of N-S and E-W orientated sub-vertical faults. Ground investigations conducted historically at the Site found red clay gouge that in sufficient quantity was found to confine and restrict groundwater flow.

2.5.4 Aquifer Recharge

2.5.4.1 In near vicinity to the Site, recharge to the CLB aquifer can occur from rainfall (as opposed to lateral flow from other aquifers) due to the elevated position of the landform at the Site and a lack of overlying deposits. Recharge is therefore expected to occur as diffuse and autogenic input through direct recharge to areas of limestone outcrop.

2.5.5 Groundwater Occurrence and Levels

The Available Data

2.5.5.1 An extensive groundwater monitoring program has been implemented at the Site since at least 1999, with data annually submitted to the NRW under the previous operator. This made use of up to 8 no. partially penetrating monitoring boreholes to capture groundwater levels in the CLB.

2.5.5.2 BCL site visit dated 31/05/23 collected groundwater level data from 4 no. active monitoring boreholes.

Groundwater Head Distribution

2.5.5.3 A groundwater level contour plan using data obtained from the site visit dated 31/05/23 is presented at *figure 6*. It should be of note that levels in the quarry sump had naturally risen to post-quarrying levels as dewatering had ceased for some time. The rest water level in the sump was some 50 maOD at this time.

2.5.5.4 *Figure 6* shows a prevailing southwest to northeast groundwater flow direction, with groundwater levels falling from 57 maOD at the southwest corner of the Site to 42 maOD at the north of the Site.

2.5.6 Temporal Groundwater Level Variations

2.5.6.1 As is typical for limestone terrain, groundwater levels within the CLB aquifer encompassing the Site respond rapidly to variations in rainfall. Thus, groundwater levels typically reach a maximum in winter and minima in summer.

2.5.6.2 Annual assessment of groundwater level variations has been provided by BCL since 2013 in the form of an Annual Hydrometric Data Statement, during which the Site was managed by a previous operator.

2.5.6.3 Further assessment of groundwater level variations is proposed in the attached Hydrometric Monitoring Scheme at *appendix 2*.

2.5.7 Aquifer Parameters

2.5.7.1 Data upon aquifer parameters has been derived from previous studies at the Site, the BGS and within range of intrinsic permeabilities of similar lithologies where not available.

2.5.7.2 The hydraulic conductivity of the LCM is assumed to be $1x10^{-8}$ ms^{-1} as typical of a coal measure sequence with high instances of mudstone[7].

2.5.7.3 The hydraulic conductivity of the MMG is assumed to be $5x10^{-6}$ ms^{-1} (0.432 m/d) as typical of a gritstone with low porosity and intergranular permeability. A transmissivity value of 43 m^3/d was derived from a test conducted at Rhymney Bridge[8].

2.5.7.4 The hydraulic conductivity of the CLB as determined by previous studies at the Site is $1x10^{-5}$ ms^{-1} (0.864 m/d), as typical of a limestone featuring negligible primary porosity[9].

2.6 Water Resources Setting

2.6.1 Background

2.6.1.1 Information concerning the water resources of the Study Area has been obtained from:

- South East Valleys Abstraction Licence Strategy, November 2017.
- Rhondda Cynon Taf County Borough Council (RCT)

[7] Freeze and Cherry, 1979. Groundwater.

[8] British Geological Society, 2000. The physical properties of minor aquifers in England and Wales, BGS Technical Report WD/00/04.

[9] Freeze and Cherry, 1979. Groundwater.

2.6.2 Catchment Abstraction Management Strategy

Overview

2.6.2.1 The Catchment Abstraction Management Strategy (CAMS) sets out how water resources are managed within river catchments, setting out the availability and reliability of water available for licensing. The South East Valleys CAMS Area covers the River Ely operational catchment, of which the Site is located in.

2.6.2.2 Water resource availability is expressed as the percentage of time that flow is exceeded and is calculated at four different flows, Q95 (lowest), Q70, Q50 and Q30 (highest).

2.6.2.3 Water resource reliability is expressed as a percentage of time of which water resources are available.

2.6.2.4 It should be noted that water resource reliability figures presented in the CAMS do not apply to non-consumptive abstraction or consumptive groundwater abstractions that are assessed to not have a negative impact on local species, habitats and / or existing water users.

Surface Water Resource Availability Status

2.6.2.5 Restricted water is available at Q95 meaning no further consumptive licenses will be granted unless an existing licence is traded. Water is available at Q70, Q50 and Q30 assessment points meaning that consumptive licences can be issued but with potential abstraction restriction conditions and that non-consumptive licences can be issued but with potential local flow restrictions.

Groundwater Resource Availability Status

2.6.2.6 The CAMS outlines that due to limited data upon groundwater flows and levels within the catchment, groundwater resource availability is assessed by the NRW on a case-by-case basis upon application for a groundwater abstraction licence.

Water Resource Reliability Status

2.6.2.7 The CAMS confirms that the Site lies in an area where water resources may be available at least 70% of the time.

2.6.3 Water Abstractions

Licenced Abstractions

2.6.3.1 A 4 km radial search of the NRW licenced abstraction database has been conducted with details of licenced abstractions presented at *figure 7* and summarised below at *table 8*.

Table 8 Licensed Abstractions				
Licence Number	Licence Holder	Source	Distance* and Direction from Site	Purpose
21/58/44/0034	David Gwyn Jones	GW	3.6 km W	Industrial, Commercial, Public Services
21/57/31/0047	P Joyce	SW	2.5 km E	Impounding
WA/057/0031/004	Vale of Glamorgan Hotel Limited	GW	3.6 km SE	Industrial, Commercial, Public Services
WA/057/0031/004	Vale of Glamorgan Hotel Limited	GW	3.6 km SE	Industrial, Commercial, Public Services
WA/057/0031/004	Vale of Glamorgan Hotel Limited	GW	3.1 km SE	Industrial, Commercial, Public Services
21/57/31/0055	Mr & Mrs Terence & June Rosier	SW	1.6 km S	Impounding
21/57/31/0054	Jenkins & Son	SW	2.6 km S	Agriculture
21/58/21/0025	DWR CYMRU CYFYNGEDIG	GW	4 km SW	Water Supply
GW: Groundwater, SW: Surface Water *From centre of Site				

2.6.3.2 The closest licenced abstraction to the Site is licence no. 21/57/31/0055 and is used for impounding surface water, situated approximately 1.6 km south of the centre of the Site.

De-regulated Abstractions

2.6.3.3 The Public Health and Protection department of the RCT have provided details of private water supplies (unlicensed abstractions of <20 m^3/d) within 4 km radius of the Site. Details are provided below at *table 9* however no data on the purpose or source is available. Approximate locations are provided at *figure 7*.

Table 9 De-regulated Abstractions	
Map Code	User Address
PWS1	Llanharry Road, Llanharry, Pontyclun, CF72 9NH
PWS2	Llanharry Road, Llanharry, Pontyclun, CF72 9NH
PWS3	Llanharry Road, Llanharry, Pontyclun, CF72 9NH
PWS4	Llanharry Road, Llanharry, Pontyclun, CF72 9NH
PWS5	Bridgend Road, Llanharan, Pontyclun, CF72 9NH
PWS6	Llanharry Road, Llanharry, Pontyclun, CF72 9NH
PWS7	Road To Garth Isaf Farm, Llanharan, Pontyclun, CF72 9NH
PWS8	Hensol Road, Miskin, Pontyclun, CF72 8JU
PWS: Private Water Supply	

2.6.4 Source Protection Zones

2.6.4.1 Source Protection Zones (SPZs) define areas of sensitive licensed groundwater abstractions from the underlying aquifer(s), often being used for public or private potable supply. SPZs are allocated in line with the following classifications:

- SPZ1: Inner Zone – 50-day travel time to source, minimum 50 m radius.
- SPZ2: Outer Zone – 400-day travel time to source, minimum radius 250 m – 500 m (depending upon scale of abstraction).
- SPZ3: Total Catchment – Area within which all groundwater are ultimately assumed to contribute to the source.

2.6.4.2 NRW have merged classifications of SPZs where individual groundwater bodies within the SPZ have been dissolved, so only outer boundaries are shown.

2.6.4.3 The closest SPZ is located 2.8 km southwest of the Site, as presented at *figure 3.*

2.7 Hydrochemical Setting

2.7.1 Background

2.7.1.1 Information concerning the water quality of the Study Area has been obtained from:

- NRW Water Quality Archive
- BGS Groundwater vulnerability data for Wales

2.7.2 Groundwater Quality

WFD Objectives and Classifications

2.7.2.1 The Site is located in the South East Valleys Carboniferous Limestone groundwater body as assessed by WFD Groundwater Cycle 3 (2021). The overall water body status and chemical status is assessed as 'Good'.

