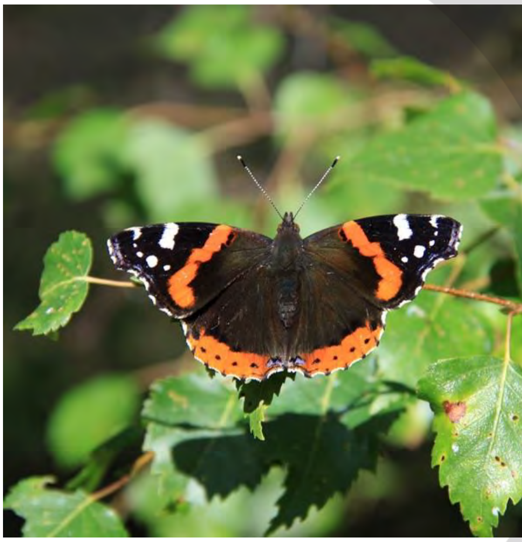
Dŵr Cymru Welsh Water

Biglis Wells

Hydrogeological Impact Assessment (HIA)



Wood Environment & Infrastructure Solutions UK Limited – January 2019

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Doc Ref. 41251R014i2

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Document revisions

No.	Details	Date
01	Draft Report	21/12/2018
02	Final Report	31/01/2019

Executive summary

Purpose of this report

The purpose of this document is to support an upcoming licence variation application for a Dŵr Cymru Welsh Water (DCWW) groundwater abstraction at Biglis Wells. Biglis Wells is a groundwater source owned and operated by DCWW, located near Barry in South Wales. The abstraction is licensed by Natural Resources Wales (NRW) under licence number (21/58/11/2), and raw water is supplied to two industrial customers.

DCWW require a Hydrogeological Impact Assessment (HIA) to support a licence variation application for the source to continue the existing licenced annual abstraction volume of 2500 Ml/a. The present licence has a time limited condition that expires on 31 March 2019, thereafter the annual abstraction rate will revert to a lower rate of 1818 Ml/a, which is lower than the volume required by the customers.

The Biglis Wells source is located east of Barry in the Vale of Glamorgan, two kilometres inland from the south coast of Wales (Figure 1.1). The abstraction has its source in the Triassic Mercia Mudstone Group, specifically the lower basal conglomerate layer known as the Marginal Facies and is located on a former spring which issued from beneath the overlying alluvial deposits. It is known that the Marginal Facies locally has a hydraulic connection with the underlying and lateral Carboniferous Limestone Group, and as a result this HIA follows the karstic approach. This is consistent with the approach used by NRW to develop the Source Protection Zone (SPZ) for the source. There has been a licensed groundwater abstraction at Biglis Wells since the 1960s. The current licence (21/58/11/2) has been effective from April 1999 and during this time the local groundwater levels have been monitored as part of the licence condition. The groundwater level record in the observation boreholes have no striking overall trend, indicating that the groundwater abstraction is not impacting the local water levels. The record of nearly 20 years contains drought years, and no difference in the groundwater levels is apparent during these years.

The desk study and water features survey identified potential receptors to the abstraction, however no impacts were evident or reported. The nearby groundwater abstractors, including the abstraction at Beauville Farm, stated no issues or concerns regarding their sources, even during the relatively dry Summer of 2018. Collectively this indicates that whilst the Biglis Wells abstraction has the potential to impact on other abstractors and water features (springs) no effect of the abstraction has been identified.

It is proposed that as part of the licence variation:

- the annual maximum quantity of water to be abstracted is maintained at 2500 Ml/year (this report has not identified any impacts on the potential receptors);
- The groundwater levels at the three remaining observation boreholes (OBH2, OBH3 and OBH4) are continued to be monitored, however the requirement to monitor the collapsed OBH1 is removed from the licence; and
- The purpose of abstraction should be updated from public water supply to industrial in line with the current use of the water.

Contents

1. Biglis Wells desk study

The aim of this document is to support an upcoming licence variation application for a Dŵr Cymru Welsh Water (DCWW) groundwater abstraction at Biglis Wells. Biglis Wells is a groundwater source owned and operated by DCWW, located near Barry in South Wales. The abstraction is licensed by Natural Resources Wales (NRW) under licence number (21/58/11/2), and raw water is supplied to two industrial customers.

DCWW require a Hydrogeological Impact Assessment (HIA) to support a licence variation application for the source to continue the existing licenced annual abstraction volume of 2500 Ml/a. The present licence has a time limited condition that expires on 31 March 2019, thereafter the annual abstraction rate will revert to a lower rate of 1818 Ml/a, which is lower than the volume required by the customers.

1.1 The source

The Biglis Wells source is located east of Barry in the Vale of Glamorgan, two kilometres inland from the south coast of Wales (Figure 1.1). The abstraction has its source in the Triassic Mercia Mudstone Group, specifically the lower basal conglomerate layer known as the Marginal Facies and is located on a former spring which issued from beneath the overlying alluvial deposits. It is known that the Marginal Facies locally has a hydraulic connection with the underlying and lateral Carboniferous Limestone Group, and as a result this HIA follows the karstic approach. This is consistent with the approach used by NRW to develop the Source Protection Zone (SPZ) for the source. Further geological context is provided in Section 2.

There are two abstraction boreholes detailed on the licence which are connected by a series of adits. The maximum licence rates have a time-limited upward variation which has been in effect since 1999. The total annual abstraction will reduce from 2500 Ml/d to 1818 Ml/d on the 1st April 2019 (Table 1.1).

This time-limited condition is the main purpose for this HIA; to support an application to retain the licence variation, as the maximum annual rate from 1st April 2019 will not meet the volume required by the customers in all years.

The purpose of the abstraction outlined on the licence is also to be amended as part of the licence variation. The licence currently states the purpose of the abstraction is for public water supply, however the raw water is supplied to two customers for industrial purposes.

Table 1.1 Summary details of Biglis Wells licence 21/58/11/2

Name	Type	Easting	Northing	Maximum licence rates until 31st March 2019		Maximum licence rates from 1st April 2019	
				Daily (Ml/d)	Annual (Ml/yr)	Daily (Ml/d)	Annual (Ml/yr)
BH1 / Point A	Two boreholes connected with an adit system	314740	169800	8.4	2500	8.4	1818
BH2 / Point B		314730	169780				

1.2 Regulatory Context

This section outlines the current water resource status as defined by the Catchment Abstraction Management Strategy (CAMS) assessment and also the Water Framework Directive (WFD) status for the area and waterbody in which the Biglis Wells source is located.

CAMS status

The Biglis Wells abstraction is located within the Thaw and Cadoxton CAMS which has concerns about surface water availability (NRW, May 2015). The surface water resource reliability is classified as available for at least 30% of the time for the Cadoxton area in which the Source is situated. There are limited data on groundwater levels and flows within this CAMS area and therefore the document states that all groundwater abstraction licences will be treated by NRW on a case by case basis.

WFD status

The current WFD status (2015) of the surface water and groundwater bodies are displayed in Table 1.2 and Table 1.3 respectively.

Surface water

The Cadoxton river waterbody (GB110058026420) has an overall status of 'Moderate' due to a 'Moderate' ecological status. The elements which have been found in the Cadoxton River which have led to the ecological classification as 'Moderate' are detailed in Table 1.2. The chemical status of the river waterbody is 'Good', with the objective overall and ecological status to be 'Good' by the year 2027.

Table 1.2 River waterbody WFD status based on New Building Blocks (NBB) 2015

Waterbody ID	Waterbody Name	Overall Status	Ecological Status	Chemical Status	WFD Element Fail	Overall Objective	Ecological Objective
GB110058026420	Cadoxton – headwaters to tidal limit	Moderate	Moderate	Good	Copper, Phytobenthos Sub Element, Macrophytes & Phytobenthos Combined, Phosphate, Macrophytes Sub Element.	Good by 2027	Good by 2027

Source: Water Watch Wales WFD Cycle 2 NBB data (NRW, December 2015).

Groundwater

The Biglis Wells abstraction is located within the Thaw & Cadoxton Jurassic Lias groundwater waterbody (GB41002G201400). Table 1.3 details the Jurassic Lias and the neighbouring groundwater body of the Thaw & Cadoxton Carboniferous Limestone (GB41002G201600) due to the potential interaction between the two waterbodies. Both groundwater waterbodies have 'Good' status for the chemical and quantitative status, with an overall 'Good' status.

Table 1.3 Groundwater waterbody WFD status based on New Building Blocks (NBB) 2015

Waterbody ID	Waterbody Name	Overall Status	Chemical Status	Quantitative Status	Overall Objective
GB41002G201400	Thaw & Cadoxton Jurassic Lias	Good	Good	Good	Good by 2015
GB41002G201600	Thaw & Cadoxton Carboniferous Limestone	Good	Good	Good	Good by 2015

Source: Water Watch Wales WFD Cycle 2 NBB data (NRW, December 2015).

Summary

The WFD groundwater status around Biglis Wells is 'Good'; therefore, the potential for a restriction on the Biglis Wells source due to WFD groundwater conditions is expected to be low. There is no CAMS assessment of the groundwater in this area due to limited data, but it is reported that there is limited surface water availability within the River Cadoxton catchment.

2. Conceptual understanding

This section details the conceptual understanding of the regional and local hydrogeology of the Biglis Wells source. The hydrogeological knowledge of the area has built upon earlier hydrogeological assessments for the delineation of Source Protection Zones (SPZs) and the previous variation to the Biglis Wells licence. Recent monitoring data (provided by DCWW and NRW) have been assessed to support and develop the conceptual model.

2.1 Site setting

The Biglis Wells source is located two kilometres from the Welsh coast within the floodplain of the River Cadoxton, approximately 400m north-west of the river (Figure 1.1.). The land immediately around the source is very gently sloping, with a topographic elevation below 10 mAOD, which is prone to flooding. The surrounding hills to the north and north-west reach 110 mAOD and 85 mAOD respectively. Many of the watercourses (tributaries of the Cadoxton River including the Nant yr Argae) originate from mapped springs in the hills to the north-west near Pencoetre Wood. These smaller watercourses and the network of field drains drain the low-lying, relatively flat land near the source.

The land use around the site is primarily agricultural (pasture and crops), and to the west of the source is the urban area of Barry. A raised embankment railway line (oriented north-east to south-west) connecting to Barry is located approximately 200m north-west of the source.

2.2 Regional geology and structure

The geology of South Wales, although locally complex, is characterised by the Devonian Old Red Sandstone overlain by the Carboniferous Limestone Group (Allen et al, 1997). Moving up through the succession, the Limestone is overlain by the Carboniferous sandstones of the Millstone Grit, and then the Coal Measures. During the Permian and early Triassic period regional uplift caused large scale erosion throughout South Wales, therefore rocks of this age are missing from the sequence, so that the younger Triassic Mercia Mudstone Group unconformably overlies the older formations. The conglomerates of the Mercia Mudstone Group are overlain by sandstones of the Penarth Group, and succeeded by the alternating shale and limestone sequence of the Lower (Blue) Lias Formation.

Table 2.1 Geological succession summary

Age	Name	Description
Quaternary	Alluvium and Till	Alluvial silts and clays with some sands. Fluvio-glacial sand and gravel
Jurassic	Lower (Blue) Lias	Alternating sequence of shales and limestones
Triassic	Penarth Group	Marly limestone/sandstone
	Mercia Mudstone	Mudstones with silty layers and conglomerates with sandy marls
Carboniferous	Coal Measures	Rhythmic sequences of mudstones, siltstones, sandstones, grits, fireclays and coals.
	Millstone Grit	Cyclic sequences of shales and sandstones

Age	Name	Description
	Upper Limestone Shales	Muddy limestones
	Main Limestone	Massive, well-jointed, dolomitic limestones and mudstones
	Lower Limestone Shales	Alternating sequence of shales and thin limestones
Devonian	Old Red Sandstone	Consolidated, well cemented, flaggy sandstones with thin sandy marls

Source: BGS (1986) Hydrogeological Map of South Wales.

The Carboniferous Limestone is a significant aquifer and Limestone outcrops are exposed in the Vale of Glamorgan (Figure 2.1). The Limestone is considered to be unconfined where it is exposed or overlain by sandy superficial deposits but confined where the overlying superficial deposits are mostly clay or where it is overlain by limestone and shales of the Blue Lias.

Regionally the Mercia Mudstone Group is a non-aquifer, in many areas however the basal section of the Group (often named the 'Triassic Marginal Facies') consisting of mudstones, siltstones and sandstones locally act as an aquifer. The following section describes the local geology and hydrogeology around Biglis Wells, where the Triassic Marginal Facies are locally a productive strata and support groundwater abstractions.

2.3 Local geology and hydrogeology around Biglis Wells

The local geology around the source of Biglis Wells is dominated by the Triassic Mercia Mudstone Group, with outcrops of Carboniferous Limestone to the north and west of the abstraction (Figure 2.1). The Carboniferous limestone directly underlies the Mercia Mudstone, and was subject to erosion and deformation before the deposition of the Mercia Mudstone Group. The area of Biglis Wells is locally heavily folded and faulted.

The basal layer of the Mercia Mudstone Group is known as the Marginal Facies, and is a conglomerate layer containing clasts derived from the Limestone rock lying immediately beneath the unconformable base. The hydrogeological properties of the Marginal Facies are similar to the underlying Limestone, and both act locally as aquifers (Table 2.2). There is the potential of high transmissivity in both the Marginal Facies and the Limestone, due to dissolution of the rock, which is likely especially where there is local deformation and faulting. This hydrogeological setting, supported by the monitoring data in section 2.4, and resulting conceptual model in Section 2.4 are key to operation of the source and the reason why this HIA follows the karstic approach.

To the west and east of Biglis Wells the Mercia Mudstone is overlain by the marine mudstones and thin limestones of the Penarth and Lias Groups. Large areas of the floodplain and valley, including the area of Biglis Wells, are covered with superficial deposits of alluvium (silty clay) which acts as a confining layer to the Mercia Mudstone Group (Figure 2.2).

Table 2.2 Local hydrogeology around Biglis Wells

Age	Geology	Aquifer designation Wales *	Aquifer properties	Description
Quaternary	Alluvium	Secondary A	Aquitard - acts as a confining layer to the underlying Mercia Mudstone	Clay and silty deposits
Jurassic	(Blue) Lias Group Locally named St Mary's Well Bay Member	Secondary A	Leaky aquifer - Small springs issue from the outcrop/from fractures	Relatively impermeable thinly interbedded limestones and mudstones
Triassic	Penarth Group	Secondary B	Aquitard	Calcareous marls/marly limestones to sandstone
	Blue Anchor Formation	Secondary B	Aquitard	Dolomitic mudstones and siltstones
	Mercia Mudstone	Secondary B	Aquitard	Red mudstones, generally compact and hard, transition into Marginal Facies
	Marginal Facies	Principal	Locally acts as an aquifer (Regionally recognised as a minor aquifer)	A variable layer, typically a conglomerate containing dolomitised limestone from the underlying geology
Carboniferous	Gully Oolite Limestone	Principal	Aquifer	Oolitic limestone (with some mudstone in upper part)
	Friars Point Limestone	Principal	Aquifer	Often dolomitised, layered beds of skeletal remains (mainly crinoid), shale skeletal packstones and mudstone
	Black Rock Limestone	Principal	Aquifer	Coal rich limestones Dark grey/black limestone with thin shale bed near base/middle
	Avon group	Principal	Aquifer	Mud rich - Mudstone interbedded with limestone

* Aquifer designation Wales source BGS Onshore Geoindex.

