HYDROGEO

Hydrogeological Impact Appraisal and Groundwater Pumping Test Report

Pyle & Kenfig Golf Club

Waun-y-mer, Bridgend, CF33 4PU

On Behalf of

Pyle & Kenfig Golf Club

Quality Management

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1 Background

Hydrogeo Limited (Hydrogeo) have been commissioned by Pyle & Kenfig Golf Club (the Client) to conduct a Hydrogeological Impact Appraisal and an abstraction borehole pumping test at Pyle & Kenfig Golf Club, Waun-y-mer, Bridgend, CF33 4PU. The Site requires additional water volume to support the operation of a new course irrigation system.

This report details the following:

- Site setting and background;
- Setup of the pumping test;
- Results of the pumping test; and
- Analysis of the pumping test.
- Hydrogeological Impact Assessment (HIA)

The works were progressed under a Natural Resources Wales (NRW) 'Consent to Investigate a Groundwater Source' (REF: WA-058-033-0007) issued on 19th February 2024.

The pumping test and subsequent analysis and reporting has been undertaken in support of a proposed abstraction license application for a groundwater abstraction borehole at The Site.

1.1 Site Setting

Pyle & Kenfig Golf Club (hereafter referred to as 'The Site') is located approximately 3.5km north of Porthcawl. An Ordnance Survey (OS) map of the Site and surrounding area is included as Figure 1-1, with an aerial image of the Site and surrounding area highlighting the borehole locations shown as Figure 1-2.

The Site is surrounded by agricultural land use to the north, east and south of the Site, with most of the golf course covering the area west / north-west of the borehole locations. The topography of the surrounding area remains generally flat, with a slight fall in gradient toward Kenfig Sands west of the Site. Both the existing and new borehole abstraction wells are located at an approximate topographic level of 30m Above Ordnance Datum (mAOD).

Figure 1-1 Ordnance Survey Map of Pyle & Kenfig Golf Club

Figure 1-2 Aerial Image of Existing and New Borehole Locations

1.2 Geology

The geology underlying The Site was determined using BGS Bedrock and Superficial datasets. The BGS geological map sheet for The Site, Bridgend Sheet 261 & 262, 1:50,000 (1990) has been utilised, alongside BGS National Grid Map SS88SW 1:10,000, (1985) and available data on the BGS Onshore GeoIndex.

The underlying geology (superficial and bedrock) at The Site is shown in Drawings 1 & 2 respectively.

Artificial Ground

Artificial ground consists of any areas where ground conditions have been significantly modified by man. These include excavations, infilled ground and made-up ground.

No artificial ground has been mapped across The Site, or in the immediate vicinity of the abstraction borehole location.

Superficial Deposits

Superficial Deposits consist of near surface unconsolidated (loose) sedimentary deposits which have not yet become solid rock.

BGS data indicates that both the new and existing boreholes are mapped as underlain by Glacial Till – diamicton. The BGs describes Glacial Till as *“Unsorted and unstratified drift, consisting of a heterogeneous mixture of clay, sand and gravel, and boulders varying widely in size and shape”.*

Bedrock Geology

Bedrock consists of the main mass of rocks forming the Earth's surface that are present everywhere, whether exposed at the surface in outcrops or concealed beneath superficial deposits or water.

BGS mapping indicates that both the new and existing boreholes are mapped as underlain by Mercia Mudstone Group – Marginal Facies. This bedrock is described as “*Variable, typically consisting of conglomerate and/or breccia with clasts derived locally from rocks lying immediately below the unconformable base of these deposits. The matric generally consists of finer-grained rock fragments, or less commonly, siltstone. Sandstone or micritic limestone”.*

1.3 BGS Borehole Records

The BGS Online GeoIndex has been reviewed for the availability of borehole logs in the vicinity of The Site. The GeoIndex indicates the presence of several boreholes, with the most relevant to The Site (closest and similar mapped geology) summarised in Table 1-1 below.