Groundwater Vulnerability

2.7.2.2 Groundwater vulnerability at the Site as assessed by the NRW and the BGS is classed as 'High' due to factors such as the lack of overlying lower permeability cover.

Groundwater Quality Data

2.7.2.3 Searches of water quality databases found no significant groundwater quality data available fully representative of the Carboniferous Limestone in the vicinity of the Site. There is some historical data on suspended solids, pH and oil, sampled at an effluent discharged from Forest Wood Quarry which would have been groundwater derived, all of which is marked as compliant by the NRW.

2.7.3 Surface Water Quality

Surface Water Quality Data

2.7.3.1 Data upon suspended solids, pH and visible signs of oil/grease for effluent (dewatering volumes) discharged to the Nant Rhydalog from Forest Wood Quarry over 2009 to 2011 is summarised below in *table 10*. Samples were usually collected at monthly intervals during this period, with no visible signs of oil or grease being recorded in any of the samples.

Table 10 Water Quality Data of Forest Wood Quarry Effluent 2009-2011

Determinand	Minimum	Maximum	Average
Suspended Soilds (mg/l)	3	31.1	6.03
pH	7.28	8.21	7.94

2.7.4 Potential Sources of Pre-existing contamination

Landfill Sites

2.7.4.1 Details of active and inactive landfills within a 4 km radius of the Site have been obtained from the NRW, with locations shown in *figure 8* and summary detail below in *table 11*.

Table 11 Summary Detail for Landfill in the Vicinity of the Site

Identification	Distance (km)*	Status	Class	Operator
Hendy Quarry Landfill	3.9	Active	Inert	Tarmac Trading Limited
Visors Down Ltd	2.7	Active	S0820: Vehicle depollution facility	Visors Down Ltd
Penbryn Coch	0.8	Historic	Unknown	
Elms Farm Landfill	0.3	Historic	Household, Industrial, Inert	J and G Developments
Taly Garn	1.8	Historic	Inert	
Railway Cutting	3.5	Historic	Inert	Mid Glamorgan Civil Engineering
Bute Quarry	3.2	Historic	Household, Industrial, Inert	Taff-Ely Borough Council
Windsor Field	2.5	Historic	Household, Industrial, Inert	
Caergwanaf Isaf Farm	2.6	Historic	Inert	
Trecastle OCCS	1.7	Historic	Household, Industrial, Inert	Cowbridge Rural District Council with permission of the National Coal Board
Llanilid OCCS	1.3	Historic	Industrial, Inert	Cowbridge Rural District Council
Isycoed Farm Landfill	0.9	Historic	Inert	Mr J J Watkins
Turner's (Tucker's) Field Landfill	2.1	Historic	Industrial	
Iron Ore Mine and Landfill	0.9	Historic	Household	R Taylor
Trecastle Farm Inert Landfill	1.5	Historic	Inert	Mr T O Hopkins

*At shortest distance from the centre of the Site

2.7.4.2 There are no active or inactive landfill sites located up hydraulic gradient of the Site.

2.7.4.3 Elms Farm Landfill is located adjacent to the eastern Site boundary and was licenced for household, inert and industrial waste, and has been inactive since 1989.

2.8 Site Water Management

2.8.1 Water Management Plan

2.8.1.1 A proposed water management plan at the Site is provided at *figure 9.*

2.8.1.2 Historically, waters abstracted from the quarry sump have been treated for suspended solids by use of a settlement lagoon and subsequently discharged to the Nant Rhydhalog. Over some 30 years of historical abstraction, no nearby abstractors had reported being affected.

2.8.1.3 A similar water management plan will be reenacted at the Site, where dewatering volumes will be pumped to a newly constructed settlement lagoon for treatment of suspended solids and subsequently piped to an outlet at the Nant Rhydhalog.

2.8.1.4 The Site has been recently granted a discharge permit (permit no. EPR/CB3696CN) to consent such activity at a maximum rate of discharge of 175 litres per seconds (l/s).

2.8.2 Proposed Abstraction Volumes

2.8.2.1 A peak instantaneous abstraction rate of 175 l/s (630 m^3/hour, 15120 m^3/day, 5518800 m^3/year) has been proposed based on historical discharge volumes and to tie in with the discharge permit at the Site.

2.8.2.2 To facilitate the abstraction, two submersible Flygt BS 2400 HT-243 90 kW pumps rated at 55 l/s at 70 m head each, totalling 110 l/s are proposed to be the main means of dewatering the sump under standard conditions. This allows capacity for a third pump of similar specifications to be installed during winter seasons when rates of groundwater ingress are typically higher.

3. CONCEPTUAL HYDROGEOLOGICAL MODEL

3.1 The Site lies on Carboniferous Limestone, representing an extensive and highly productive aquifer (the Limestone Aquifer), supporting public water supplies and environmental baseflows. The Limestone Aquifer features negligible primary (intergranular) permeability, with groundwater movement being controlled by the presence of fissures, fractures and other discontinuities (secondary porosity).

3.2 Recharge to the Limestone Aquifer is diffuse and autogenic, through direct recharge to areas of Carboniferous Limestone outcrop (via leakage through overlying topsoils). Infiltration is rapid and vertical, with the Limestone Aquifer featuring a substantial unsaturated thickness.

3.3 The groundwater flow direction in the Limestone Aquifer at the Site is from southwest to northeast, broadly consistent with the regional topographical gradient. Groundwater level data obtained in May 2023 whilst workings were partially submerged found groundwaters levels fell from 57 maOD at the southwest corner of the Site to 42 maOD at the north of the Site.

3.4 Data upon aquifer parameters *i.e.,* hydraulic conductivity, for various aquifers in the region has been derived from previous studies at the Site, the BGS and within range of intrinsic permeabilities of similar lithologies in the aquifer handbook where not available.

3.5 The Limestone Aquifer is unconfined; the lower boundary being the low permeability mudstones of the Cwmyniscoy Mudstone Formation, which forms its base. A number of N-S and E-S faults transect the Site, with evidence of red clay fault gouge. Where occurring in sufficient quantities, low permeability features (such as red clay fault gouge) can confine and restrict groundwater flow within the Limestone Aquifer.

4. IMPACT ASSESSMENT & MITIGATION MEASURES

4.1 Background

4.1.1 Assessment has facilitated the conceptualisation of the extant groundwater and surface water regimes operating within and around the Site.

4.1.2 This understanding has been utilised to inform assessment of the potential impacts that may be posed by the proposed abstraction upon the water environment.

4.1.3 Where significant potential for adverse impact is identified, recommendations for specific mitigation measures are proposed.

4.1.4 Both specific mitigation measures and those incorporated into the design of the Site are described.

4.2 Generic Potential Impacts

4.2.1 Direct Impacts

4.2.1.1 As is typical of the majority of operations of this type and scale, the proposed abstraction has the potential to impact upon the water environment in the following direct ways:

- Potential for impact upon groundwater levels and flows;
- Potential for impact upon surface water levels and flows;
- Potential for derogation of groundwater quality;
- Potential for derogation of surface water quality, and;
- Potential for the exacerbation of extant flood risk.

4.2.2 Indirect Impacts

4.2.2.1 The direct impacts outlined above may lead, in-turn, to indirect impacts upon:

- Potential for indirect derogation of surface water flow rates and / or waterbodies;
- Potential for indirect impact upon the volume of groundwater and / or surface water available to existing abstractions;
- Potential for indirect impact upon the quality of groundwater and / or surface water available to existing abstractions;
- Potential impact upon floral and / or faunal habitats as a result of flow / quality derogation within surface water-courses / wetland areas.

4.3 Preliminary Risk Screening

4.3.1 A preliminary screening of the potential impacts of the proposed abstraction upon the water environment has been undertaken to identify where such impacts are potentially significant.

4.3.2 Where potential for significant impact is identified, further assessment has been undertaken at *section 4.4* with mitigation measures / planning controls being formulated as required (summarised at *section 4.5*).

The results of preliminary risk screening are presented at *table 12* below.