2.4 Monitoring data

Rainfall data

Observed daily rainfall data has been provided (from NRW) for the sewage treatment works (STW) at Cog Moors (located in Figure 1.1). The record supplied starts in July 2004 and ends in mid-November 2018 (Figure 2.3). Notable gaps (with a length of more than one calendar month) in the record are in the first 7 years of the record, and include; August 2004 – December 2004, October 2006 – March 2007, and November 2009 – April 2010. The average annual total rainfall for 2013-2017 (years with a full daily record) is 926mm/a.

Biglis Wells abstraction

Groundwater levels in the abstraction well and flow rates for the two customers at Biglis Wells were provided by DCWW. These datasets are recorded at 15-minute intervals and the record extends from August 1998 until the end of July 2018. The average daily water levels (mAOD) and abstraction rates (Ml/d) are presented in Figure 2.4. The total annual abstraction rates are also presented in Figure 2.4 as daily equivalent abstraction rates for comparison.

There is a noticeable gap in both records, with limited data between June 2012 and July 2013. Regardless of this data gap, the groundwater levels in the well and the abstraction from Biglis Wells both appear to show a slight decline over time, as shown by the linear trendlines in Figure 2.4. The average daily abstraction rate falls from approximately 5.5 Ml/d to 4 Ml/d, with the daily average groundwater level in the well falling from 5.5 mAOD to approximately 4.5 mAOD. Over this 10-year period there may be multiple factors that could contribute to this observation; such as possible changes to the datum/dataloggers and other monitoring changes, or changes to the pumps in the well amongst many others. DCWW are aware of this apparent decline in well performance, which they are investigating.

Groundwater levels

There are four observation boreholes (OBH) noted on the Biglis Wells licence which are required to be monitored by dataloggers or dipped every two weeks (detailed in Table 2.3 and locations presented in Figure 1.1). The boreholes monitor the groundwater levels in the Mercia Mudstone and any overlying superficial deposits (Table 2.3).

Table 2.3 Summary of Biglis Wells observation boreholes

OBH	Easting	Northing	Ground Level (mAOD)*	Depth (m)*	Distance from Biglis Well 1 (m)*	Monitored geology**	Record start date	Record end date
OB1 (collapsed)	315090	169600	6.55	11.5	400 (southeast)	Alluvium and Marl Bedrock	01/06/1999	31/12/2007
OB2	314750	169750	7.75	8	20 (south)	Alluvium and Marl Bedrock	01/06/1999	04/09/2018
OB3	314050	170790	12.67	15	1200 (north/northwest)	Marl Bedrock	01/06/1999	04/09/2018
OB4	313900	170080	10.80	13.9	900 (northwest)	Marl Bedrock	01/06/1999	04/09/2018

* Source: Hyder Consulting Limited (2003)
** Source: HCL (1997) in Entec (2009).

The groundwater level record at OB1 ends in December 2007 as the borehole collapsed. Communication in December 2007 from NRW (formerly Environment Agency Wales) to DCWW confirmed that there was no requirement to re-drill this borehole as OB4 had a similar response to that of OB1 for the data record from March 2006 to October 2007 (Appendix A). The three remaining boreholes are monitored by dataloggers at 15-minute intervals. The daily average ground water levels (mAOD) for the full records of all four boreholes are presented in Figure 2.5.

There are gaps in the groundwater level records, notably from August 2002 to January/February 2004 for all four observation boreholes. This was reported as a battery failure in OB1, OB2 and OB4, and that the chamber of OB3 was flooded which caused a general failure (Hyder Consulting Ltd, 2003).

The observed groundwater levels are shallow, often within 2-3m of the ground level. The highest groundwater elevations (~12.8mAOD) are recorded at OB3, 1.2 Km north/northwest of the abstraction, and the lowest elevations (~1.5mAOD) are recorded at OB2, 20m south of the abstraction. The seasonal trends observed at all boreholes are similar, although OB1 and OB4 appear to have smaller seasonal ranges compared to OB2 and OB3. The record at OB3 appears to have fewer 'flashy' responses compared to the other three boreholes.

Groundwater level responses

To aid analysis and understand the possible responses in groundwater to rainfall and abstraction, the groundwater levels in the observation boreholes are plotted with the daily rainfall at Cog Moors STW and the levels and the abstraction rate in the Biglis Wells source, the full records are shown in Figure 2.6. The locations of these sites are mapped in Figure 1.1.

There are three observation boreholes with groundwater level elevations for most of the record from June 1999 until September 2018. As noted above, OB1 collapsed and was not re-drilled, as such this record ends in December 2007. The rainfall record at Cog Moors begins in July 2004, and the abstraction well levels and rates for the Biglis Wells source extend from August 1998 until July 2018.

The groundwater levels in OB3 and OB4 (Figure 2.6) display no clear long-term trend; whilst seasonal highs and lows vary, the overall levels show no obvious rise or fall. The level at OB2 (closest observation borehole to the well) displays a small rise in groundwater levels, with seasonal highs more frequently above 7 mAOD and seasonal lows less frequently below 2 mAOD in the last decade of the record. There does appear to be an overall fall in abstraction rate from the Biglis Wells source, with average daily rates declining from ~5 to ~4 Ml/d. The level in the well, perhaps not as you would expect, also displays a fall in the daily average groundwater level (from 5 to 4 mAOD). As groundwater levels overall display no clear trend, and the levels in OB2 show a potential rise, the fall in groundwater levels in the well is most likely attributed to the construction of the borehole (i.e. it is a small-scale localised issue).

2006 responses – Dry Period

The year 2006 was relatively dry, and the 2006 record of all data sets is presented in Figure 2.7. Focussing on the Winter/Spring of 2006, three rainfall events (highlighted by the blue dashed lines) each triggered relatively fast rises in groundwater levels, seen by similar elevation changes in OB3 and OB4. Responses to the same rainfall events in OB2 have different ranges in water level; flashier responses with steeper rising and falling limbs, and influences of the abstraction rates at Biglis Wells can also be seen. The response in OB1 is similar to OB3 and OB4, although the response lag to some rainfall events is shorter (quicker) than OB3 and OB4. The response to a sudden decrease in abstraction (followed by an increase) in early February (highlighted by the purple dashed line) is seen in OB2 by a steep rise and fall, which mirrors the response seen in the well. No response to the change in abstraction rate is seen in OB3 or OB4 (and no data is available for OB1).

The relatively long rainfall event during early to mid-May coincides with an increase in abstraction at Biglis Wells. Regardless of the increased abstraction, the response seen in the well and the two closest observation boreholes (OB1 and OB2) is a rise in levels. A similar gradient of rise and range of increase is seen amongst most boreholes, except for OB1 where the total change is smaller. The difference in response at OB1 (the smaller change in level) is likely due to its location; sited south-east (down-gradient) of the abstraction, confined beneath alluvium and furthest from the area of recharge in the north (which is seen in the Source Protection Zone delineation in Figure 1.1).

The rainfall event at the end of June causes a rise in groundwater levels, however at a similar time the abstraction rate falls. It is likely that the rise in levels in the boreholes closest to the source (OB1, OB2) are responding to the combined effect of rainfall and reduced abstraction. This rise in groundwater levels is noticeable in the overall seasonal trends, as after this date the levels in other boreholes continue to fall to their seasonal lows. The rate of Summer groundwater level decline in the OB3 is relatively constant, whilst the record at OB4 also shows the same seasonal decline it also contains responses to the abstraction. The levels at OB1 appear to remain constant for much of the Summer, suggesting that the datalogger may be above the water level.

The rainfall data contains gaps in the record for much of the last 6 months of 2006. Therefore, specific changes in levels cannot be attributed to rainfall or abstraction with confidence. The overall trend in the Autumn/Winter groundwater level responses are similar, with less influence of the abstraction seen in the levels at OB3.

2017/2018

The most recent 18 months of data is presented in Figure 2.8. The record is complete for most datasets until the end of July 2018, with some gaps in the observed levels at OB4 and a gap in the levels at OB3.

Summer 2018 was relatively warm and dry, however the groundwater levels in the observation boreholes display no markedly different responses when compared to Summer 2017 observations. The response in OB2 is almost identical to the response within the Biglis Wells source, but tracks ~0.6m above the levels in the well. The response at OB4 is similar to the response in OB2, although in OB4 the response to the changes in abstraction is less. Groundwater levels in OB3 display fast responses to Autumn/Winter rainfall events, and provides a record of the overall seasonality, but little response to the abstraction at Biglis Wells.

2.5 Conceptual model

The Biglis Wells source is abstracting from the Marginal Facies of the lower Mercia Mudstone Group, which is confined by the overlying hard, red mudstones of the Mercia Mudstone Group and up to 3m of the silty-clay alluvium deposits. Groundwater levels in the Marginal Facies display fast responses to both rainfall and abstraction (Section 2.4) which can be attributed to fractured, fissured and karstic response to changes in the local groundwater level. The Marginal Facies behaves in hydraulic continuity with the underlying Carboniferous Limestone. There are many mapped and inferred faults in the Carboniferous Limestone and Triassic Lias Group (Figure 2.1) within the Cadoxton catchment.

The Biglis Wells source is located in the catchment of the Cadoxton River, which is dominated by the Mercia Mudstone Group, but with outcrops of Carboniferous Limestone and the interbedded layers of limestone and mudstone layers of the Triassic Lias Group, associated with the areas of higher topographic elevation. The Cadoxton River and its tributaries are underlain by deposits of consolidated silty clays (alluvium) for much of their reaches, with minimal direct contact between the watercourses and the Mercia Mudstone Group. The alluvial deposits and the Mercia Mudstone Group act as a confining layer to the underlying Marginal Facies aquifer. Results from a pump test conducted by HCL (December 1997) as reported in Entec (2009) showed no evidence for induced infiltration from any monitored surface-water sources, which included several springs, the Cadoxton River and Nant yr Argae stream. The overlying alluvial deposits and the low permeability red mudstone of the Mercia Mudstone Group confine the Marginal Facies aquifer across the valley basin, disconnecting the aquifer from surface-water sources.

Recharge to the Marginal Facies aquifer is limited to areas of exposed outcrop where the alluvial deposits are not present, and it is not confined by the overlying Mercia Mudstone. Recharge will also occur from direct rainfall over the areas of higher elevation of outcropping Limestone to the north, near Beauville Wood and Park Wood, and to the south-west in the urban area of Palmerstown. Subsequent lateral recharge and upwelling from the Limestone to the overlying Marginal Facies will directly recharge the aquifer supplying the Biglis Wells source. The hydraulic connection between the Marginal Facies and the Carboniferous Limestone is supported by water chemistry. As reported in Entec (2009), water quality results from observation boreholes and several springs in the area indicate water sourced from carbonate system groundwaters (HCL, May 1997, December 1997).

Although there are few observation boreholes within the Cadoxton catchment, groundwater flows south following the topographic gradient and the general surface-water direction. There are many mapped springs within the catchment, often associated with the Limestone – Mercia Mudstone contact and mapped faults within or along the Limestone or Lias Group.

A block diagram illustrating the conceptual model of the source is presented in Figure 2.9 (reproduced from Entec, 2009). This conceptual model is consistent with that used to delineate the SPZ for the source, in agreement with NRW. None of the information presented in this report, collated since development of the SPZ, suggests that a deviation from this conceptual model should be considered.

3. Sensitive sites

Evidence supports the hydraulic disconnection of many surface-water features from the Marginal Facies aquifer due to the low permeabilities of the confining Mercia Mudstone and alluvial deposits. This section identifies any sites that have the potential to be impacted by the abstraction at Biglis Wells.

3.1 Water features survey

As part of the study a site visit was conducted (15/16 November 2018) to further develop the conceptual understanding and confirm or identify any water dependent features. The photos and notes taken during the visit are in Appendix B.

Water courses, SSSIs and springs

The site visit included a walkover to identify water courses and determine those which are rivers and streams which flow under 'normal' conditions and any drains or channels which have been constructed to alleviate localised flooding. Springs which were identified from OS mapping were also visited if land access was permitted (note that access was only on public footpaths for all of the site visit).

The desk study identified eight Special Sites of Scientific Interest (SSSIs) within the 5km radius of Biglis Wells source. Of these eight, only three were identified during the desk study as potential receptors; Barry Woodlands, Cog Moors and Cosmeston Lakes. Both Barry Woodlands and Cog Moors SSSIs were not accessible during the water features survey due to limited access.

Barry Woodlands SSSI is located near mapped OS springs which are emerging from the younger formations of the Penarth and Blue Anchor overlying the Mercia Mudstone. As such there will be no hydraulic connection with these springs to the Marginal Facies aquifer. The springs will provide water to the Nant yr Argae watercourse, however there is no evidence of a hydraulic connection with the stream networks in the floodplain and the Marginal Facies. Therefore, Barry Woodlands SSSI and the springs which may sustain the SSSI can be removed as potential receptors.

Cog Moors SSSI is located south-west of Biglis Wells, on the alluvial deposits in the floodplain south of the Cadoxton River. There is no evidence of a hydraulic connection with the Marginal Facies aquifer and the surface water features flowing over the alluvium and Mercia Mudstone. Whilst there was no access to Cog Moors SSSI during the water features survey, many mapped watercourses are drains (Sully Drain and Cog Moors Drains) of which many sections which were accessible in November 2018 were noted as dry or containing stagnant water. As there is no evidence of a hydraulic connection with the Marginal Facies aquifer, Cog Moors SSSI can be removed as a potential receptor.

The SSSIs along the coast, Severn Estuary, Penarth Coast, Sully Island and Barry Island, were removed as potential receptors due to their coastal location and limited potential to be influenced by the source located over 3km inland. The remaining SSSI, Cwm Cydfin, was removed as a potential receptor due to its distance from the source (over 4 Km) and its proximity to the River Ely in a neighbouring water catchment.

Many of the springs identified from OS mapping emerge along the contact of the Blue Anchor Formation with the underlying the Mercia Mudstone. As such these springs have no hydraulic connection with the underlying Marginal Facies aquifer and can be removed as potential receptors. The springs emerging along contacts with the Mercia Mudstone Group and the underlying Carboniferous Limestone remain as potential receptors. Similarly, springs along areas of mapped faulting with the Mercia Mudstone Group remain as potential receptors due to the potential hydraulic connection with the Marginal Facies aquifer.