Table 1-1 BGS Borehole Record Summary

Borehole Details	Ground Conditions and Additional Information
BGS Reference: SS87NW47 Name: Royal Porthcawl Golf Club OBH Easting / Northing: 280700, 178880 Location: 1.26km south, south-west. Date: November 1998 Depth (m):42	• Ground level to 1m – Topsoil and Sand; • 1m to 6m – Soft wet CLAY with cobbles; • 6m to 18m – Limestone; • 18m to 40m – Limestone and Mudstone interbedded; • 40m to 42m – heavily fractured Limestone with red silt. Water strikes at 15m, 18m and 40m. Borehole drilled at 282mm diameter from surface to 6m, then 165mm from 6m – 42m. Installed with slotted UPVC pipe at 18.6m – 21.6m & 36m – 42m. Rest water level – 16.5m.

<table>
<tr><th>Borehole Details</th><th>Ground Conditions and Additional Information</th></tr>
<tr><td>BGS Reference: SS87NW54

Name: Royal Porthcawl Golf Club Production Borehole

Easting / Northing: 280370, 179210

Location: 1.04km south-west

Date: 2005

Depth (m): 50</td><td>• Ground level to 1m – Soft red SAND;
• 1m to 26m – Interbedded limestone and mudstone;
• 26m to 31m – Sandstone;
• 31m to 34m – Limestone;
• 34m to 42m – Interbedded Sandstone and Mudstone;
• 42m to 49m – Interbedded Limestone and Mudstone;
• 49m to 50m – Sandstone

Water struck at 25m – 29m.

Borehole drilled at 280mm diameter to 6m, and 120mm diameter to 50m.

Installed with slotted UPVC from 6m – 50m

Rest water level on completion: 16.5m.

Estimated blowout yield: 6.1m^3/hour.</td></tr>
<tr><td>BGS Reference: SS87NW54

Name: Royal Porthcawl Golf Club Borehole B

Easting / Northing: 280660, 179150

Location: 1.04km south-west

Date: 2005

Depth (m): 50</td><td>• Ground level to 1m – Soft red SAND;
• 1m to 5m – Clays and gravels;
• 5m to 50m - Limestone

Water struck at 33m & 49m.

Borehole drilled at 280mm diameter to 6m, and 120mm diameter to 50m.

Installed with slotted UPVC from 29m – 50m

Rest water level on completion: 18m.</td></tr>
</table>

1.4 Existing On-Site Abstraction Boreholes

A Geophysical Logging and CCTV Report prepared for Pyle and Kenfig Golf Club was shared with Hydrogeo as part of this study. The report was commissioned in March 2005 reporting on a borehole that was originally installed at the Golf Club in 1988. The report advised that the borehole installed had a diameter of 150 – 100mm surveyed to a total depth of 39.8m. The conductivity during testing indicated 530 µS at rest water level falling to 505 µS at the base of the borehole. These electrical conductivity values do not indicate the presence of any saline groundwater within the underlying aquifer.

The geophysical log of differential temperature / conductivity suggested possible flow horizons between 28m – 30m and 34m - 38m.

The natural gamma log showed a clay rich response to 10m, a reduced response from 10m – 12m, a small increase between 12m – 16m. Below 16 m – 27m there was a reduction in gamma response till 28m, where there were three minor gamma peaks. From 33m there was a reduction in gamma response.

The CCTV survey also indicated the borehole had some damage and recommended a pump test should be progressed to determine borehole efficiency and yield.

In accordance with the recommendations set out in the Geophysical report, the 1988 borehole was pump tested during October 2005 at an abstraction rate of 6.8m^3/hour for 24 hours. The pump test indicated a maximum drawdown of 1.31m, with the groundwater level reducing from 20.33m below datum to 21.64m below datum. The groundwater level recovered to 20.32m below datum in 3 days.

It is understood that the original (1988) on-site abstraction borehole was re-drilled by APEX Drilling during 2013 following an issue with the 1988 abstraction borehole at the Site. Details provided to Hydrogeo by the client indicates that the borehole was advanced to a maximum depth of 40m utilising both rotary and Down The Hole (DTH) percussive drilling techniques.