Table 12 Preliminary Risk Screening

Activity	Impact Class	Potential Primary Impact	Note	Potential Secondary Impacts	Requirement for Further Assessment
Dewatering of mineral workings	Groundwater levels and flows	Principal aquifer: Modification to groundwater levels and flows in proximity to dewatered working phases.	Groundwater levels at the locality have been modified by dewatering for over 20 years with no reported derogation to other abstractors	Reduction of groundwater levels in proximity of existing groundwater abstractors, falling within radius of influence.	Yes
	Surface water levels and flows	Modification to surface water levels and flows in proximity to dewatered working phases.	None	Reduction of surface water levels and flow for features located within radius of influence.	Yes
	Groundwater quality	Principal Aquifer: Contamination from mobile/fixed plant.	Site operates an Environmental Management Scheme, including controls for management of refuelling and mobile plant operation etc.	None	No
	Surface water quality	Contamination from mobile/fixed plant and mobilisation of suspended solids in dewatering discharge.	Any offsite discharge will require discharge permits and hence will be regulated by associated water quality limits.	None	No

4.4 Further Assessment of Potential Impacts

4.4.1 Groundwater Levels and Flows

Background

4.4.1.1 The Proposed Development as described herein is considered to have the potential to impact upon groundwater levels and flows in the following ways:

- Dewatering – modification to groundwater levels and flow in vicinity to Site.

Dewatering

4.4.1.2 To allow for sub-water table working at the Site, groundwater levels in and around the quarry will need to be lowered. The magnitude of groundwater lowering will decrease with increasing distance from the workings, forming an idealised 'cone' of groundwater depression around the dewatered workings.

4.4.1.3 The radius of influence of the proposed dewatering operation has been estimated as some 940 m using the Niccoli et al (1998) method. This method uses known parameters such as rest water table height (H), saturated thickness to seepage face (h_s), hydraulic conductivity (K), recharge (P) and radius of quarry (r_w), as expressed by the below equation:

$$H = \sqrt{h_s^2 + \frac{P}{K_{h1}}\left[R_0^2 \ln\left(\frac{R_0}{r_w}\right) - \frac{R_0^2 - r_w^2}{2}\right]}$$

4.4.1.4 A sheet showing calculations and methodology has been included at *appendix 3*.

Potential for Associated Secondary Impacts

Groundwater abstraction

4.4.1.5 No groundwater dependent registered private water supplies have been identified within the calculated ROI; the closest being PWS4 located 2.6 km north of the centre of workings.

4.4.1.6 Two water features have been identified as within the ROI of the proposed abstraction (Map ref. 1 & 2). The Thiem-Dupoit equation was used to assess drawdown impacts on each of the identified water features, as summarised below at *table 13*[10]. It should be noted that this methodology is suited for porous medium aquifers in steady-state conditions, therefore errors may be induced upon application to a fracture flow dominated aquifer such as at the CLB where in practice, steady-state conditions rarely occur.

[10] Hydrogeological Impact Appraisal for a proposed extension of Forest Wood Quarry, Pontclun (SRK, January 2009)

Table 13 Water dependant features located within the calculated radius of influence and associated maximum drawdown						
Map Ref.	Title	Name	Distance*	X (Easting)	Y (Northing)	Potential Drawdown (m)
1	Stream	Nant Rhydhalog	520	302058	179802	17.78
2	Spring	S of Tynewydd	530	302053	179862	17.14
*From centre of workings.						

Requirement for Mitigation / Planning Controls

4.4.1.7 In terms of impact upon the surrounding groundwater body, there have been no reports of derogation to groundwater supplies in the area in over 30 years of historic dewatering at the Site. Furthermore, the groundwater body status as assessed by WFD Groundwater Cycle 3 (2021) is 'Good' showing groundwater levels in the area are in line with expectations.

4.4.1.8 It is proposed to collect and analyse groundwater data at monitoring boreholes at the Site as detailed in the accompanying Hydrometric Monitoring Scheme attached at *Appendix 2*. Therefore, no additional measures for mitigation are considered necessary.

4.4.2 Surface Water Levels and Flows

4.4.2.1 A lowering of groundwater levels in the area via dewatering has the potential to cause drawdown in interconnected surface water features, thus potentially modifying their normal levels of flow.

4.4.2.2 Assessment using the Thiem-Dupoit methodology estimates up to 17.78 m drawdown in the Nant Rhydhalog and up to 17.14 m drawdown in the spring south of Tynewydd.

4.4.2.3 Groundwater abstracted from the Site is to be discharged to the Nant Rhydhalog stream which is expected to compensate for any dewatering related drawdown.

4.4.2.4 There is some potential for the abstraction to cause a reduction in flows at the spring south of Tynewydd (map ref. 2). This spring is noted to discharge to the edge of an open field used for grazing and so would not impact on water users. Therefore, mitigation is not deemed necessary at this stage and will be reviewed in annual hydrometric monitoring reporting.

Potential for Associated Secondary Impacts

Surface Water Abstraction

4.4.2.5 No surface water dependent registered private water supplies have been identified within the calculated ROI; the closest being PWS4 located 2.6 km north of the centre of workings.

4.4.2.6 There are no licenced surface water dependent abstractions which lie within the estimated ROI.

Requirement for Mitigation / Planning Controls

4.4.2.7 All abstracted groundwater is to be discharged to the Nant Rhydhalog (the surface water feature most likely to be at risk of impact), and there have been no reports of derogation to any abstractions over the past 30 years of dewatering operations, therefore no recommendations for mitigation at this point are deemed necessary.

4.5 Summary Impact & Mitigation Schedule

4.5.1 The measures and procedures incorporated into the design of the Site, together with additional specific measures and planning condition requirements recommended for the minimisation of impact upon the water environment are summarised overleaf at *table 14.*

Table 14 Summary Schedule of Potential Impacts & Mitigation Measures			
Impact Class	**Mitigation by Design**	**Mitigation by Procedure**	**Contingency Action**
Groundwater Levels and Flows	Rainfall / runoff to be returned to CLB aquifer via groundwater seepage in base of workings (the Site forming a closed depression). Abstracted water to be ultimately discharged to local downstream watercourse allowing for leakage back into CLB aquifer.	Monitoring of groundwater levels as specified by attached Hydrometric Monitoring Scheme	None
Surface Water Levels and Flows	Abstracted water to be discharged to the Nant Rydhalog, the watercourse in which surface water levels and flows are predicted to be most impacted.	Annual program of maintenance required for drainage and related infrastructure to ensure ongoing efficiency	None

5. CONCLUSIONS

5.1 A Hydrogeological Impact Appraisal has been conducted with respect to the re-opening of the Site and subsequent need to dewater submerged mineral workings, in line with guidance set out by the NRW for HIA for dewatering abstractions at Forest Wood Quarry, Pontyclun, Vale of Glamorgan.

5.2 Baseline assessment has described the hydrological, hydrogeological and water resources setting of the Site and its environs. This has allowed for development of a conceptual hydrogeological model of the local water environment.

5.3 Summary description of the proposal has been presented, this being combined with the conceptual hydrogeological model to allow for identification of any potential or significant impacts to occur.

5.4 Initial screening of such potential risks has allowed identification of areas where further consideration of potential impacts is required. Such further assessment has allowed formulation where necessary of mitigation measures designed to limit such risks to acceptable levels.

5.5 The potential for the proposed abstraction to result in significant impacts upon the water environment is inherently low, and adequately mitigated where necessary, thus negating potential for occurrence of cumulative impact. Subject to implementation of the recommendations included herein, significant residual impacts are not anticipated in association with the proposed abstraction.

5.6 In view of the findings of assessment and the planned approach to the Proposed Development, which includes specific measures for the protection of the water environment, there are considered to be no over-riding hydrogeologically or hydrologically based reasons why the proposed abstraction should not proceed in the manner described by the Application.