Groundwater abstractions (GWAB)

There are two licensed groundwater abstractions within a 5km radius of the Biglis Wells source. The abstraction at Glamorganshire Golf Club is approximate 3km east of the source, toward the coast, and as such is unlikely to be a receptor. The abstraction at Greenyard Farm is 1km north-west of the source and has the potential to be a receptor. During the survey it was confirmed by the farmer at Greenyard Farm that there have been no issues with the source, and the source has been in operation since the 1990s. This suggests that whilst the abstraction at Greenyard Farm is a potential receptor there have been no reported issues during the operation of the Biglis Wells abstraction.

Locations of private groundwater abstractions were provided by the Vale of Glamorgan Council to DCWW in November 2018. Only one abstraction is located within a 5km radius of the Biglis Wells source, located at Beauville Farm (Figure 2.2). The borehole was constructed within the last "few years" to replace an abstraction from the river which failed due to an old pump. The Farmer reported no known issues with the abstraction and estimated that the abstraction was operating for an hour a day.

3.2 Water dependent features

Table 3.1 details the water dependent features identified from the desk study and observations taken from the Water Features Survey (WFS) in November 2018. The final column details a status on their potential as a receptor. Many surface-water features such as rivers and drains have been removed as potential receptors due to the low-permeability confining Mercia Mudstone and alluvial deposits overlying the Marginal Facies. The potential receptors which have not been ruled out represent groundwater abstractions and springs, these are also in Figure 3.1.

Table 3.1 Water dependent features

Name	Feature	Grid reference (and site number in Appendix B)	Approximate distance from source (units detailed individually)	WFS comment	Potential receptor	Receptor reason
Cog Moors	SSSI	ST1561669668 (29)	<1Km	Inaccessible due to private land. Area is very flat and low lying.	No	No evidence of hydraulic connection between surface water features and the Marginal Facies aquifer (overlain by Mercia Mudstone and alluvial deposits).
Cosmeston Lakes	SSSI	ST1755869083	2.3Km	Cosmeston lake east flows into the Sully Brook.	No	Lakes located on younger St Mary;s Well Bay Member and Penarth Group. Lake has discharges to the Sully Brook, which has no connection to the Marginal Facies aquifer (overlain by Mercia Mudstone).
Barry Woodlands (and nearby springs)	SSSI	ST1266870969 (35)	2Km	No access during survey due to private land.	No	Springs emerging from younger Penarth Group and Blue Anchor Formation with no hydraulic connection to the Marginal Facies aquifer.
Cwm Cydfin, Leckwith	SSSI	ST1653173941	4Km	Not visited.	No	Ruled out as a potential receptor due to proximity to the River Ely, over 4Km north-east of Biglis Wells and outside the Cadoxton River catchment.
Severn Estuary	SSSI	ST3689781810	3.8Km	Not visited.	No	Ruled out as a potential receptor due to proximity to the coast and distance from Biglis Wells.
Penarth Coast	SSSI	ST1870868690	3.5Km	Not visited.	No	Ruled out as a potential receptor due to proximity to the coast and distance from Biglis Wells.
Sully Island	SSSI	ST1669866964	3Km	Not visited.	No	Ruled out as a potential receptor due to proximity to the coast and distance from Biglis Wells.
Hayes Point To Bendrick Rock	SSSI	ST1401567229	2Km	Not visited.	No	Ruled out as a potential receptor due to proximity to the coast and distance from Biglis Wells.
Barry Island	SSSI	ST1097366161	4.5Km	Not visited.	No	Ruled out as a potential receptor due to proximity to the coast and distance from Biglis Wells.
River Cadoxton	River	ST1485969227 (53)	400m	Flow visible at most locations. Some blockages observed but audible flowing water noted at these locations. Upstream banks vegetated. Substrate varies (if could be seen) from gravels/cobbles in upstream reaches to gravel/sand/silt.	No	No evidence of hydraulic connection between surface water features and the Marginal Facies aquifer (overlain by Mercia Mudstone and alluvial deposits).
Wrinstone Brook (tributary of River Cadoxton)	River	ST1364472616 (44)	3Km	Flow visible, cobble/gravel substrate with some trees along banks.	No	No evidence of hydraulic connection between surface water features and the Marginal Facies aquifer (overlain by Mercia Mudstone and alluvial deposits).
East Brook (tributary of River Cadoxton)	River	ST1577571052 (45)	1.5Km	Canalised channel with little flow (water 0-5cm deep).	No	No evidence of hydraulic connection between surface water features and the Marginal Facies aquifer (overlain by Mercia Mudstone and alluvial deposits).
River Nant-yr-Argae	River	ST1350671052 (18)	200m	Visible flow in channel. River banks are tree lined and incised.	No	No evidence of hydraulic connection between surface water features and the Marginal Facies aquifer (overlain by Mercia Mudstone and alluvial deposits).
Nant yr Argae Drain	River	ST1380970296 (6)	200m	Visibly flowing channel, with vegetated banks.	No	No evidence of hydraulic connection between surface water features and the Marginal Facies aquifer (overlain by Mercia Mudstone and alluvial deposits).
Biglis Moors Drain	River	ST1461769812 (1) ST14211370700 (12)	100m	Shallow drain observed as dry along majority of its course. At this location the drain was lined with grass. Standing water observed upstream (no flow) with established vegetative banks.	No	No evidence of hydraulic connection between surface water features and the Marginal Facies aquifer (overlain by Mercia Mudstone and alluvial deposits).

Name	Feature	Grid reference (and site number in Appendix B)	Approximate distance from source (units detailed individually)	WFS comment	Potential receptor	Receptor reason
Cold Brook	River	ST1388470098 (5)	125m	Visible fast flowing channel at this location. The channel has flowing water along its course, with silt/gravels substrate and incised banks, often vegetated and in some locations overgrown.	No	No evidence of hydraulic connection between surface water features and the Marginal Facies aquifer (overlain by Mercia Mudstone and alluvial deposits).
Pwl Erw-Naw Drain	River	ST1499269651 (31)	300m	Drain observed as dry at multiple locations and often grass-lined.	No	No evidence of hydraulic connection between surface water features and the Marginal Facies aquifer (overlain by Mercia Mudstone and alluvial deposits).
Sully Brook	River	ST1774168986 (49)	800m	Stagnant water in the Brook upstream of outflow from Cosmeston Lake SSSI (with leaves in channel base). Downstream of the outflow water is flowing although the substrate contains leaves and is silty. The Brook bifurcates near the urban area of Sully. The southern channel has visible flow however the channel is heavily vegetated. The northern channel is also heavily vegetated with no visible flow and water appears stagnant.	No	No evidence of hydraulic connection between surface water features and the Marginal Facies aquifer (overlain by Mercia Mudstone and alluvial deposits).
Springs	Springs	ST1616472929 (37) ST1621372874 (38)	N/A multiple locations	Springs were identified from OS mapping. Many could not be accessed due to limited public footpaths, however some springs/emergence were visible.	Yes	Springs with potential hydraulic connection with the Marginal Facies
Beauville Farm	GWAB (private)	ST1384672361 (41)	3 Km north-west	Water abstracted from borehole constructed within last few years (to replace the surface water abstraction which failed due to an old pump). No issues with the groundwater abstraction.	Yes	Located up-gradient of Biglis Wells, abstracting from Limestone which has a likely connection to the Marginal Facies aquifer of Biglis Wells.
Borehole at Greenyard Farm	GWAB (licenced under 21/58/11/0012)	ST1373170507 (30)	1 Km north-west	Water abstracted from borehole constructed in 1990s, water used to irrigate the golf course. Abstraction has been in operation throughout Summer 2018 (although potentially only at night time). The source has never run dry.	Yes	Approximately 1Km from Biglis Wells, abstracting from same aquifer.
Borehole at Glamorganshire Golf Club	GWAB (licenced under 21/58/11/0009)	ST1792369518	3 Km east	Not visited.	No	Located 3km east of Biglis Wells towards the coast

3.3 Potential receptors

The potential receptors identified in Table 3.1 cannot be ruled out as receptors of the Biglis Wells abstraction, although from the water features survey and records provided no impacts have been identified. The nearby groundwater abstractors (Beauville Farm and Greenyard Farm) have had no issues with abstracting and no issues were reported during the relatively dry Summer of 2018.

Springs identified from OS mapping which are not ruled out as potential receptors are emerging from contacts with the Mercia Mudstone and the underlying Carboniferous Limestone or along areas of mapped faulting. As their source or connectivity to the Marginal Facies is either possible or uncertain (especially in areas of faulting) these springs remain a potential receptor. As access to many of these springs during the water features survey was restricted, any impact could not be identified or reported. However, monitoring data for the site indicates no abstraction impacts beyond the immediate vicinity of the site (OB2). It should also be noted that the five springs which remain as potential receptors are not sources of mapped watercourses or sustain flow to environmentally sensitive sites (i.e. SSSIs).

To summarise, potential receptors have been identified however no impacts have been observed or reported. The WFD status of the Thaw and Cadoxton Jurassic Lias groundwater body is classed as 'Good' and the groundwater abstractors have reported no issues or concerns with their individual sources.

4. Proposed future assessment

This section details the proposed objectives for future assessment, where any measures are proposed to monitor or minimise the potential impacts of abstractions.

4.1 Monitoring

The current licence for Biglis Wells has a condition which states that four observation boreholes must be monitored. After one borehole collapsed in 2007, DCWW received confirmation from NRW in December 2009 (Appendix A) that it would not be necessary to be re-drilled, and as such three observation boreholes currently monitor the groundwater levels. It is proposed that the three observation boreholes currently in operation remain on the licence. These observation boreholes provide a long-term record of the groundwater levels, where observations of their responses to long term change, seasonal trends, local rainfall events and the influence of abstraction from the Biglis Wells source (or not) can be identified. The observed groundwater level record includes drought years and no significantly lower levels have been observed, even during these drier years the abstraction has remained in operation. The monitoring provides important evidence that the direct influence of the Biglis Wells abstraction is not observed in groundwater levels at certain locations, such as OB3.

The monitoring is important for another existing condition on the licence, stating that the Biglis Wells abstraction could stop or be reduced if the abstractors at Beauville Farm are unable to abstract water. During the water features survey (in November 2018) communication with the owner at Beauville Farm confirmed that the abstraction is from a borehole (not a spring as stated on the licence), and that they report no issues with the abstraction even throughout the dry Summer of 2018. The monitoring data collected and the communication with Beauville Farm confirms that the current abstraction in operation at Biglis Wells hasn't impacted the private abstraction. However, DCWW are not proposing to remove the condition from the licence and are happy to continue monitoring,

The proposed future assessment is to continue monitoring the existing three observation boreholes. This will provide evidence of any potential impacts to Beauville Farm, or trends in the local ground water levels during drought events.

4.2 Mitigation and trigger levels

The desk study and water features survey have not identified any impacts that require the need for proposed mitigation measures or quantifiable trigger levels which may be used to reduce or stop abstraction.

5. Conclusions

There has been a groundwater abstraction at Biglis Wells since the 1960s. The current licence (21/58/11/2) has been effective from April 1999 and during this time the local groundwater levels have been monitored as part of the licence condition. The groundwater level record in the observation boreholes have no striking overall trend, indicating that the groundwater abstraction is not impacting the local water levels. The record of nearly 20 years contains drought years, and no difference in the groundwater levels is apparent during these years.

The desk study and water features survey identified potential receptors to the abstraction, however no impacts were evident or reported. The nearby groundwater abstractors, including the abstraction at Beauville Farm, stated no issues or concerns regarding their sources, even during the relatively dry Summer of 2018. Collectively this indicates that whilst the Biglis Wells abstraction has the potential to impact on other abstractors and water features (springs) no effect of the abstraction has been identified.

It is proposed that as part of the licence variation:

- the annual maximum quantity of water to be abstracted is maintained at 2500 Ml/year (this report has not identified any impacts on the potential receptors);
- The groundwater levels at the three remaining observation boreholes (OBH2, OBH3 and OBH4) are continued to be monitored, however the requirement to monitor the collapsed OBH1 is removed from the licence; and
- The purpose of abstraction should be updated from public water supply to industrial in line with the current use of the water.

Figures

Key

- Biglis Wells groundwater abstraction
- Observation boreholes (OBH)
- Springs (identified from OS)
- Rain gauge
- Private groundwater abstraction

Licenced abstractions

- Groundwater
- Surface Water
- Watercourse
- Sites of Special Scientific Interest (SSSIs)
- Biglis Wells 5km buffer
- WFD Operational Catchments (Cycle 2)

Source Protection Zones (SPZs)

- Zone 1
- Zone 2
- Zone 3

0 250 500 750 1,000 1,250 1,500 1,750 2,000 2,250 m
Scale at A3: 1:40,000

Biglis Wells
Hydrogeological Impact Assessment (HIA)

Figure 1.1
Biglis Wells site setting

December 2018

wood.

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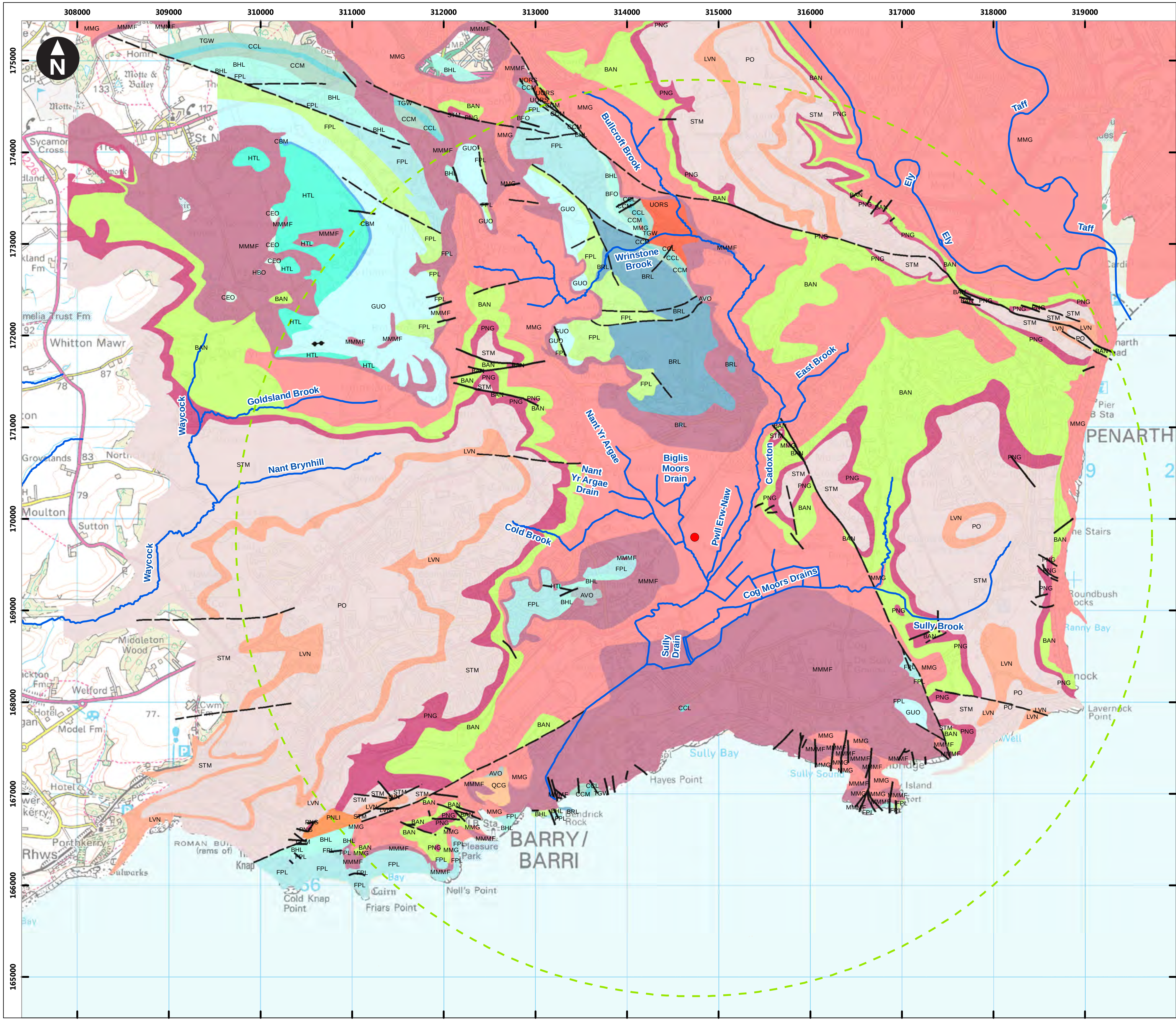