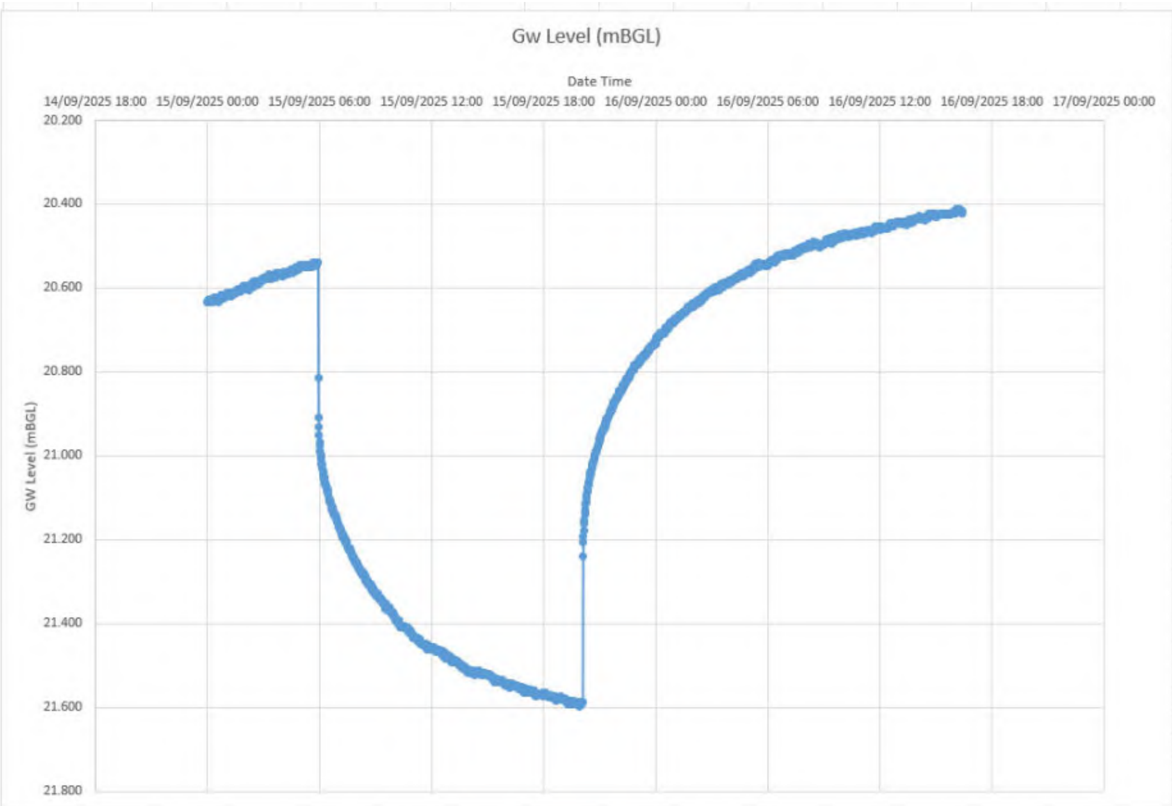
A permanent 193.70 x 187.70mm diameter thin-walled steel casing was installed through the superficial deposits into the bedrock. Rotary drilling advanced at 165mm diameter within bedrock to a depth of 40m. Boode UPVC well liner comprising plain 125mm x 115mm was installed throughout the superficial deposits, with the well screen placed through the underlying limestone bedrock.

Following commissioning Hydrogeo the existing on-site borehole was initially tested during September 2025 to give an indication of aquifer properties including the transmissivity and storage coefficient. This allowed for testing during a drier period of the year with groundwater levels at a seasonally low level beneath the Site. Test pumping indicated a maximum drawdown of 1m during the constant rate test progressed in September 2025.

Using the Cooper and Jacob Straight Line analysis methodology, transmissivity of the underlying aquifer was calculated at 79.9m^2/day, with a storage coefficient of 0.29. Using the Theis analysis methodology a transmissivity of 95.8m^2/day and storage coefficient of 0.13 was derived.