Gavinder Meetca, BSc, MSc, FGS
Hydrogeologist

BCL Consultant Hydrogeologists Limited
March 2024

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Aggregates Express

Forest Wood Quarry

Pontyclun, Vale of Glamorgan

Hydrogeological Impact Appraisal

March 2024

Figures

BCL HYDRO
BCL Consultant Hydrogeologists Limited

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Site boundary

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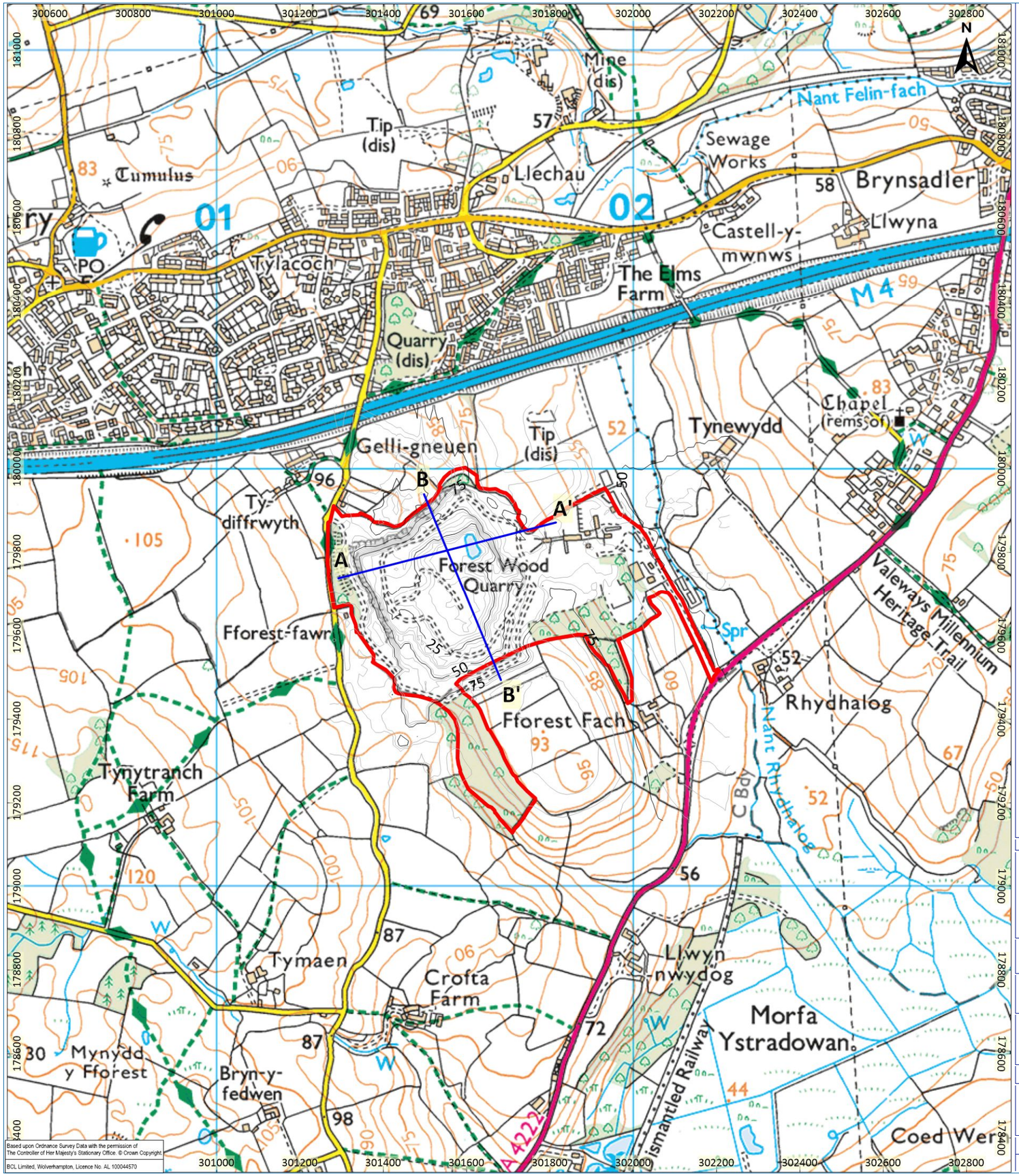
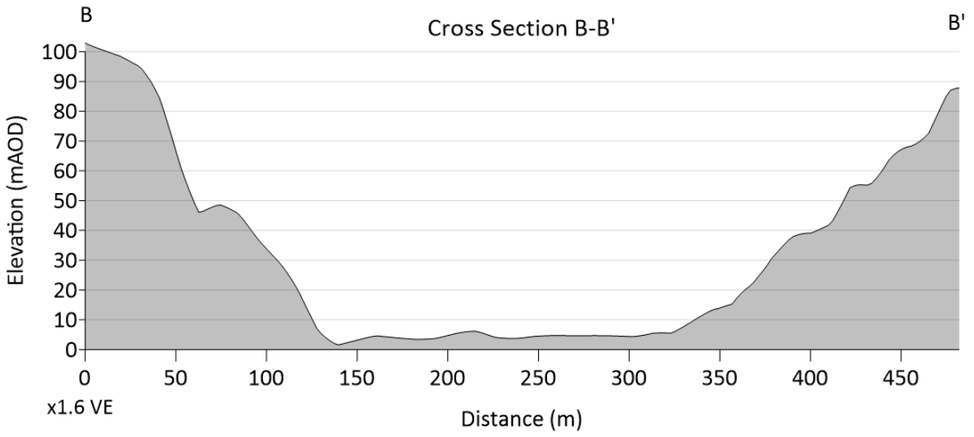
Figure 1: Site Location Plan

Drawn By: GM	Scale: 1:30000
Date: Dec-23	Format: A3L



Site boundary



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Forest Wood Quarry, Pontyclun, Vale of Glamorgan

Hydrogeological Impact Appraisal

Figure 2: Topographical Cross Sections

Drawn By: GM	Scale: 1:1000
Date: Dec-23	Format: A3L

Brynna a Wern Tarw

Breigam Moor

Argoed Isha Quarry

The Parish Field, Cae'r Rhedyn

Llantrisant: Cefn Parc

Llantrisant: Rhiwsaeson

Llantrisant: Llantrisant By-pass

Bute Iron Mine

Mwyndy Mine tip

Ely Valley

Pysgodlyn Mawr

- Site Boundary
- Regionally Important Geodiversity Sites (RIGS)
- Source Protection Zone (SPZ)
- Site of Special Scientific Interest (SSSI)

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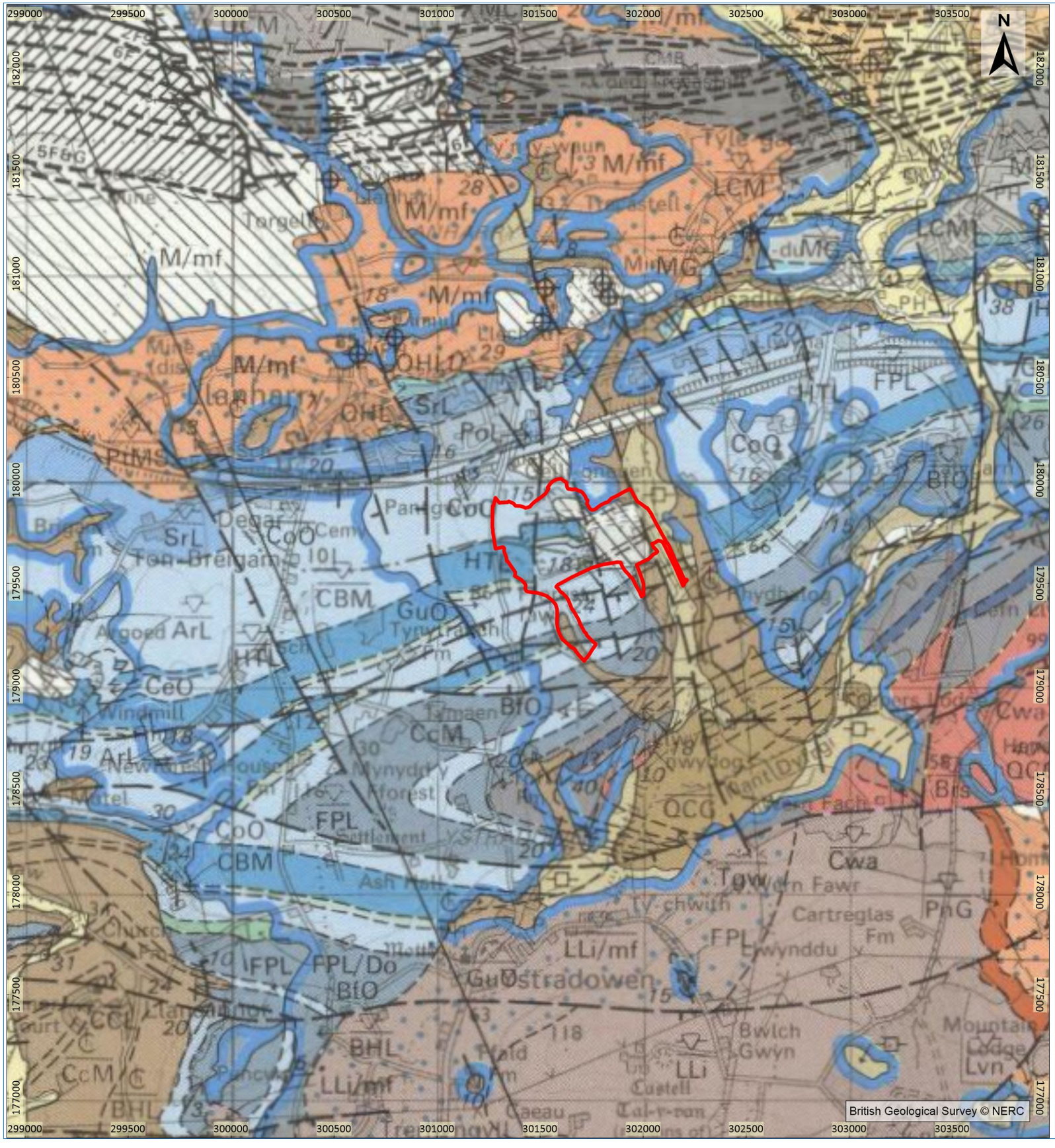
Hydrogeological Impact Appraisal