Key

- Biglis Wells groundwater abstraction
- Watercourse
- Biglis Wells 5km buffer
- BGS 50k Fault Inferred
- BGS 50k Fault Observed

BGS 50k Solid Geology

LVN	Lavernock Shales Member (Mudstone)
PO	Porthkerry Member (Limestone & Mudstone)
PNG	Penarth Group (Mudstone & Limestone)
PNLI	Penarth Group & Lias Group (Mudstone)
STM	St Mary's Well Bay Member (Limestone & Mudstone)
BAN	Blue Anchor Formation
MMG	Mercia Mudstone Group (Mudstone)
MMMF	Marginal Facies (MMG - Conglomerate)
CBM	Caswell Bay Mudstone Formation (Limestone & Mudstone)
CEO	Cefnyrhendy Oolite Member (Ooidal Limestone)
HBO	Hunts Bay Oolite Subgroup (Ooidal Limestone)
HTL	High Tor Limestone Formation (Limestone)
GUO	Gully Oolite Formation (Ooidal Limestone)
AVO	Avon Group (Limestone & Mudstone)
BFO	Brofiscin Oolite Formation (Ooidal Limestone)
BHL	Barry Harbour Limestone Formation (Dolomitised)
BHL	Barry Harbour Limestone Formation (Limestone)
BRL	Black Rock Limestone Subgroup (Limestone)
CCL	Castell Coch Limestone Formation (Oodial Limestone)
CCM	Cwmyniscoy Mudstone Formation (Mudstone & Limestone)
FPL	Friars Point Limestone Formation (Dolomite)
FPL	Friars Point Limestone Formation (Limestone)
TGW	Tongwynlais Formation (Limestone & Mudstone)
QCG	Quartz Conglomerte Group (Sandstone & Conglomerate)
UORS	Upper Old Red Sandstone (Sandstone & Siltstone)

0 250 500 750 1,000 1,250 1,500 1,750 2,000 2,250 m

Scale at A3: 1:40,000

Biglis Wells
Hydrogeological Impact Assessment (HIA)

Figure 2.1
Solid geology and mapped faults around Biglis Wells

December 2018

wood.

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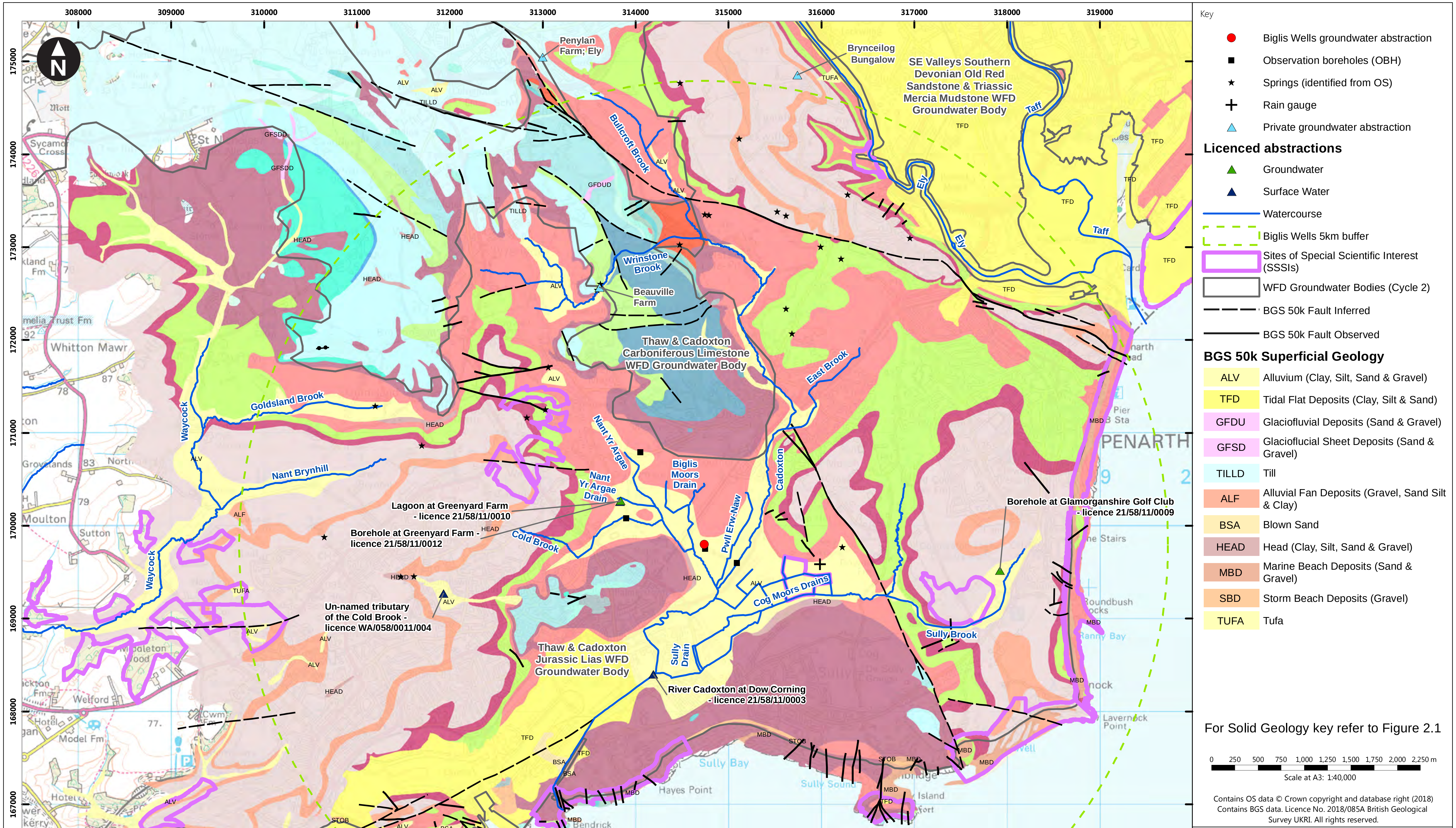

Biglis Wells
Hydrogeological Impact Assessment (HIA)

Figure 2.2
Superficial geology and key sites around Biglis Wells

December 2018

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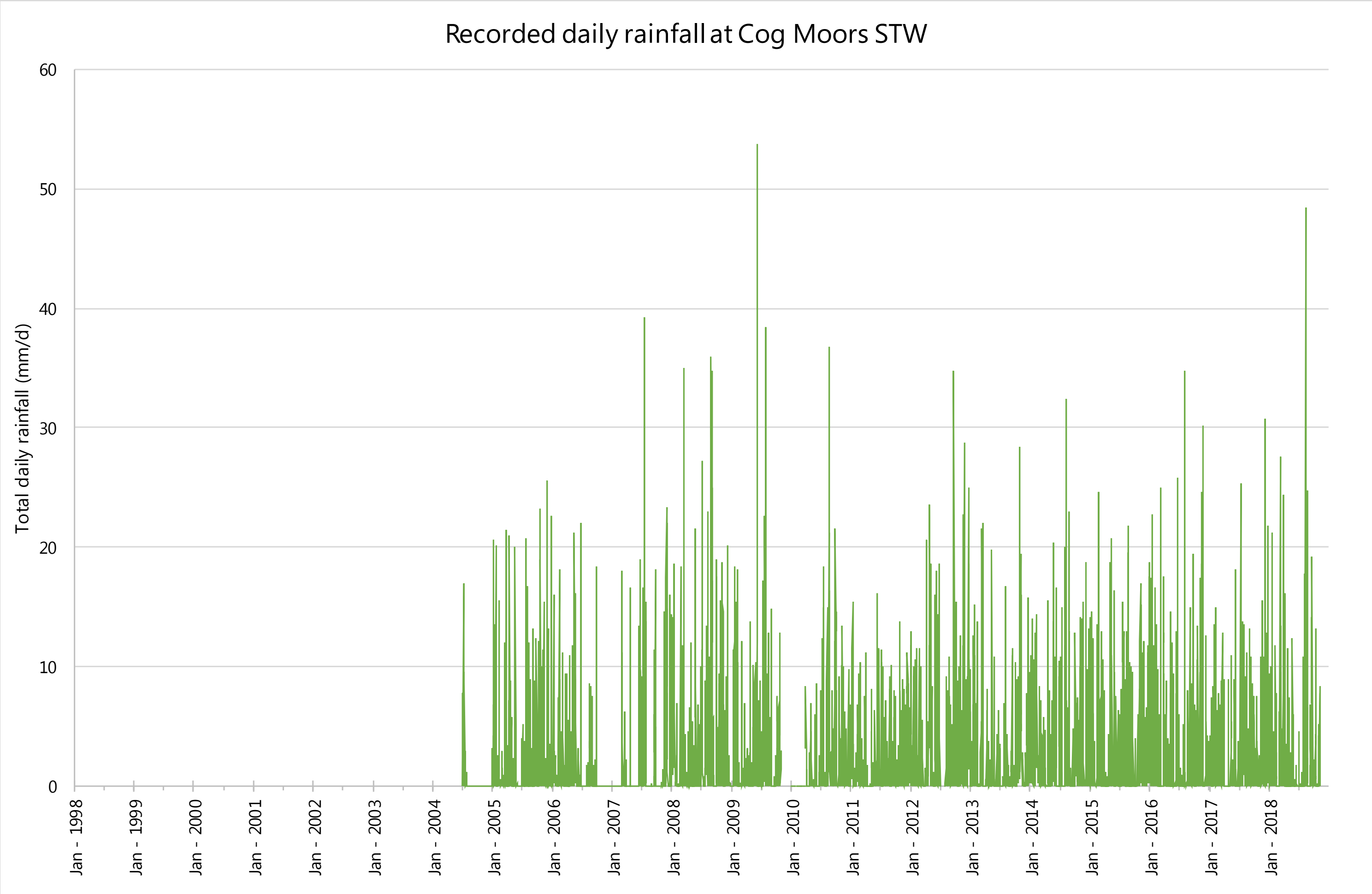
Key

Cog Moors STW daily rainfall (mm)



Biglis Wells
Hydrogeological Impact Assessment (HIA)

Figure 2.3
Daily rainfall timeseries at Cog Moors STW TBR

December 2018

wood.