Figure 1-3 present the monitored groundwater levels at the existing borehole during the initial pump test in September 2025.

Figure 1-3 Existing Borehole September 2025 Constant Rate Test



The calculated transmissivity values fall toward the higher end of the literature range of 4m^2/day – 130m^2/day, and both are greater than the literature geometric mean transmissivity of 34m^2/day.

1.5 New Abstraction Borehole

The new abstraction well was drilled and installed by APEX Drilling Limited over the period 5th November 2025 – 7th November 2025. The borehole was drilled using a Fraste Klemm drill rig.

The borehole was advanced to a maximum depth of 50m Below Ground Level (mBGL), and encountered the following ground conditions, as per the APEX Drilling Logs attached as Appendix A.

- Ground level to 7.20mBGL – CLAY;
- 7.20mBGL to 11.80mBGL – LIMESTONE with clay bands;
- 11.80mBGL to 13.80mBGL – CAVITY;
- 13.80mBGL to 15.60mBGL – LIMESTONE;
- 15.60mBGL to 16.00mBGL – Broken LIMESTONE;
- 16.00mBGL to 50.00mBGL – LIMESTONE with clay bands;

The rest water level upon completion of drilling was recorded at 14.00 mBGL.

During the drill, steel casing was installed to 9.00mBGL, at the contact with competent rockhead. The borehole was then advanced as open hole within the bedrock to the base at 50.00mBGL. The borehole installation detail comprises:

- Ground level to 10.00mBGL – Plain UPVC standpipe;
- 10.00mBGL to 50.00mBGL – Slotted UPVC standpipe with endcap;

1.6 Hydrogeology

Although the borehole locations are mapped as underlain by the Conglomerate Marginal Facies of the Mercia Mudstone Group, the boreholes target the underlying Oxwich Head Limestone Formation, described by the BGS as *"Thick bedded, fine- to coarse-grained, recrystalised, bioturbated skeletal pack stones with distinctive pale to ark grey mottling and pseudo-brecciation and ooidal limestone".*

The aquifer unit in the vicinity of the Site is referred to as the Porthcawl-Schwyll aquifer unit, which is used as a potable water supply for Bridgend and parts of the Vale of Glamorgan. The aquifer is also used for several private water supplies.

Limited data of the aquifer properties exists for the site area, available data is generally grouped together with other surrounding limestone aquifers. Transmissivities from 6 no. boreholes vary between 4m^2/day and 130m^2/day, with a geometric mean of 34m^2/day. No storage coefficient data from pumping tests exist for the aquifer, but calculations based on water level responses to rainfall suggest a specific yield of 0.06 – 0.08 in the upper 5m – 10m of the limestone, with values of 0.005 – 0.02 below this.

1.7 Hydrology

Whilst obtaining the Groundwater Investigation Consent (GIC) with Natural Resources Wales (NRW), a Water Features Survey (WFS) has identified several on-site and off-site hydrological and hydrogeological features as shown in Figure 2-1. It is recommended that the WFS is reviewed in conjunction with this section of the Report.

As part of the GIC to investigate a groundwater source, NRW have required the monitoring of a number of these points, including select on-site ponds, and the nearby Kenfig Pool SSSI and Nature Reserve. These features were monitored over the course of the pumping tests at both the existing and new borehole via electronic pressure transducer. Additional on-site water features were monitored at regular intervals using measurements taken from gauge boards installed prior to testing.

2 Pumping Test

As part of the Groundwater Investigation Consent, the following pump testing parameters were agreed with Natural Resources Wales (NRW):

- Step-test of existing abstraction borehole with 5 steps each of 1.7 hours at respective rates of 5, 6.7, 8.3 10 and 11.7m^3/hour;
- Step-test of new abstraction borehole with 5 steps each of 1.7 hours at respective rates of 4.2, 7.5, 10.8, 14.2 and 17.5m^3/hour;
- Existing abstraction borehole constant rate test at 7m^3/hour for 24 hours;
- New abstraction borehole constant rate test at 10.5m^3/hour for 24 hours;
- Combined constant rate test at 17.5m^3/hour for a minimum of 48 hours.