Figure 3: Statutory and Non-Statutory Designated Sites of Ecological Importance

Drawn By: GM	Scale: 1:3000
Date: Dec-23	Format: A3L



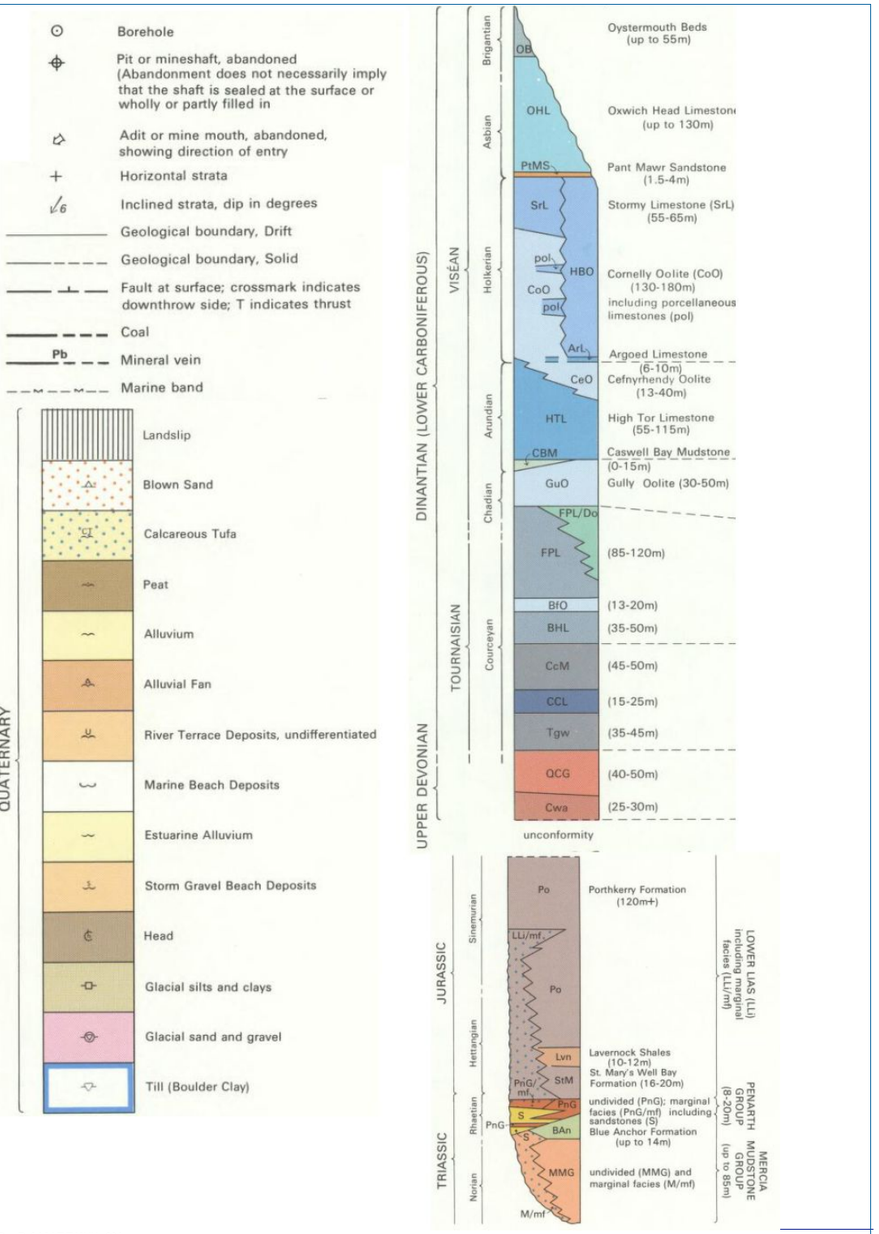


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Figure 4: BGS Solid and Drift Geology (50k Mapping)

Drawn By: GM	Scale: 1:2000
Date: Dec-23	Format: A3L

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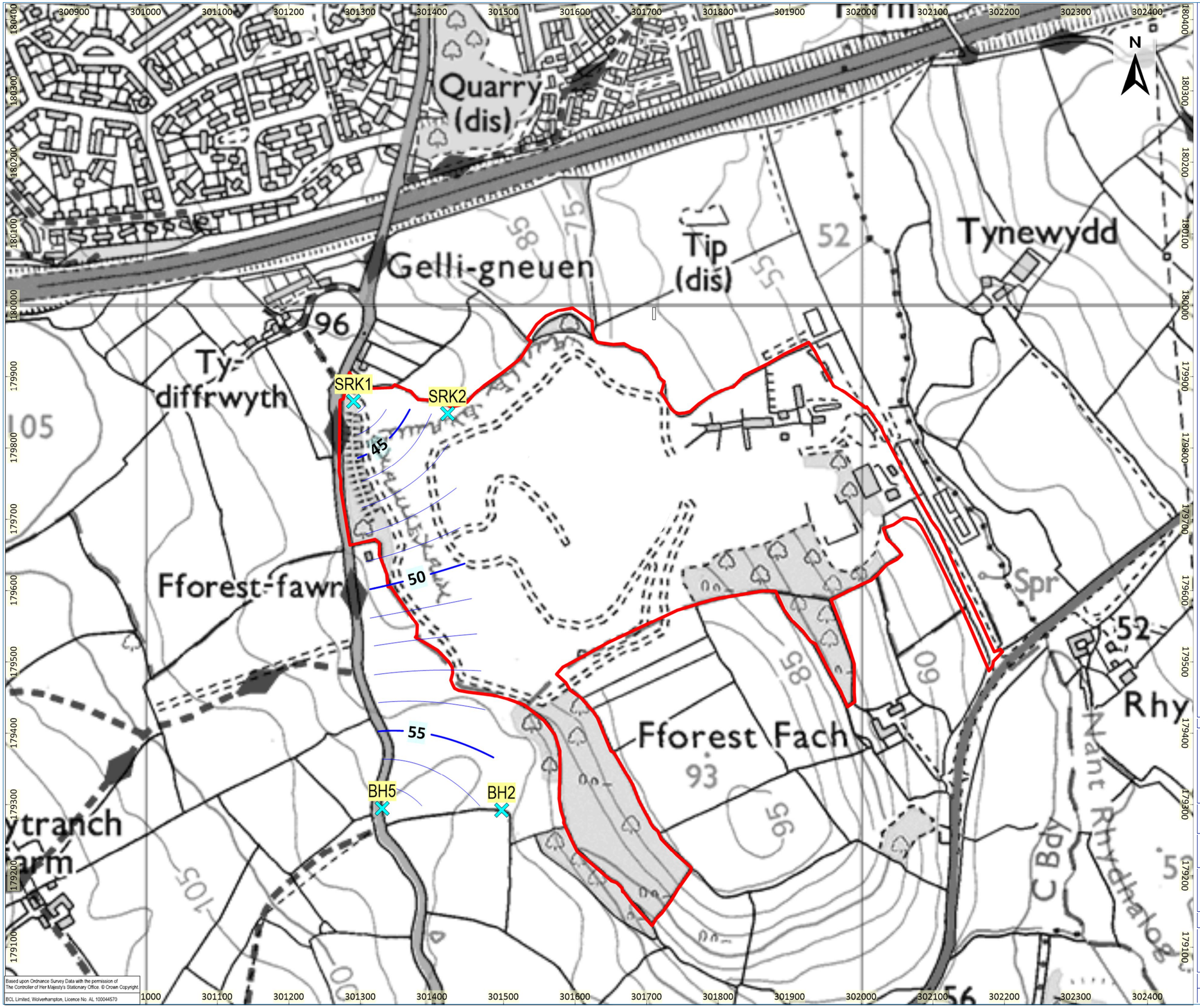
Figure 5: Locations of Water Features Survey Points