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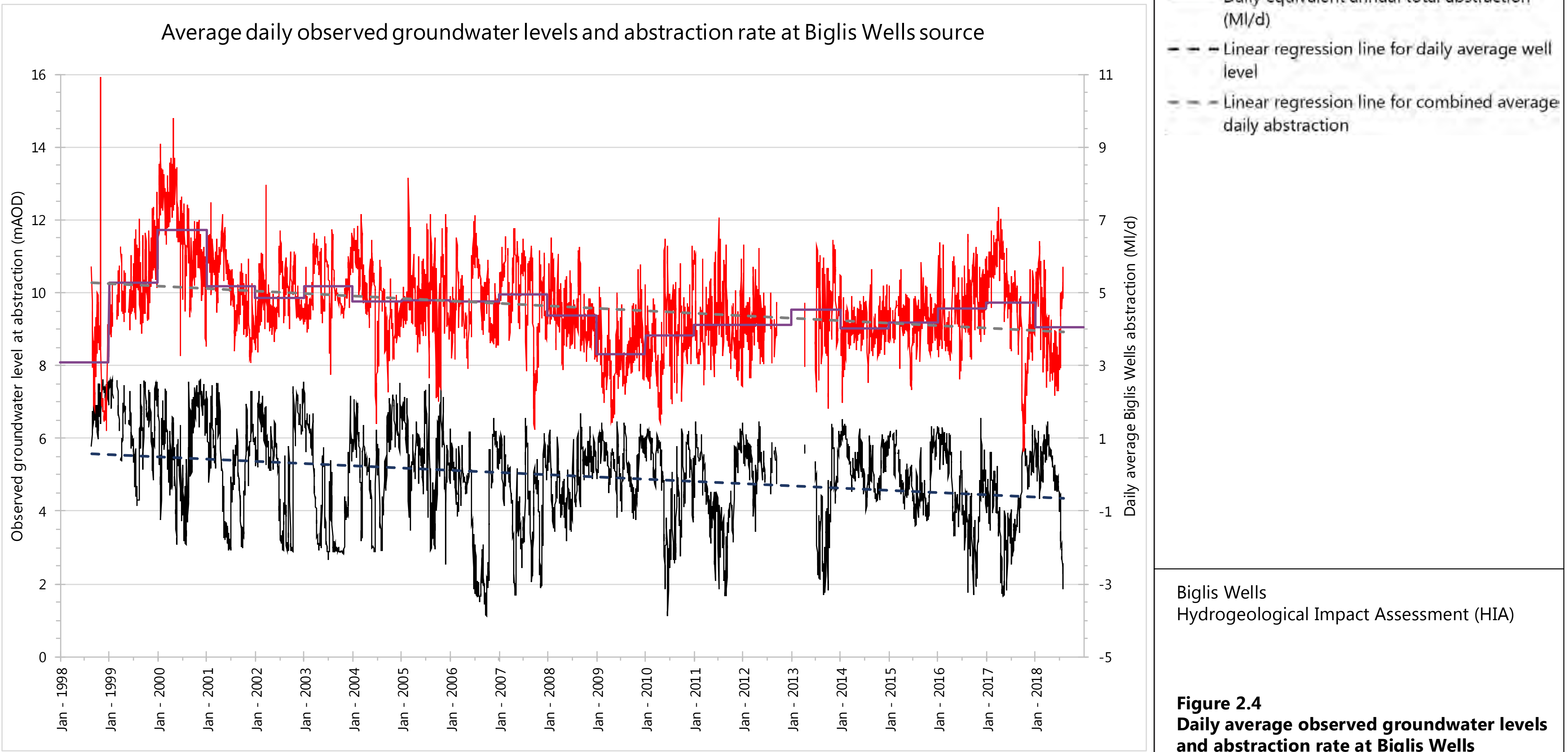
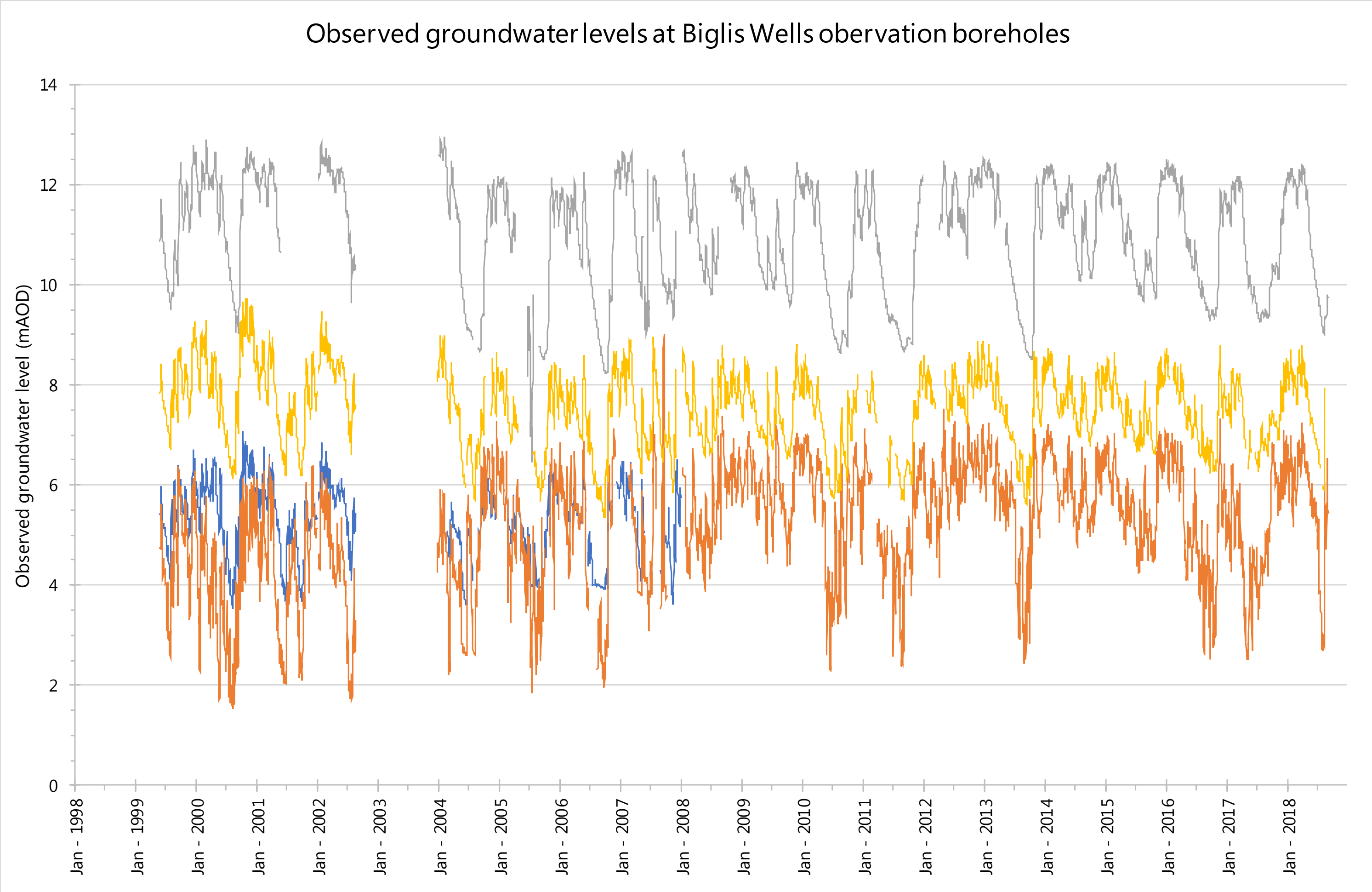


Biglis Wells
Hydrogeological Impact Assessment (HIA)

Figure 2.4
Daily average observed groundwater levels and abstraction rate at Biglis Wells

December 2018

wood.



Key

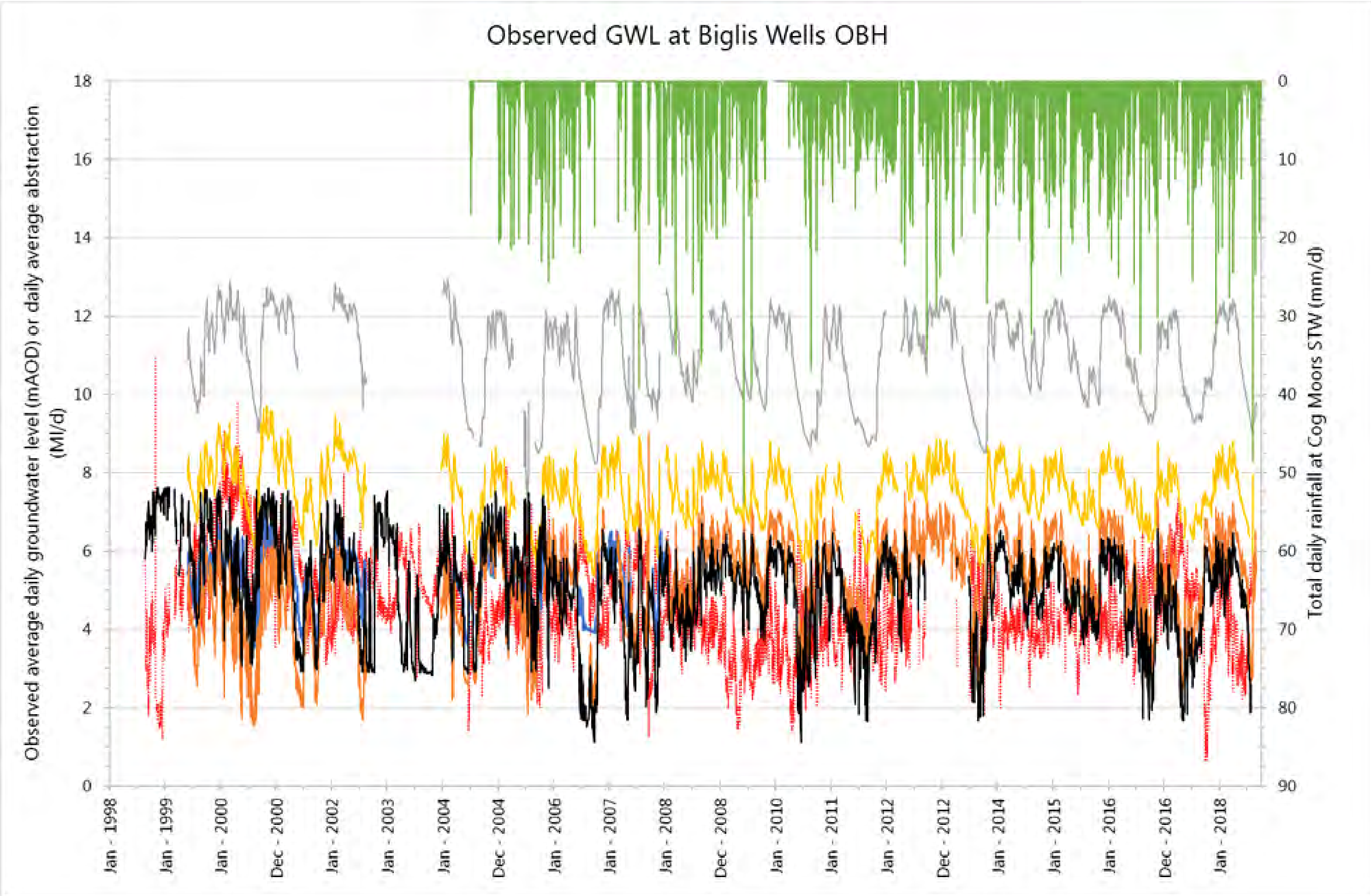
- OB1
- OB2
- OB3
- OB4

Biglis Wells
Hydrogeological Impact Assessment (HIA)

Figure 2.5
Daily average groundwater level timeseries at Biglis Wells observation boreholes

December 2018

wood.



Key

Combined average daily abstraction (Ml/d)

Daily average well level (mAOD)

OB1

OB2

OB3

OB4

Cog Moors STW daily rainfall (mm)

Biglis Wells
Hydrogeological Impact Assessment (HIA)

Figure 2.6
Timeseries records of observed daily average groundwater levels, combined average daily abstraction and daily rainfall

December 2018

wood.

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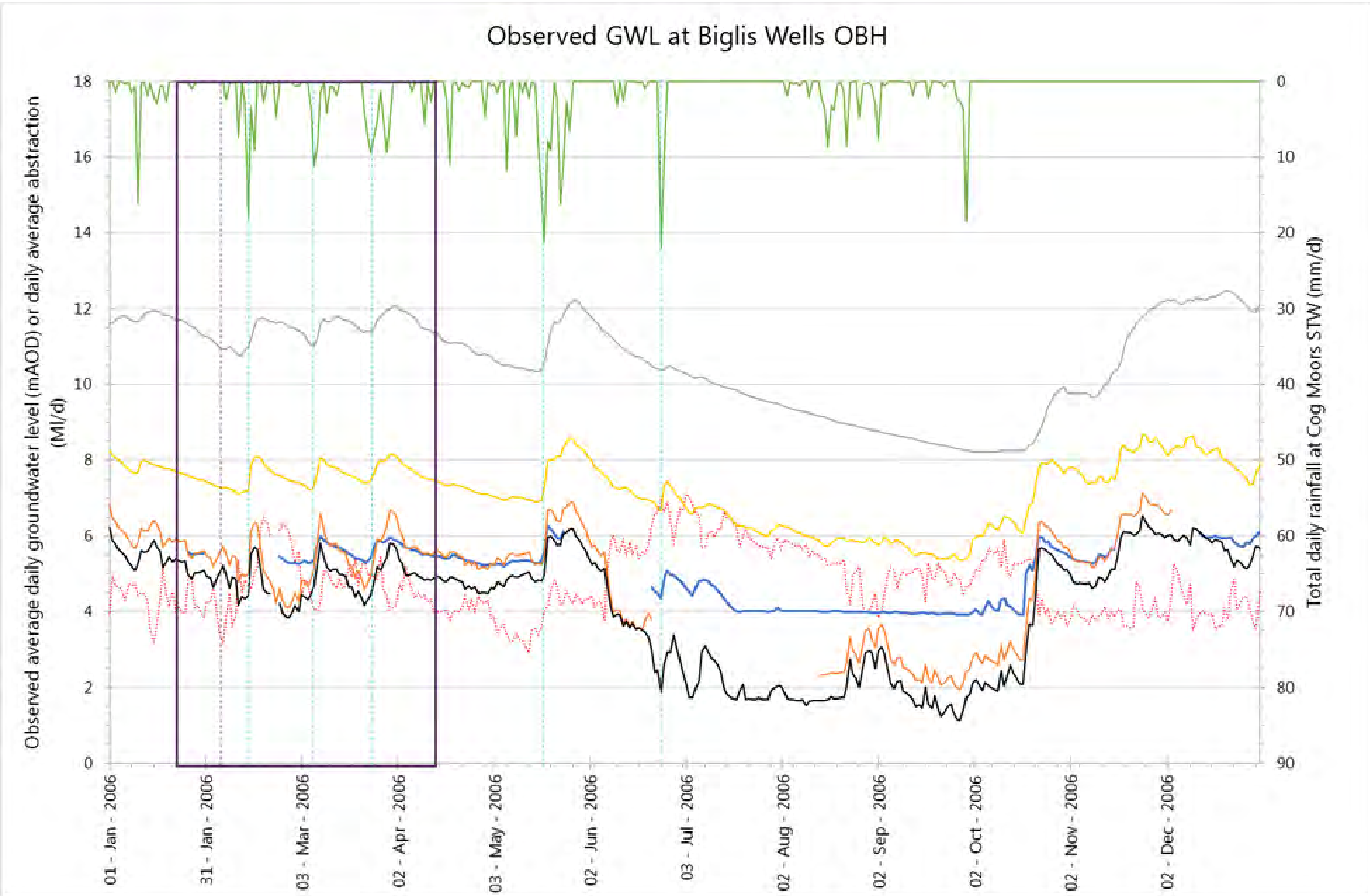


Key

Combined average daily abstraction (Ml/d)

Daily average well level (mAOD)

OB1

OB2

OB3

OB4

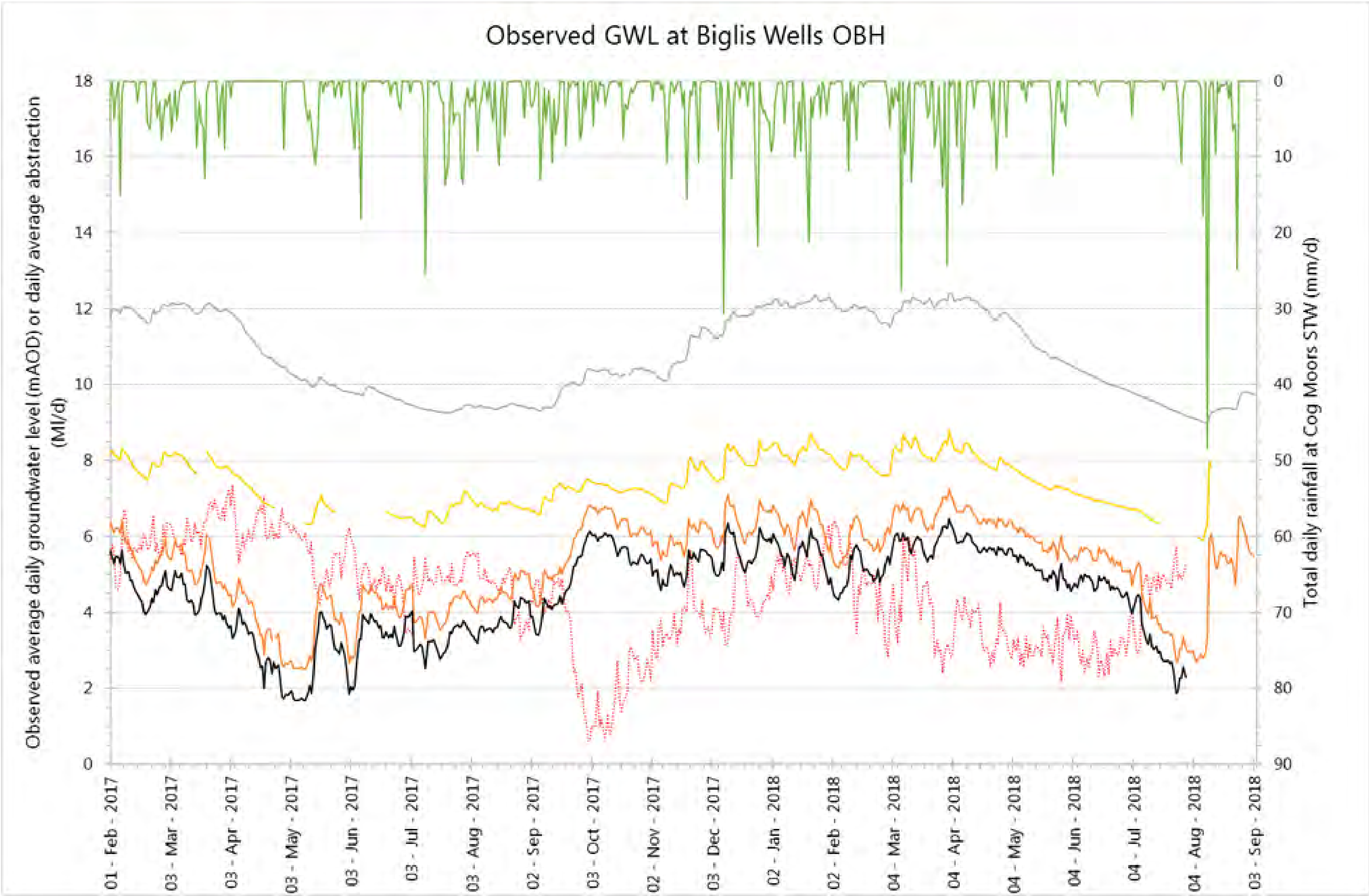
Cog Moors STW daily rainfall (mm)

Biglis Wells
Hydrogeological Impact Assessment (HIA)

Figure 2.7
Timeseries records for 2006 of observed daily average groundwater levels, combined average daily abstraction and daily rainfall

December 2018

wood.