Amendments of the borehole flow rates within the step-tests and constant rate tests were discussed and agreed with NRW prior to commencement based on existing and proposed groundwater pumps installed within each of the boreholes. It was proposed that the step-test flow rates and constant rate flow rates should be progressed at the following rates:

- **Existing Borehole Step-Test –** 2.5m^3/hour (Q1), 5m^3/hour (Q2), 7.5m^3/hour (Q3), 8m^3/hour (Q4);
- **New Borehole Step-Test -** 3.33m^3/hour (Q1), 6.66m^3/hour (Q2), 9.99m^3/hour (Q3), 13.33m^3/hour (Q4), 16m^3/hour (Q5).
- **Existing Borehole Constant Rate Test –** 8m^3/hour
- **New Borehole Constant Rate Test –** 12m^3/hour

2.1 Monitoring Points

Based on the WFS selected representative ground and surface water monitoring points were also agreed with NRW prior to commencement of the pump tests. The monitoring points are identified within Figure 2-1 and include:

- Kenfig Pool National Nature Reserve, SAC / SSSI;
- Pyle and Kenfig Golf Club Ponds
- Farmers Field Pond;
- New Abstraction Borehole;
- Existing Abstraction Borehole;

Surface water levels and groundwater levels within the on-site abstraction boreholes were recorded using electronic pressure transducers, with the on-site boreholes also being recorded at regular intervals using manual dips with an electronic dip-tape.

Table 2-1 provides a summary of the monitoring points during the pump testing of both on-site abstractions boreholes, with Figure 2-1 providing a map of the monitoring points.

Table 2-1 Pump Test Monitoring Points Summary Table

Point Ref	**Location**	**Grid Reference**	**Approx. depth (m)**	Distance **from Borehole Locations (m)**	**Monitoring parameter**	**Monitoring Method**	**Monitoring horizon**
Existing BH	On-site	SS 80951 80235	40	On-site	Groundwater Level	Water level data logger	Oxwich Head Limestone
New BH	On-site	SS 80985 80285	50	On-site	Groundwater Level	Water level data logger	Oxwich Head Limestone
P&K GC 10th Tee Box Ponds	On-site	SS 80814 80065	N/A	220m south-west	Surface Water Level	Water level data logger	Pond
P&K GC 8th Fairway Ponds	On-site	SS 80847 80737	N/A	500m north	Surface Water Level	Gauge Board	Pond
Farmers Field Pond	Off-site	SS 81061 80105	N/A	175m south-east	Surface Water Level	Gauge Board	Pond
Kenfig Pool	Off-site	SS 79723 81187	N/A	1.5km north-west	Surface Water Level	Water level data logger	Pool