Drawn By: GM	Scale: 1:3000
Date: Dec-23	Format: A3L



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Hydrogeological Impact Appraisal

Figure 6: Groundwater Elevation Contours (31/05/23 data)

Drawn By: GM	Scale: 1:500
Date: Dec-23	Format: A3L

Site Boundary

Licenced Abstraction

Private Water Supply

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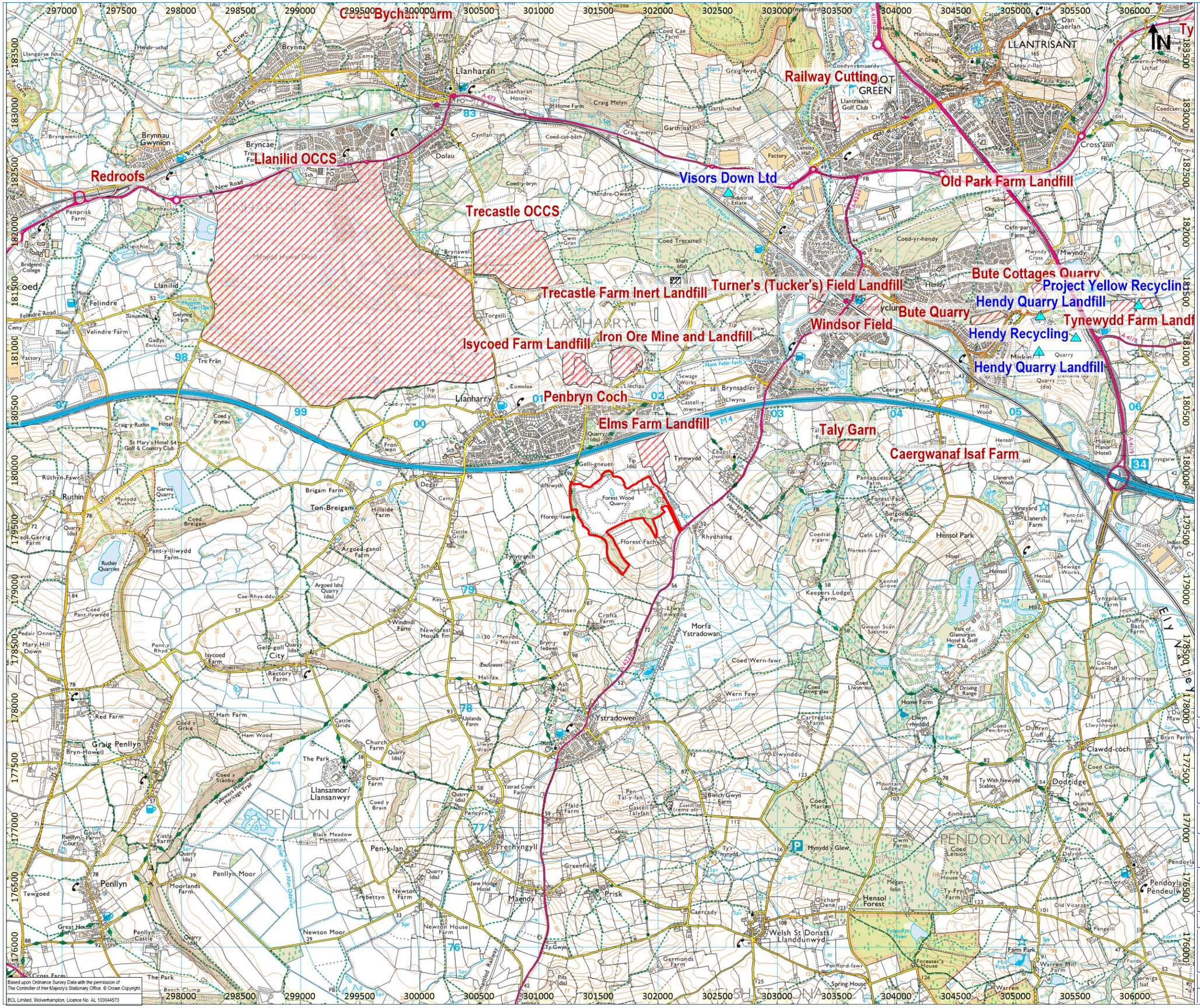
Forest Wood Quarry, Pontyclun, Vale of Glamorgan

Hydrogeological Impact Appraisal

Figure 7: Licenced Abstractions and Private Water Supplies

Drawn By: GM	Scale: 1:30000
Date: Dec-23	Format: A3L



Site Boundary

Historic Landfill Site

Active Landfill Site

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Figure 8: Historic and Active Landfills

Drawn By: GM	Scale: 1:3000
Date: Dec-23	Format: A3L

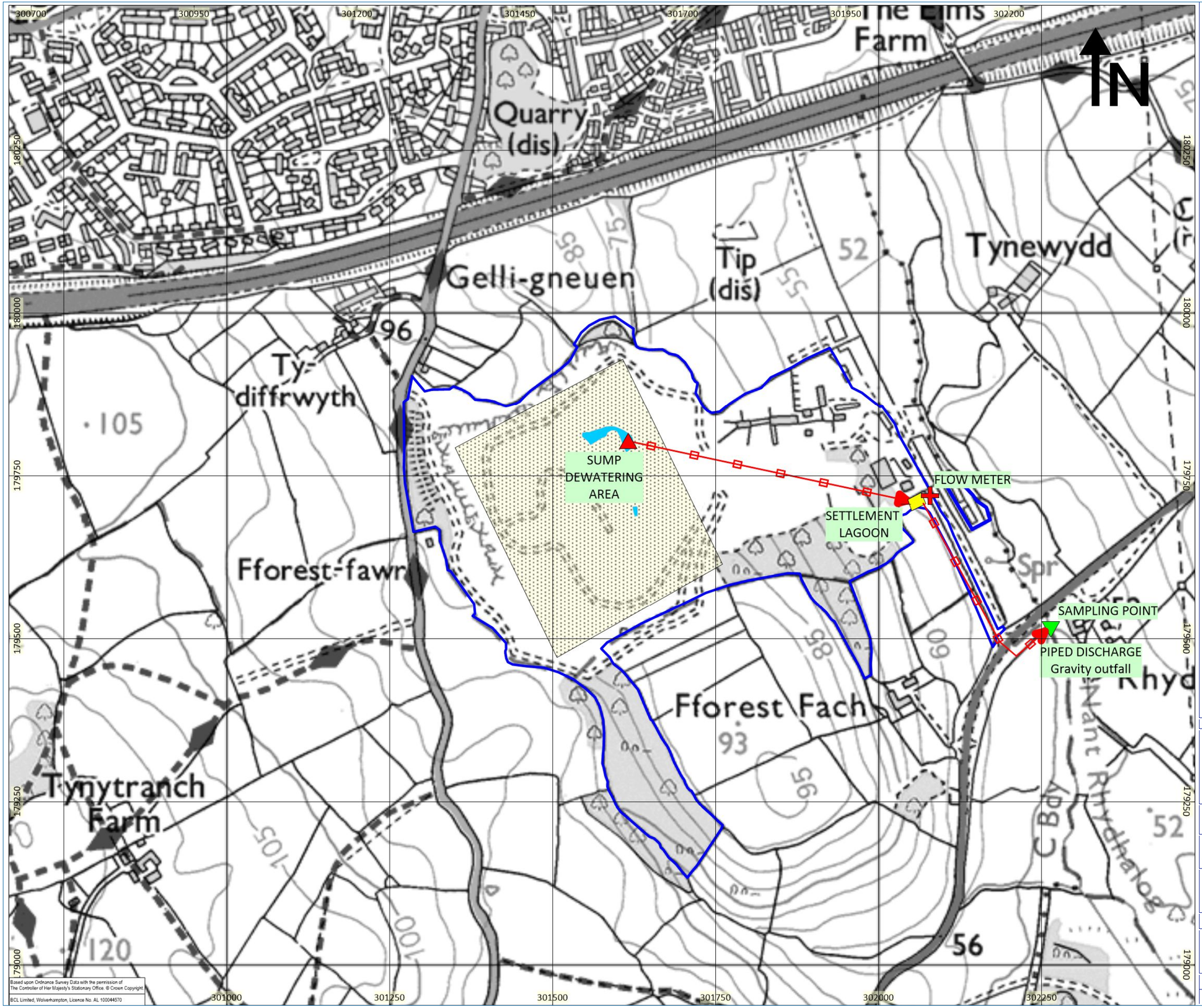

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Figure 9: Proposed Water Management Scheme