Key

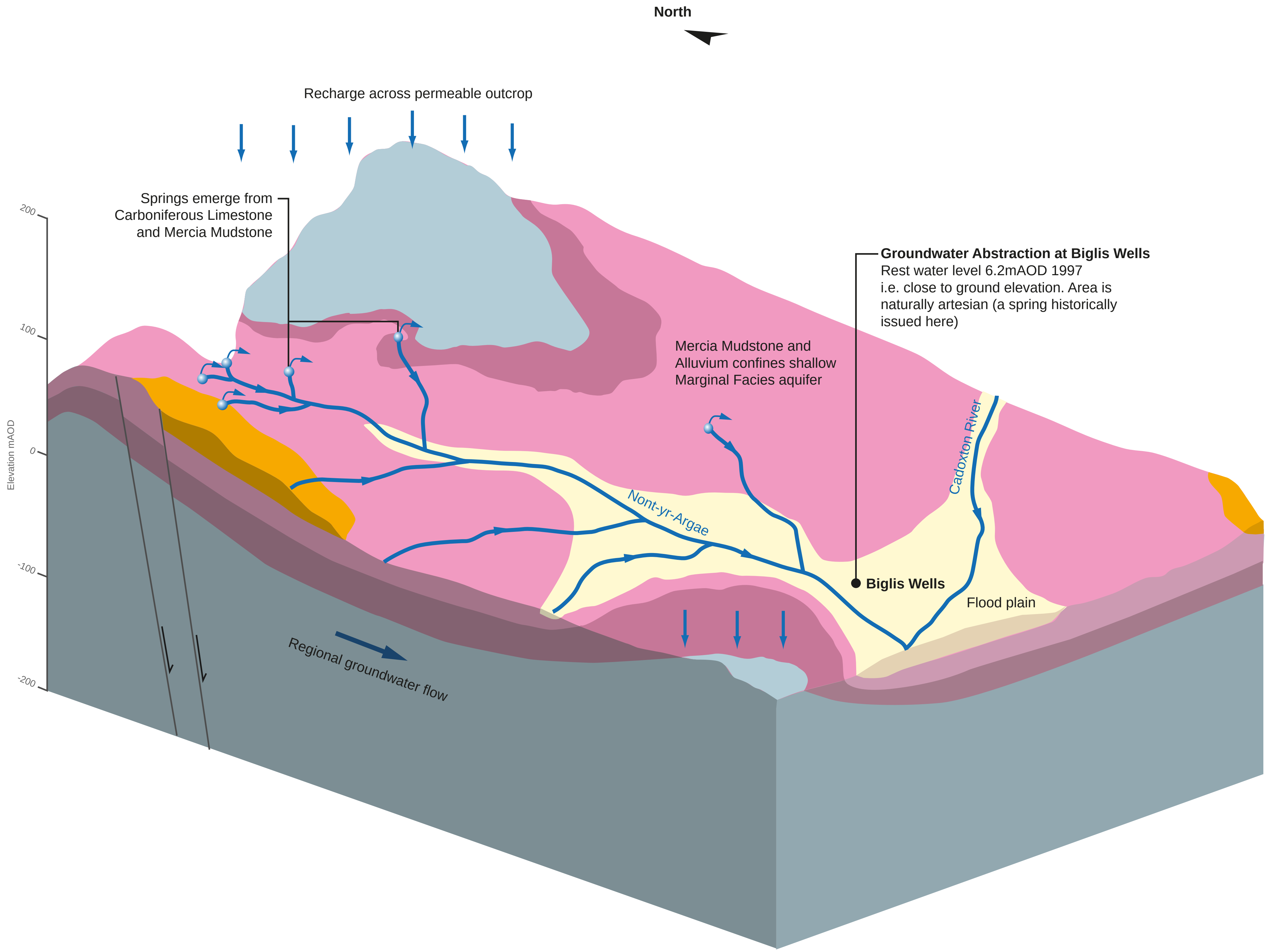
- Combined average daily abstraction (Ml/d)
- OB2
- OB3
- OB4
- Daily average well level (mAOD)
- Cog Moors STW daily rainfall (mm)

Biglis Wells
Hydrogeological Impact Assessment (HIA)

Figure 2.8
Timeseries records from February 2017 - September 2018 of observed daily average groundwater levels, combined average daily abstraction and daily rainfall

December 2018

wood.



Key

- Spring
- Recharge area
- Groundwater flow direction
- Fault

Geology

- Alluvium
- Lower Lias Limestone
- Mercia Mudstone Group
- Mercia Mudstone Group (Marginal Facies)
- Carboniferous Limestone (Black Rock Limestone)

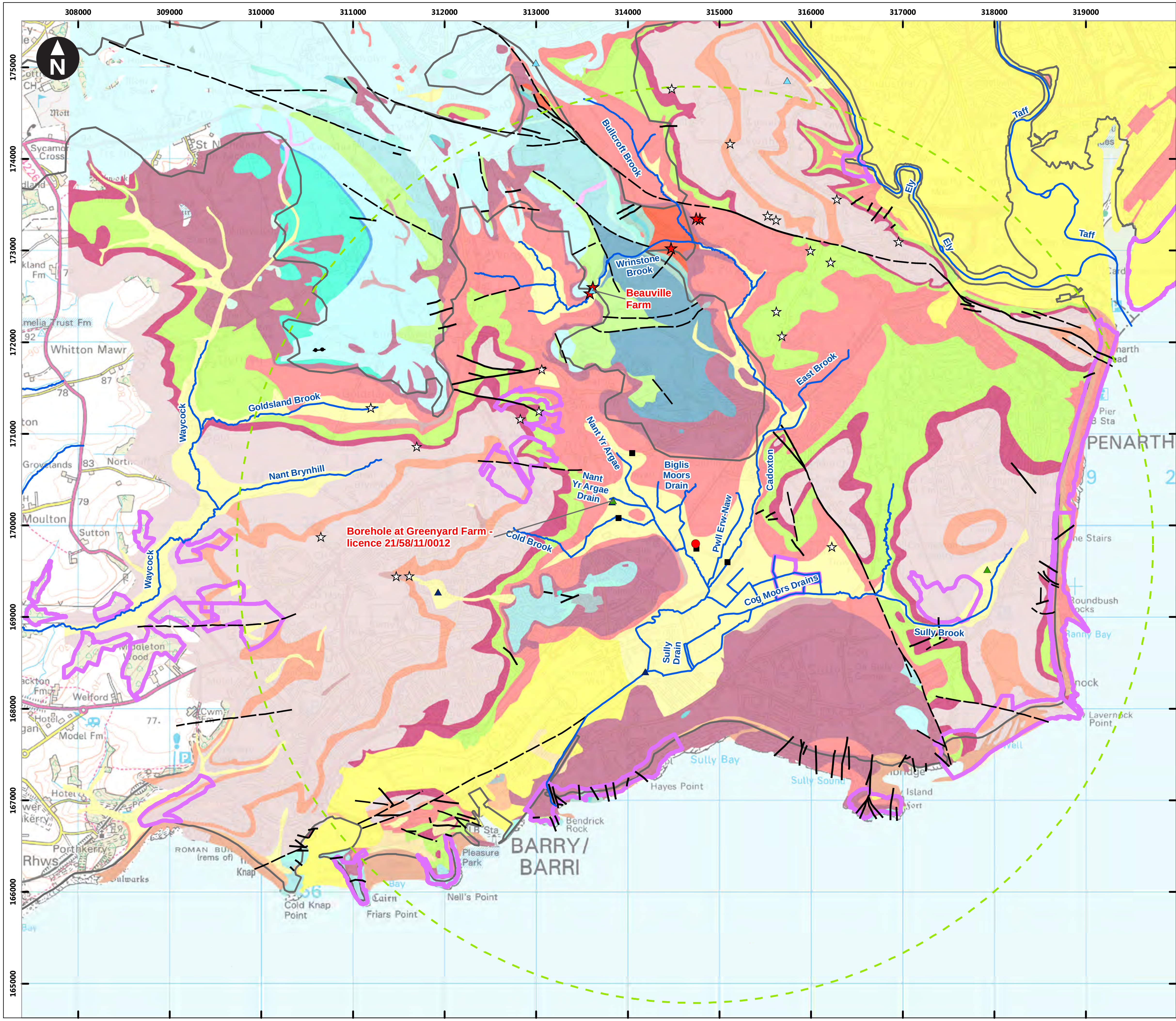
Reproduced from Figure 5.26 in the Delineation of Source Protection Zones – South East Wales Sources report, Entec (2009) (Ref 26390-S12.ai)

Biglis Wells
Hydrogeological Impact Assessment (HIA)

Figure 2.9
3D Conceptual Diagram of Hydrogeological Features at Biglis Wells

December 2018

wood.



Key

- Biglis Wells groundwater abstraction
- Observation boreholes (OBH)

Springs (identified from OS)

- Springs (not potential receptor)
- Springs (potential receptor)
- Private groundwater abstraction

Licenced abstractions

- Groundwater
- Surface Water
- Watercourse
- Biglis Wells 5km buffer
- Sites of Special Scientific Interest (SSSIs)
- WFD Groundwater Bodies (Cycle 2)
- BGS 50k Fault Inferred
- BGS 50k Fault Observed

For Solid Geology key refer to Figure 2.1

For Superficial Geology key refer to Figure 2.2

0 250 500 750 1,000 1,250 1,500 1,750 2,000 2,250 m

Scale at A3: 1:40,000

Biglis Wells
Hydrogeological Impact Assessment (HIA)

Figure 3.1
Potential receptors of Biglis Wells

December 2018

wood.

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Appendix A
Communication from Environment Agency to DCWW December 2007 (ref SERWR/MD /21/58/11/02)

Dwr Cymru Cyf
Pentwyn Road
Nelson
Treharris
Mid Glam
CF46 6LY

Our ref: SERWR/MD /21/58/11/02
Your ref:

Date: 6th December 2007

Dear Ian

Biglis Well Licence number 21/58/11/02

My apologies for the delay in responding to your letter dated 16 August 2007, in which there were two issues which needed to be addressed.

Discharge of monitoring condition

If you require to discharge the condition relating to monitoring of the four observation boreholes we would expect that data for the last 10 years is fully analysed (including the interaction between the drift and solid water levels as measured in the upper and lower boreholes of ObBH1 and ObBH2) and an interpretative report is submitted to us. Our inspections have confirmed that a comprehensive monitoring programme began in 2002. This data has proved to useful to both parties and the retrieval of such information has not been to onerous. We would therefore recommend that you establish 10 years worth of records to allow us to consider removal of this condition. Alternatively you can continue monitoring until the expiry of the licence in 2019.

Maintain/re-drill the observation borehole ObBH1

As the borehole has fully collapsed our ground water team as agreed that there will be no requirement to re-drill this bore hole. Based on the information provided (March 2006 to October 2007), ObBH4 appears to give a similar response to ObBH1. Please continue to monitor the existing boreholes as per licence conditions.

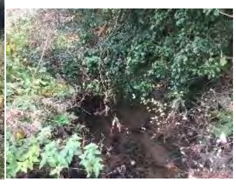
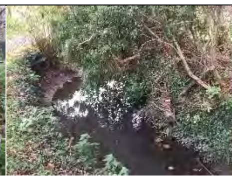
If you have any further questions , please contact Martyn Davies on 029 2024 5128.

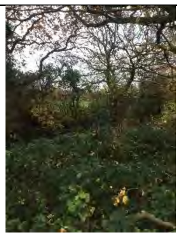
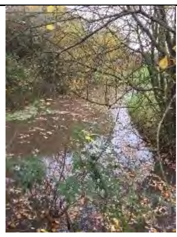
Yours sincerely

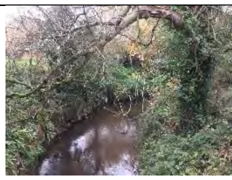
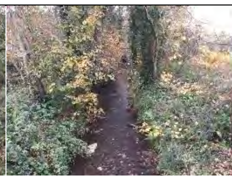
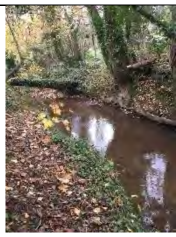
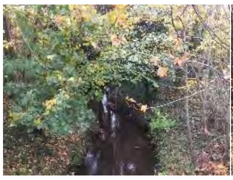
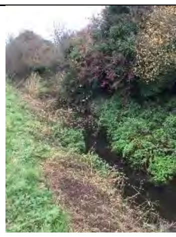
STEVE RHIND
Team Leader Regulatory Team Leader

Direct dial 029 2024 5058
Direct fax 029 2036 2095
Direct e-mail Martyn.Davies@environment-agency.gov.uk

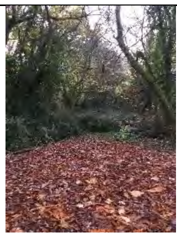
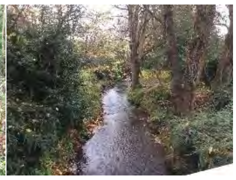
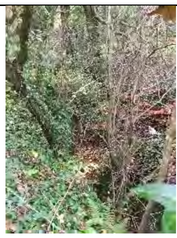
Appendix B
Water Features Survey notes

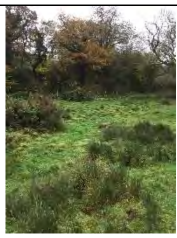
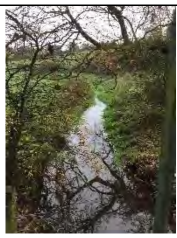
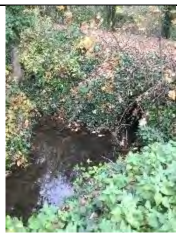
Observation point	Grid Reference	Notes	Photographs
1	ST1461769812	Cold brook dry shallow drains/ river. Grass in river bed no water	 
2	ST1449969758	2m deep and 3 m wide but flowing channel about a 20cm deep. Visibly flowing with silty substrate. Bracken on banks.	 
3	ST1443669840	U/s of railway bridge	
4	ST1386770074	Observation well location	
5	ST1388470098	Cold brook approx. bank to bank 5 m wide and 1.5m deep. River channel 1 m wide 20 cm deep silt substrate with some large boulders. Visible fast flow. Downstream photo only.	
6	ST1380970296	Drain. 1.5 wide .1m deep. River channel 10cm deep with silt substrate and some gravel. Approx. 30m flowing channel. Visible flow. Vegetated banks (ivy). U/s photo only.	
7	ST1392970073	Watercourse	 
8	ST1408470041	Gently meandering with increasing depth. Incised banks. Silt and gravel substrate.	 