Figure 2-1 Monitoring Locations

2.2 Discharge

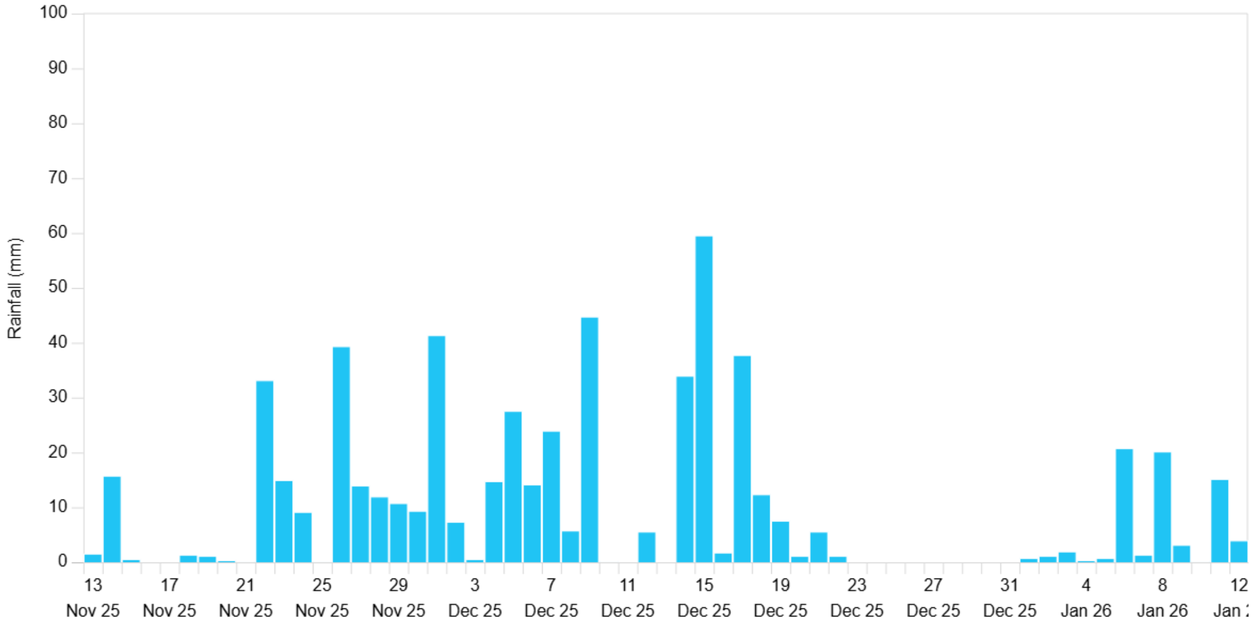
During all pump testing (including individual step-tests, individual constant rate tests, and combined constant rate test) abstracted groundwater was initially discharged into a holding tank which serves the golf club irrigation system. The stored water was then discharged via the irrigation system to points agreed with NRW, Discharge A and Discharge B as indicated in Figure 2-2.

Figure 2-2 Pump Testing Discharge Locations

2.3 Rainfall

Rainfall data from the Natural Resources Wales (NRW) Llety Brongu rain gauge, located approximately 10km north-east of the abstraction boreholes. The rain gauge is located at National Grid Reference (NGR): SS8787588194. Rainfall data collected at the gauge over the pump testing monitoring and testing period is presented in Figure 2-3.

Figure 2-3 Llety Brongu Rain Gauge Data November 2025 - January 2026



The rain gauge data indicates that rainfall was present across the majority of the testing period, with a small drier spell between 23rd December 2025 and 30th December 2025. The peak rainfall received over the period was 59.6mm on 15th December 2025. It is noted that rainfall levels have likely influenced groundwater levels across the pre-test monitoring and testing periods.

2.4 Pre-test Monitoring

Groundwater levels were recorded over the days preceding the pumping tests at both the existing and new boreholes to establish baseline groundwater levels using an electronic pressure transducer. Monitoring was progressed over the periods 25th November 2025 – 12th January 2026.

Pre-test monitoring has not identified any semidiurnal rises and falls in groundwater level indicative of tidal fluctuations to groundwater levels beneath the Site.

Existing Borehole Pre-Testing Monitoring

Pre-test monitoring at the existing on-site borehole (25th – 26th November) indicates a marginally reducing groundwater level in the build-up to the step-test. Over the course of the pre-testing period the groundwater level reduced from 13.41mBGL to a level immediately prior to testing of 13.489mBGL, indicating a reduction in level of 0.07m.

New Borehole Pre-Test Monitoring

Pre-test monitoring at the new on-site borehole (25th – 26th November) also indicates a marginally reducing groundwater level in the build-up to on-site testing. Over the course of the pre-testing period groundwater levels reduced from 23.185mBGL, to a level immediately prior to testing of 23.256mBGL, indicating a reduction in groundwater level of 0.07m.

2.5 Step Test

Step tests were progressed at both the existing and new boreholes to determine the performance characteristics of the well, including the maximum, efficient, and sustainable yield of the boreholes. The step-test at the existing borehole was progressed on 26th November 2025, beginning at 08:20, and completing at 14:47, with the new borehole step-test progressed across the period 15th December 2025 09:52 – 15th December 2025 18:14.