Drawn By: GM	Scale: 1:5500
Date: Dec-23	Format: A3L

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Appendix 1 Guidance & Information Sources

BCL HYDRO
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Registered in England & Wales. Company Registration Number: 4043373

Regulatory & Industry Standard Guidance & Methodologies & Literature References

Published Data Sources

- BGS Geoindex, well details and borehole logs.
- British Geological Survey (BGS): Published 1:50,000 scale solid and drift geological mapping.
- Centre for Ecology & Hydrology Flood Estimation Handbook Web Service, FEH13 Rainfall Model (https://fehweb.ceh.ac.uk/), November 2018.
- "Climate & Drainage", Technical Bulletin No.34, Ministry of Agriculture Fisheries & Food (MAFF), September 1976.
- Data regarding licenced abstractions, source protection zones, flood risk mapping & landfill sites. Environment Agency (EA), 2022
- "Estimation of Open Water Evaporation, Guidance for Environment Agency Practitioners", R&D Handbook W6-043/HB, J W Finch and R L Hall, October 2001.
- "Flood Estimation for Small Catchments (IH 124)", Institute of Hydrology, Report No.124, Marshall DCW & Bayliss AC, June 1994.
- Flood studies report, Volume II: Meteorological Studies", National Environment Research Council (NERC), 1975.
- "Greenfield Runoff Estimation for Sites", HR Wallingford (HRW), on-line calculation tool, UK Sustainable Drainage, Guidance & Tools.
- "National Planning Policy Framework", Ministry of Housing, Communities and Local Government, March 2012.
- Ordnance Survey (OS): Topographic maps at scales of 1:50,000 and 1:25,000.
- OS open-source digital data (Meridian 2, Panorama & Terra50 data-sets).
- "Planning Practice Guidance", Ministry of Housing, Communities and Local Government, October 2019.
- "The Calculation of Actual Evaporation and Soil Moisture Deficit over Specified Catchment Areas", Grindley J, November 1969, Hydrological Memorandum 38, Meteorological Office, Bracknell, UK.
- "The Chalk aquifer of Yorkshire" British Geological Survey Research Report RR/06/04, I N Galr and H K Rutter, 2006.
- "The Environment Agency's Approach to Groundwater Protection", EA, v1.1, February 2018.
- "The Physical Properties of Major Aquifers in England and Wales", Hydrogeology Group Technical Report WD/97/34, Allen, D J, Brewerton, L J, Coleby, L M, Gibbs, B R, Lewis, M A, MacDonald, A M, Wagstaff, S J, and Williams, A T, 1997.
- "The SUDS Manual v5", Construction Industry Research and Information Association (CIRIA): report no. c753, 2015.
- "Rainfall Runoff Management for Developments", Kellagher R, joint DEFRA / Environment Agency (EA) Flood and Coastal Erosion Risk Management R&D Programme, Report SC030219, October 2013.

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Appendix 2 Hydrometric Monitoring Scheme

BCL HYDRO
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1. INTRODUCTION

1.1 Forest Wood Quarry (the Site) is a limestone quarry operated by Aggregates Express since 2021. The Site has been worked since the 1930s and is located south of Llanharry, Rhondda Cynon Taf, South Wales.

1.2 As workings have historically sunk below the depth of groundwater at the Site, there is a need to dewater for workings to progress. To facilitate this, a new abstraction licence (transfer licence) will be required. BCL Hydro have thus been instructed to prepare a Hydrogeological Impact Assessment (the HIA) and Hydrometric Monitoring Scheme (the HMS) to support the abstraction licence application.

1.3 The HMS is the proposed method of monitoring to measure the potential changes in groundwater levels surrounding workings at the Site.

2. MONITORING REQUIREMENTS

2.1 ***Table 1*** below gives details of existing infrastructure status and frequency of monitoring suggested under the HMS. The locations of all monitoring infrastructure can be seen at ***Figure 1***.

Table 1 Features for inclusion in the Forest Wood Quarry Hydrometric Monitoring Scheme

	Identification	Location (NGR)	Status	Method of monitoring	Frequency of monitoring
Groundwater	SRK1	301290 179865	Active	Data logger to record barometrically compensated groundwater levels	Datalogger - 1-Hour
	SRK2	301422 179848	Active		
	PZ1/23	302021 179675	Proposed	Manual measurement of groundwater level in units of metres below ground level using a portable dip meter.	Monthly
	PZ2/23	301550 179474	Proposed		
Surface Water	FM1	302062 179719*	Active	Flow meter measuring volume of abstraction in cubic metres (m^3). Date/time to be recorded upon measurement.	Weekly
	FW Raingauge	-	Proposed	Tipping bucket style raingauge with count datalogger	Monthly
	SP1	302259 179523	Active	In accordance with discharge permit no. EPR/CB3696CN	

*Approximate location

2.2 Installation records will be prepared for each proposed groundwater monitoring installation to include:

- Piezometer identification, location & elevation (NGR / maOD)
- Drilling contractor and operators name
- Date of drilling

- Equipment and technique used
- Diameter and depth of borehole and any casing used
- Depth of each change of stratum
- Description of each stratum
- Depth of groundwater strikes
- Completion details of piezometer installation
- Rest water level (mbgl) at completion of piezometer installation

2.3 Groundwater elevations at all active piezometers listed at ***Table 1*** should be measured manually, on a monthly basis using an electronic water level meter (dip tape). Measurements are to be made to the nearest centimetre against fixed and surveyed datums.

2.4 Post monitoring, manual measurements should be converted to Ordnance Datum (OD) with both levels being stored digitally (*i.e.,* spreadsheet / database), along with a record of any corrections made to the data or issues affecting collection.

2.5 Data loggers are to be installed at all active piezometers set at a 1-hour logging frequency. All data should be barometrically compensated, corrected to OD, corrected for drift in relation to manual measurements, and stored digitally.