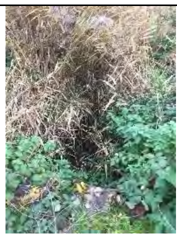
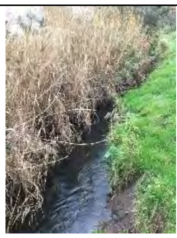
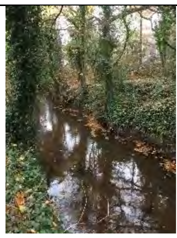
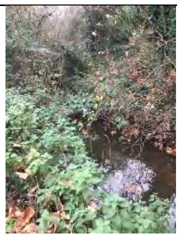
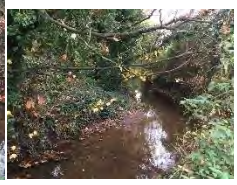
9	ST1388270778	Nant yr Argae watercourse - deep water under bridge although something causing water to pond downstream although no visibility - not very representative of river as whole? Audible and visible flow under bridge. D/s photo only	
10	ST1404670779	Observation borehole	
11	ST1413170727	Heavily modified pond with water inlets	 
12	ST1421370700	Field drain with standing water only silt substrate with established vegetative banks. No flow	 
13	ST1423270618	Field drain dry	 
14	ST1428670452	Field drain dry with shallow banks and heavily overgrown with dry bracken. Photo taken looking towards drain.	
15	ST1431970414	D/s photo of NRW main river . Visibilty poor no audible flow.	
16	ST1430270318	Pond feature not mapped. Very square sides …man made?	 

17	ST1431170306	No through access. Main river some distance from path. Photo of blockage.	 
18	ST1350671052	Additional point to assess flows along Nant yr Argae. Large channel with moderate flow in channel - heras fencing in channel causing slight blockage. 8 m wide 1.5 m deep. Visible not audible flow. Incised channel with tree lined banks.	 
19	ST1544070424	Cadoxton river. 10 m wide 3m deep Chanel. Substantial flow gravel and cobble substrate. Water depth 30cm approx. 2m wide. Incised steep banks with trees on banks.	 
20	ST1542470519	Cadoxton river. Reinforced banks 15m wide 3m deep. Visible flow. Bracken on left bank. Discharge from pipe u/s.	 
21	ST1540270294	Cadoxton river	 
22	ST1538570240	Cadoxton river at park road bridge. River becoming wider and shallower. Bank to bank 15m and 2 m deep. Gravel and cobble substrate and visible flow. Water approx.. 10cm deep and 2.5 m wide.	 
23	ST1492069419	Drain along Cadoxton river	 
24	ST1495169406	Cadoxton river.8m bank to bank. More instream vegetation dying bank. Hard to ascertain depth approx.. 75cm deep but flowing channel through reefs narrower c. 1m. Hard to see substrate. Visible flow.	 

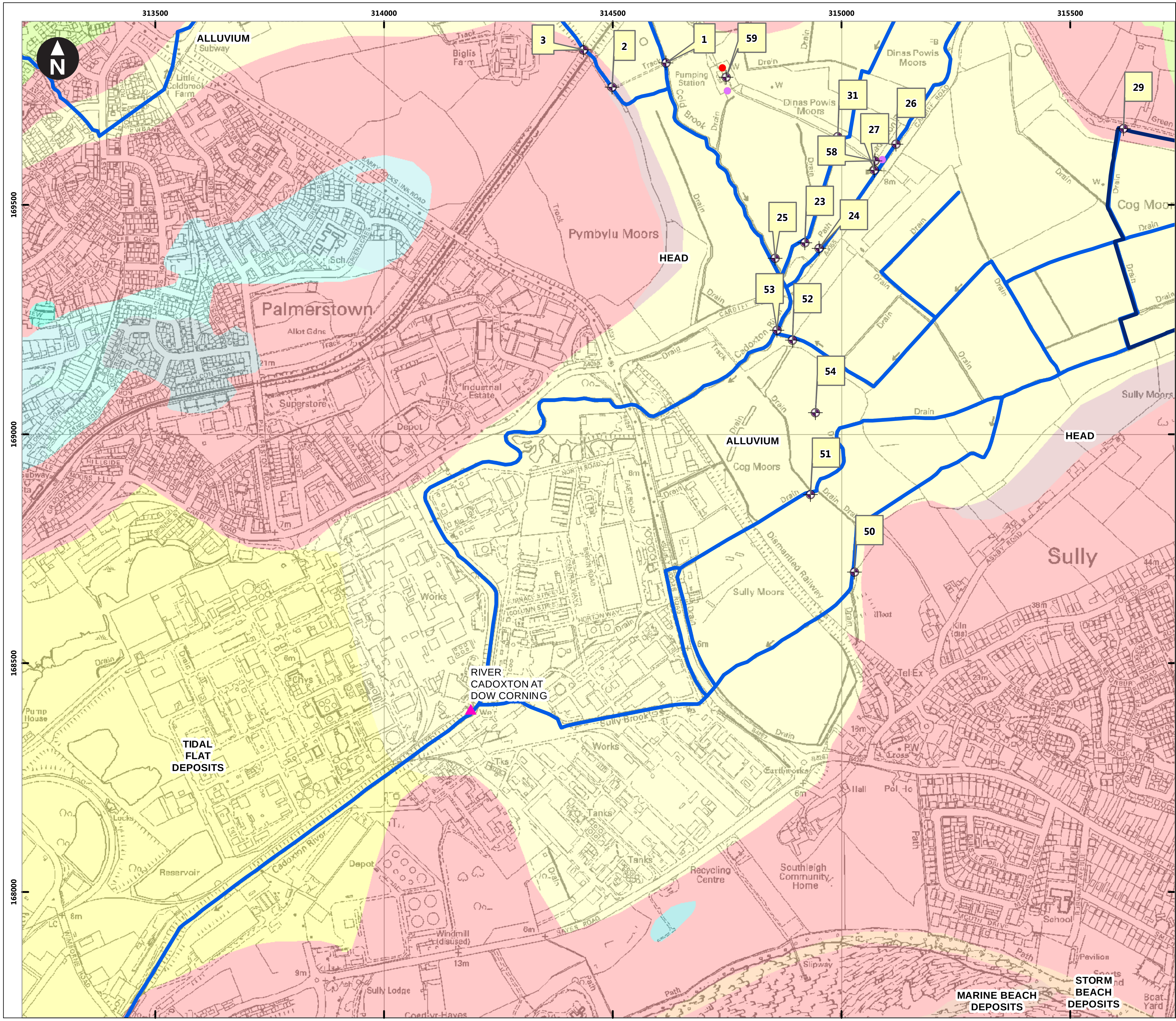
25	ST1485569384	Cold Brook. Quite overgrown with brambles but audible flow.	 
26	ST1511969633	Cadoxton river by Biglis. In channel blockage here but fast audible flow. Some in channel vegetation. Slightly silty substrate with gravel and cobbles 4m wide by 2m deep.	 
27	ST1507269577	Cadoxton river. River has narrowed slightly and water channel is na it were deeper with in channel vegetation. Deep enough that bottom not visible.	 
28	ST1577269636	Cog Moors and drain along STW.	 
29	ST1561669668	Cog Moors. Private land inaccessible. Low lying flat land. Set up for grazing?	  
30	ST1373170507	Greenyard Farm owns golf course and owner put abstraction well for golf course in during 1990s. 180ft deep with water strike at 50ft. Constantly pumped through the summer although he thinks only at night. Contact for the green keeper for more information = Nigel Edmunds 07974478155 or Andrew 07816816249. Never run dry.	
31	ST1499269651	Drain. Dry	

32	ST1516870280	No evidence of drain to east of car park. Ditch to west of mapped watercourse but this is dry. Too overgrown for photo.	
33	ST1521770314	Drain in trees? Culvert under car park unknown.	
34	ST1526770237	Drain along road here DRY.	
35	ST1266870969	No access up lane no access along Gilbert hill	
36	ST1543371570	Cadoxton under Mill Road bridge. Cobble and gravel substrate, channel 3m wide, 20cm deep bank to bank 20m and 2m deep grass banks, incised channel with good flow. Tree lined both sides no in channel vegetation.	 
37	ST1616472929	Spring line?	
38	ST1621372874	Spring outflow. Audible flow not visible on photo . Small trickle.	
39	ST1549372756	Capture point for springs not located. NRW main river. Upstream. Bank to bank 3m wide. 1.5 m deep. Watercourse 1m wide and 10cm deep. Reasonable flow rate. Vegetated banks with some trees. Little in channel vegetation. Gravel substrate. Downstream flow absent and channel narrows significantly. Water appears to be flowing into pool under bridge _ runoff from last nights rain?	 
40	ST1473573076	Cadoxton Michealston le Pit. Gently meandering with shallow sloping vegetated banks. Some light tree cover. Watercourse 2.5 m wide and 10cm deep. Relatively fast flow. (downstream of weir)	 

41	ST1384672361	Beauville Farm bh. 30 m deep put in last few years. No issues with abstracting water doesn't know anything pump depth or pump rate he says on for one hour per day. Was put to replace river abstraction. The pump at abstraction point stopped working as pump from 1957. No issues this summer despite dry weather. Cousin across in Wrinstone Farm no longer using river abstraction.	
42	ST1359872551	This bh does not exist	
43	ST1358872505		 
44	ST1364472616	Wrinstone brook. Flow more obvious here where weeds absent. Watercourse approx. 1.5m across and 20cm deep. Cobble substrate with some travels. Tree banks with trees downstream.	 
45	ST1577571052	Eastbrook. Canelised with very little flow. 2m wide channel 1.2m deep. Water channel 0 to 5 cm deep	 
46	ST1757369091	Cosmeston lake west	
47	ST1755869083	Cosmeston lake west	
48	ST1763868943	Downstream of culvert where outflow from east lake flows in Sully Brook. Flow in brook. Silt and leaves in substrate.	 

49	ST1774168986	Sully Brook fairly stagnant. Standing water with leaves in base probably dry until recently.	
50	ST1502868699	Sully moor bifurcation. Heavy inchannel grasses. Visible flow although appears slow. No shading. Cannot see substrate. Bank to bank 4m approx. 1m deep? water depth unknown.	 
51	ST1493368869	Bifurcation of Sully Brook. No flow and stagnant water.	 
52	ST1489369206	Drain. Zero flow seen due to heavy overgrowth.	 
53	ST1485969227	Cadoxton River. Deep 80cm? Grasses on channel edge quite fast flow. Watercourse approx.1m wide. Bank to bank 8m. Approx. 2m deep.	 
54	ST1494469048	View to Cog Moors. Flat with ponded water	
55	ST1534970118	Cadoxton River. Gravel and silt and sand substrate. Flow visible. Shaded tree cover	 
56	ST1533170027	Gently meandering, and increasing water depth. Visible flow.	 

57	ST1530969982	Cadoxton	 
58	ST1507369597	Obs BH	
59	ST1474769780	Source and pump house	 



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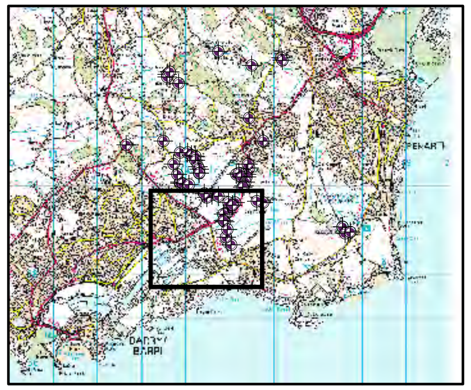

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41251 Biglis Wells HIA

Walkover Survey

November 2018

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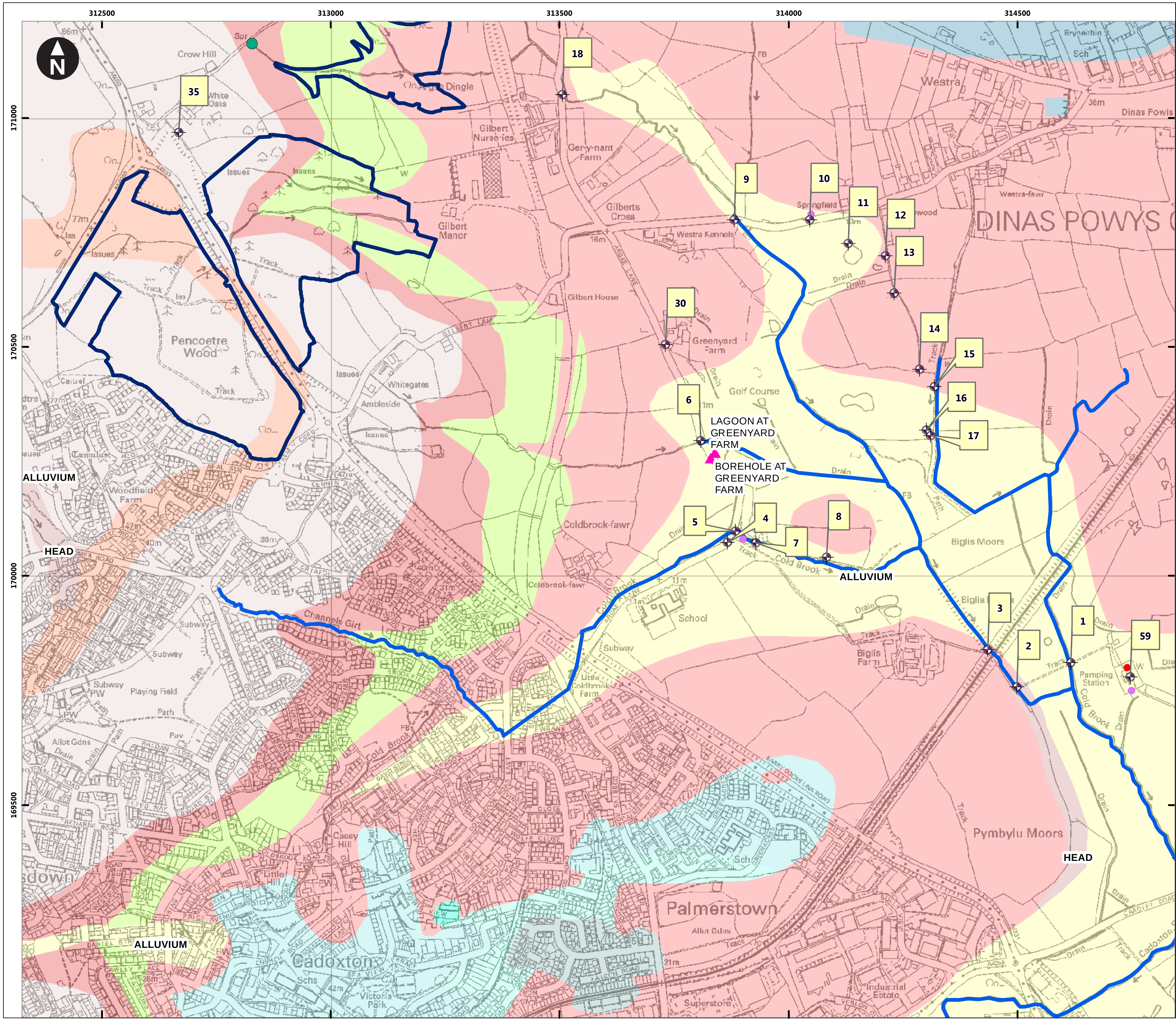