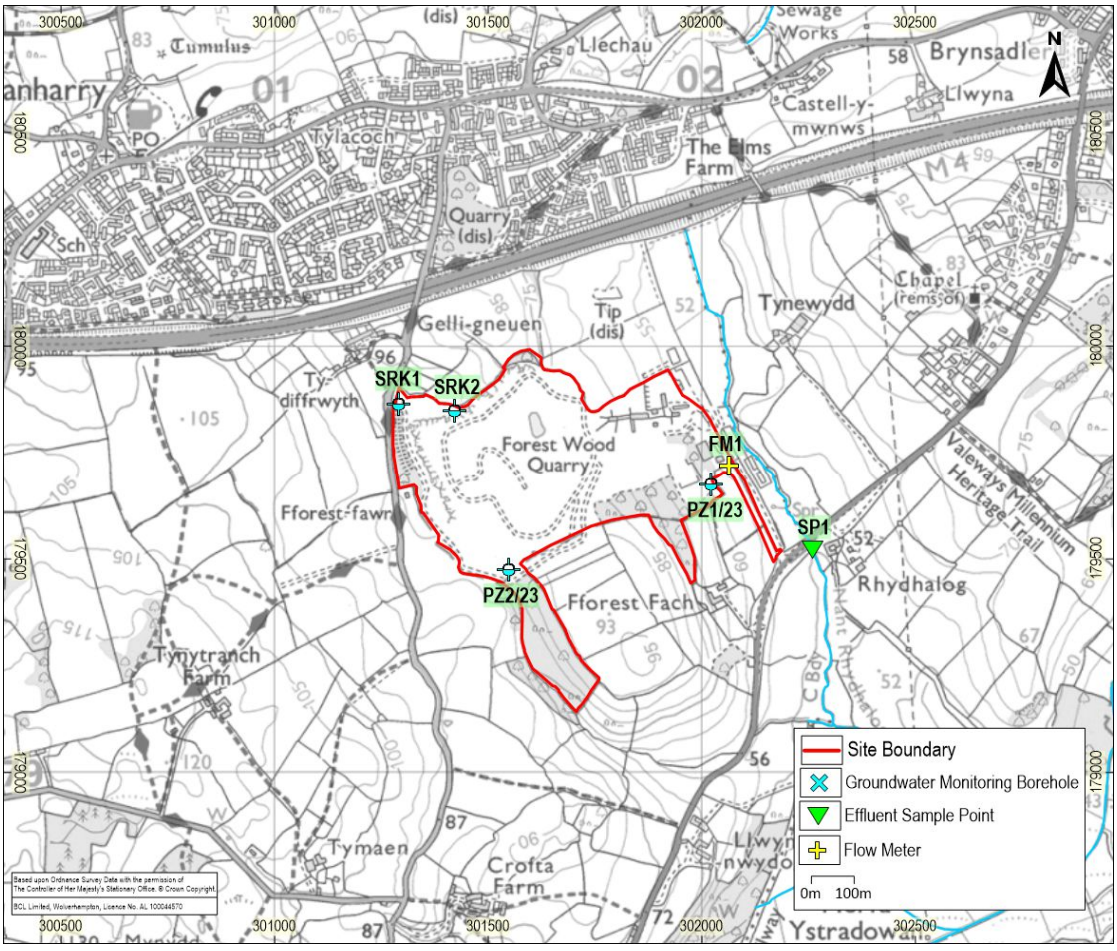

Figure 1 - Locations of Monitoring Infrastructure

3. MAINTENANCE SCHEDULE

3.1 Management / maintenance measures, designed to ensure the continued efficacy of the HMS, are as detailed below at *Table 2*.

Table 2 Management / Maintenance Schedule				
Type	**Description**	**Records**	**Frequency**	**Commencement**
Piezometers				
Regular Maintenance	Dip to base to identify blockages	Digital	Quarterly	Immediate
	Visual inspection of headworks/access		Monthly	
Occasional Tasks	Clearance of vegetation to facilitate safe access.		Where required by regular maintenance.	
Remedial Works	Clearance of blockages			As required (recommended within 6 months).
	Headworks replacement.			
	Re-survey.			
	Replacement of piezometer			

3.2 It is not anticipated that any piezometers will be removed as a result of Site operations, however replacement due to loss or damage of piezometers shall be undertaken within a period of 6-months, unless otherwise agreed in writing with the Mineral Planning Authority (MPA) in consultation with Natural Resources Wales (NRW).

3.3 Replacement or repair due to damage or malfunction of flow meters / raingauges shall be undertaken within a period of 2-months, unless otherwise agreed in writing with the Mineral Planning Authority (MPA) in consultation with Natural Resources Wales (NRW).

4. REPORTING, ASSESSMENT AND MITIGATION

4.1 All hydrometric data collected should be presented annually by a competent person in the form of an Annual Hydrometric Data Report, providing details of the following but not limited to:

- Status of monitoring infrastructure;
- Commentary upon groundwater trends;
- Review of collected data against the hydrogeological conceptual model and update if necessary;
- Recommendations for changes to working / dewatering practices in the quarry to mitigate any effects where groundwater drawdown is considered to be impacting on local abstractors.

4.2 There is currently insufficient groundwater level data available describing background conditions outwith the Site to allow development of assessment criteria.

4.3 It is recommended that a minimum of 12-months baseline data is collected prior to the commencement of dewatering. This can then be compared to rainfall and used for setting low-level trigger values for investigation and mitigation if required as described below.

4.2 Required Scope of Assessment Criteria

4.2.1.1 It is a pre-requisite that, when formulated, the Assessment Criteria shall:

i. have ability to distinguish between dewatering induced effects and natural background variations in groundwater levels (*i.e.* due to short or long-term rainfall variation), and;

ii. provide timely indication of possible future impact such that mitigation may be appropriately designed, implemented and its effectiveness monitored.

4.3 Likely Format of Assessment Criteria

4.3.1.1 In order to fulfil pre-requisite i) above, it is appropriate to assess ("trigger") groundwater level data collected during dewatering against a stable hydrometric variable measured elsewhere within the catchment. For such a variable to be stable during quarry workings it must be unlikely to be affected by the dewatering. One of two principal methods are typically applied, namely:

i. adopting rainfall as the "control" variable against which "trigger" variables of groundwater levels, measured adjacent the dewatering area, may be assessed.

ii. adopting groundwater levels measured in a locality unlikely to be affected by dewatering (distant groundwater levels) as the control against which trigger groundwater levels can be assessed.

4.3.1.2 In order to establish Assessment Criteria using either method i) or ii) above, it is necessary to establish that presence of a reliable relationship between the baseline control and trigger variables.

4.3.1.3 The submissions required by and described above will present an assessment of the relationships between hydrometric variables, the results which will be used to inform the selection of the final form of Assessment Criteria and the trigger and control values associated with those criteria.

4.4 Mitigation

4.1 In the event that Monthly Data Assessment determines a breach of Assessment Criteria, then, the operator will immediately advise the MPA and the NRW.

4.2 If derogation to groundwater water supply attributable to the dewatering operation at Forest Wood Quarry is reported by local abstractors, mitigation options are to lower the elevation of the pump or drill a replacement deeper abstraction well based on the identified impact and magnitude. For surface water abstractors, mitigation options are to provide a pumped supply from the quarry or provide a new borehole supply.

4.3 In the event that additional mitigation is required, further steps will be agreed with the MPA.

4.4 Should mitigative action be required under the HMS, details of works undertaken, and measures implemented will be recorded within the ongoing monitoring reports. These will include an assessment to confirm the effectiveness of mitigation provision and consideration of any further action required.

5. SUMMARY AND CONCLUSIONS

5.1 A Hydrometric Monitoring Scheme has been prepared for Forest Wood Quarry, Pontyclun, South Wales, seeking to regularise hydrometric monitoring practices to allow for safe sub-water table access at the Site via the dewatering of mineral workings.

5.2 The HMS proposes a monitoring program of collection for groundwater levels, abstraction volumes and rainfall levels.

5.3 Data collection frequencies and maintenance measures have been specified to ensure the ongoing efficacy of the HMS throughout its operation.

5.4 Recommendations of Assessment Criteria have been set out in the HMS to identify significant deviation of groundwater levels.

5.5 The HMS includes potential mitigation options to enable a reversal of reduction in groundwater levels, or for direct augmentation supply in the eventuality that alteration of groundwater/surface water levels are identified and deemed attributable to the ongoing dewatering operation at Forest Wood Quarry.

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BCL Consultant Hydrogeologists Limited
March 2024

Doc Ref: M\AE\FW\HIA_004

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Appendix 3 Radius of Influence Calculations

BCL HYDRO
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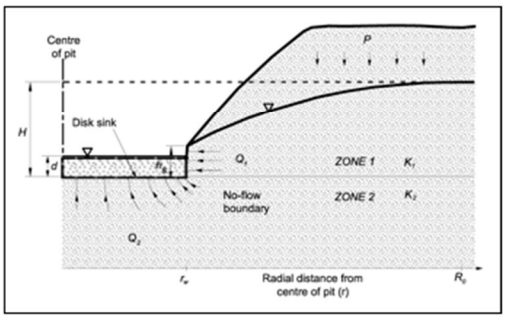
19) Radius of influence (Niccoli et al, 1998) - Method to estimate radius of influence if other parameters can be estimated with reasonable accuracy

$$H = \sqrt{h_s^2 + \frac{P}{K_{h1}}\left[R_0^2 \ln\left(\frac{R_0}{r_w}\right) - \frac{R_0^2 - r_w^2}{2}\right]}$$

Essential input
Optional input
Calculated

Height of water table at radius of influence	H	50	m	45	55	m
Saturated thickness to seepage face	h_s	5	m	0	10	m
Drawdown = (H-h_p)	s	45	m	35	55	m
Layer 1 horizontal hydraulic conductivity	K_{h1}	0.864	m/d	0.5	1.728	m/d
Recharge	P	0.00181	m/d	0.00156	0.00181	m/d
Radius of quarry	r_w	150	m			
Effective radius	R_0	936.50		755.42	1294.82	



The following assumptions apply to this equation

- steady-state, unconfined, horizontal radial flow
- uniformly distributed recharge at the water table
- pit walls are approximated as a right circular cylinder
- the static water table is horizontal
- groundwater flow is horizontal
- groundwater flow to the pit is axially symmetric

(Niccoli et al, 1998)

Data sources (to complete an audit trail)

Height of water table at radius of influence	H	50.00
Saturated thickness to seepage face	h_s	4
Layer 1 horizontal hydraulic conductivity	K_{h1}	0.864
Recharge	P	0.00181
Radius of quarry	r_w	150