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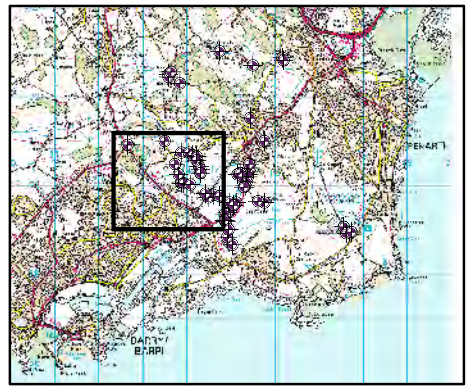

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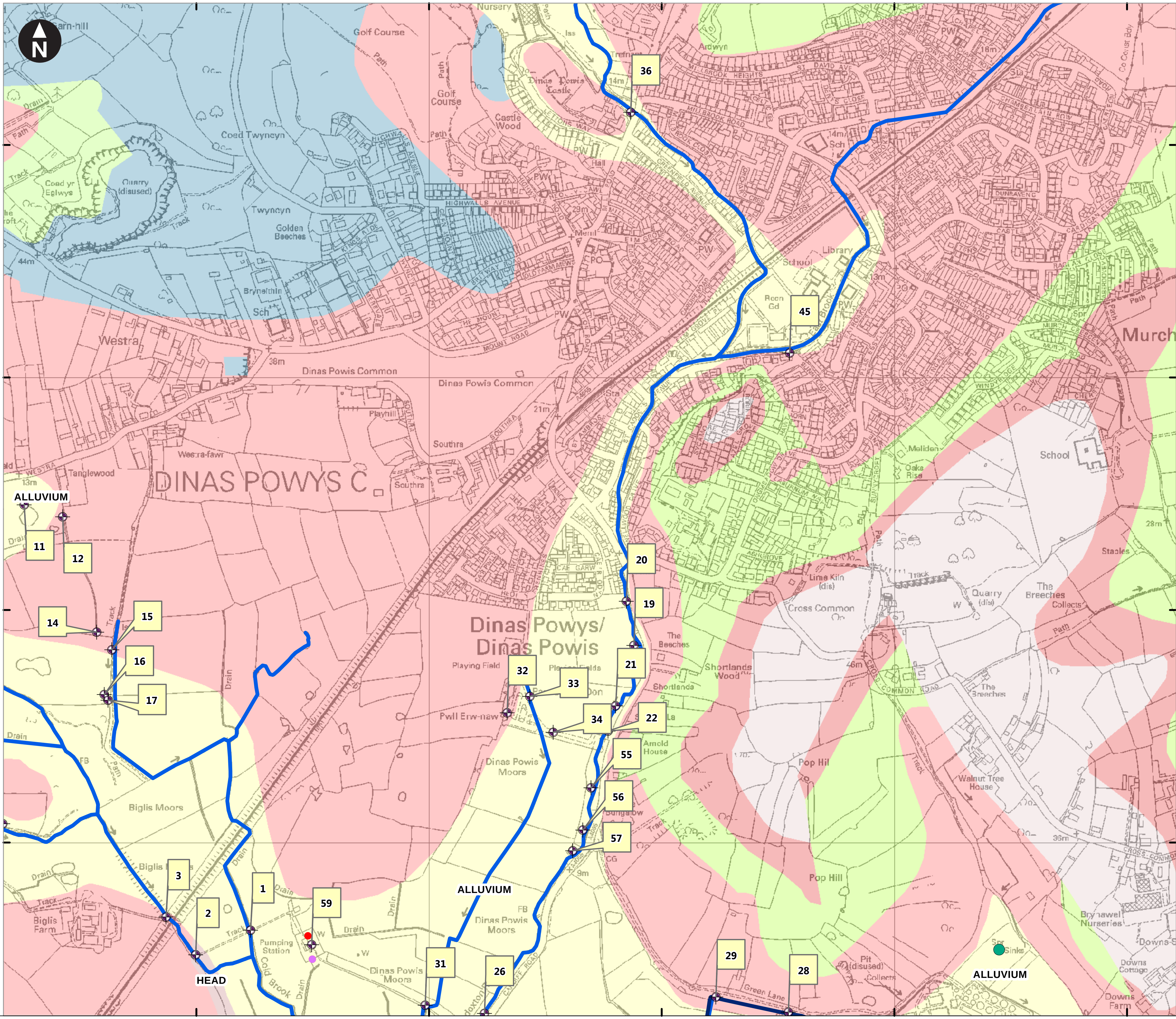

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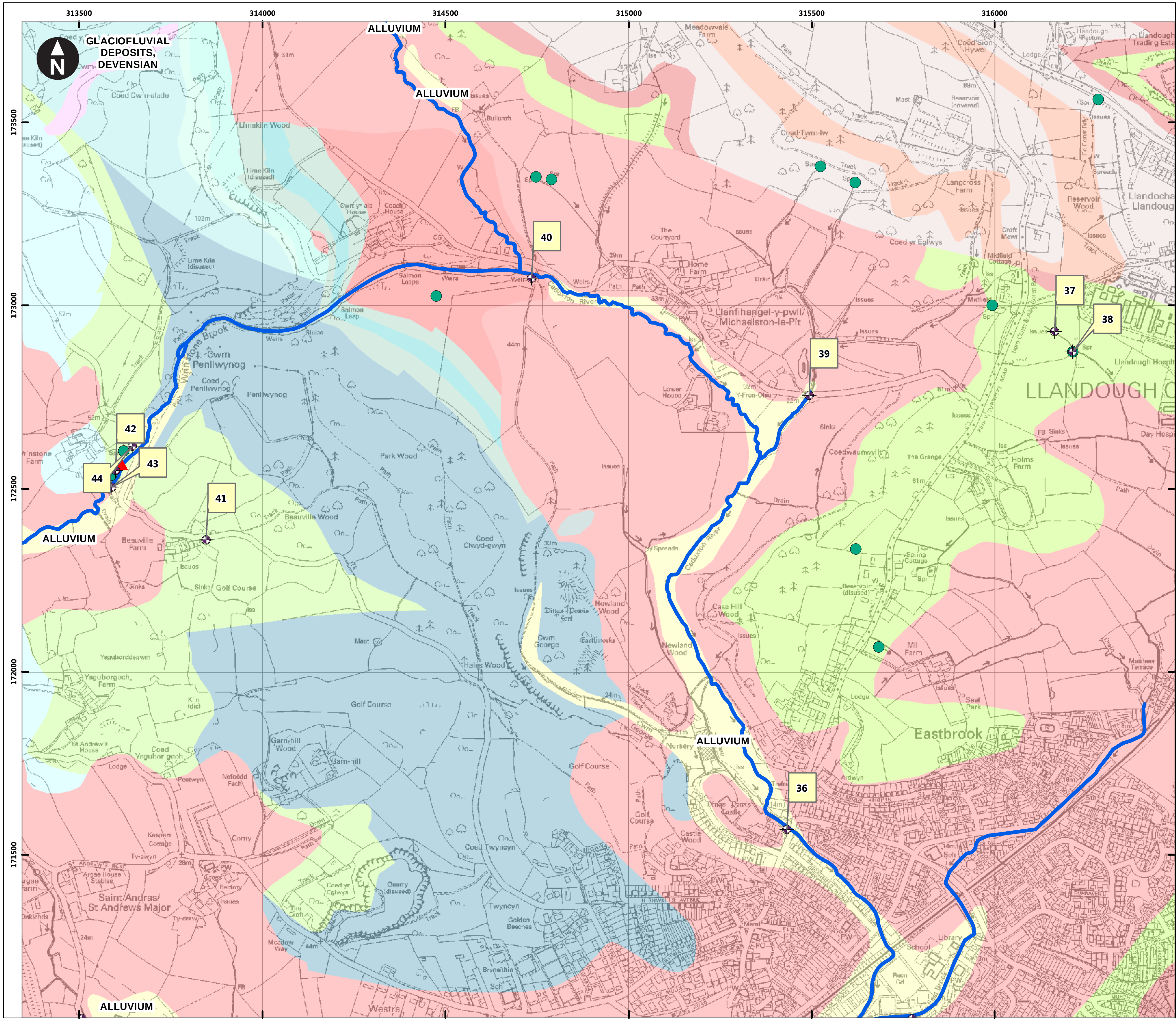

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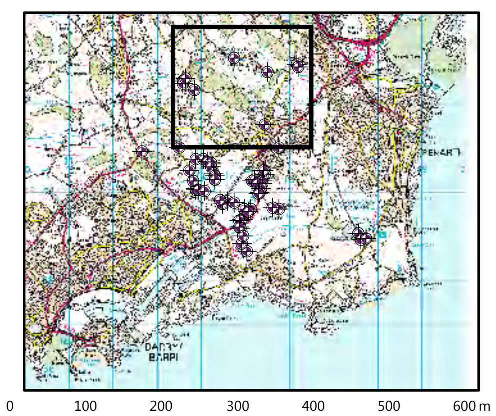

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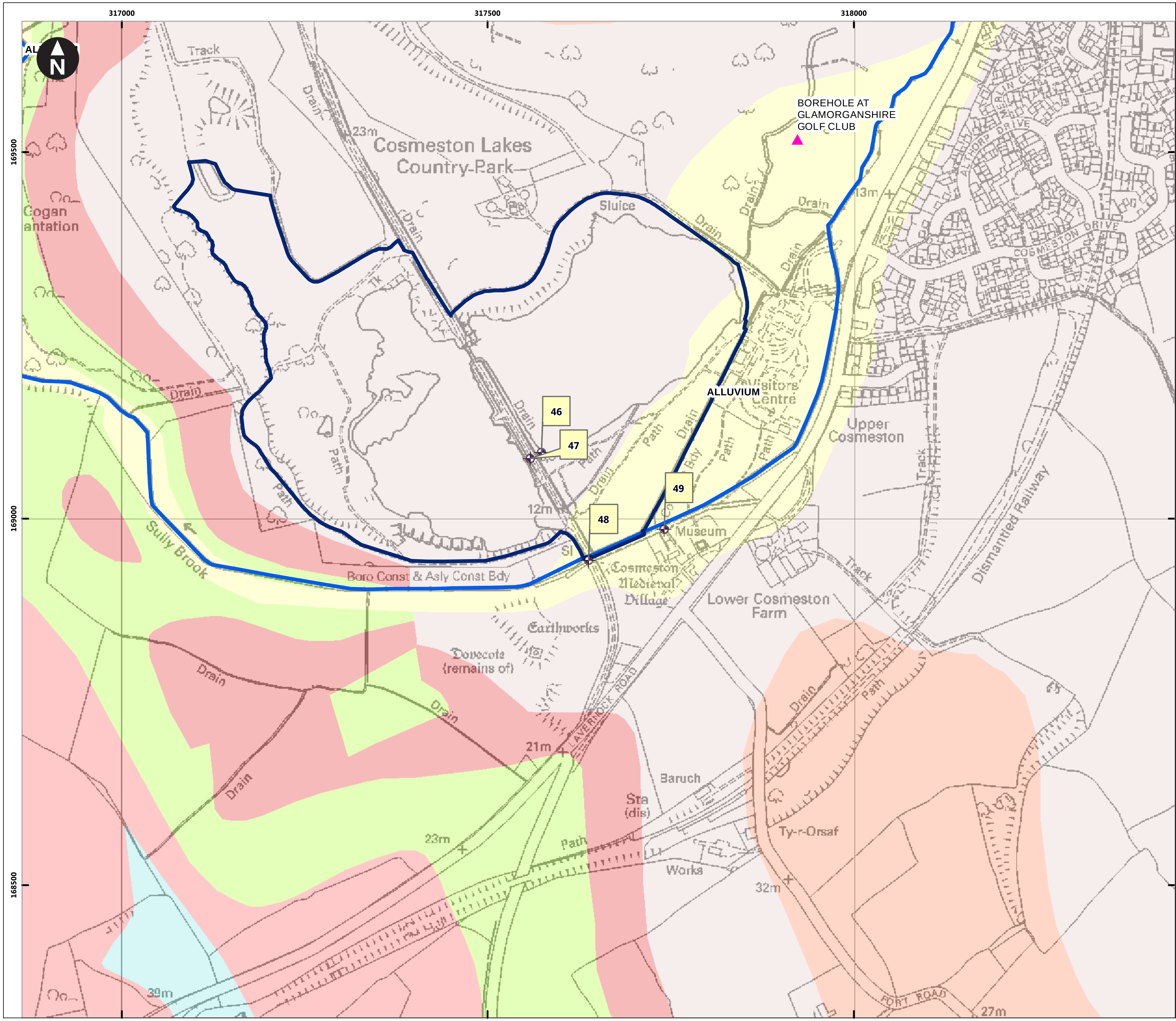

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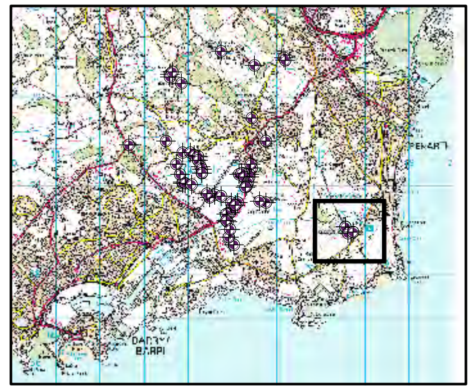

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