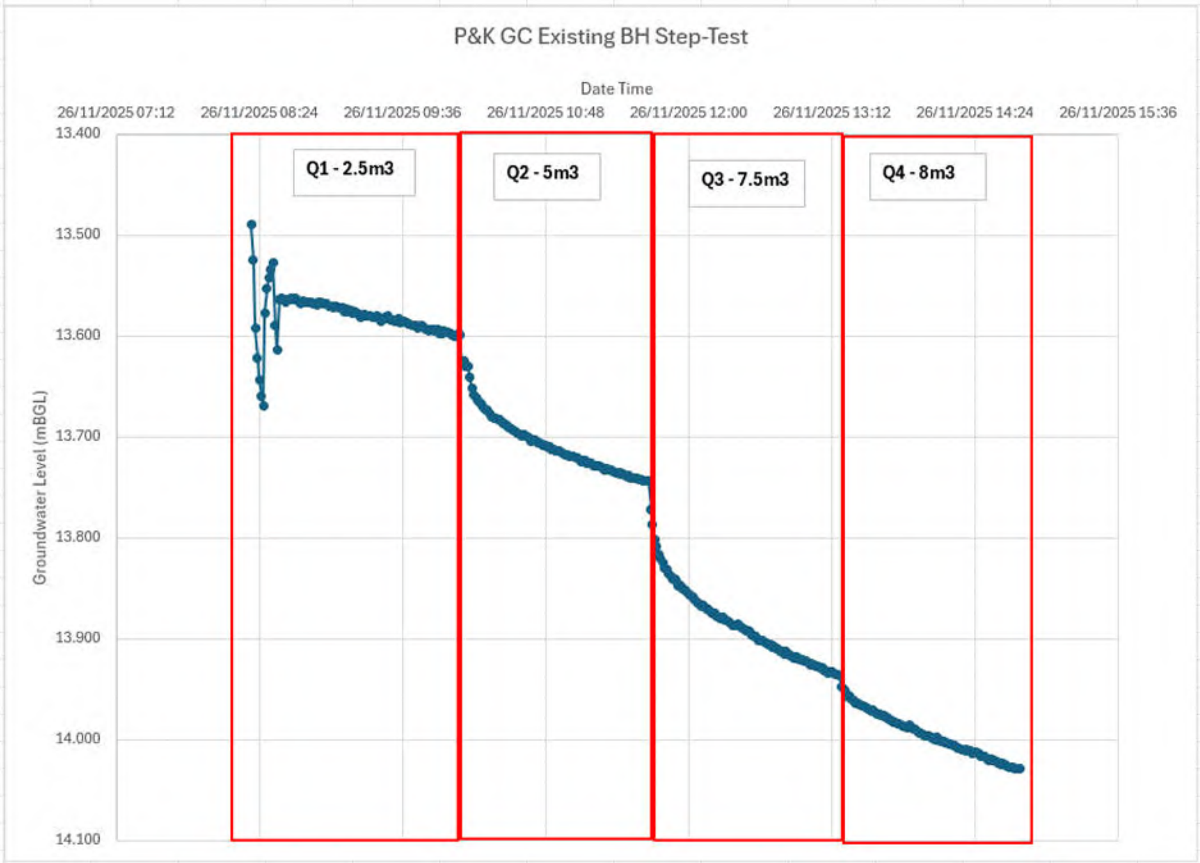
The agreed step-test intervals were determined using ‘*The Analysis and Planning of Step Drawdown Tests, Clark, 1977; Analysing Step-Drawdown Tests in Heterogeneous Aquifers, Karami and Younger, 2002’.*

Existing Borehole Step-Test

The step-test at the existing borehole consisted of 4no. steps at borehole flow rates of 2.5m^3/hour (Q1), 5m^3/hour (Q2), 7.5m^3/hour (Q3) and finally 8m^3/hour (Q4). Prior to testing the client team indicated that the maximum capability of the installed submersible borehole pump was approximately 8m^3/hour, therefore the final step of the step-test was progressed at a near maximum achievable flowrate.

Prior to commencement of the step-test, groundwater levels were recorded at 13.49m Below Ground Level (mBGL), which is 7.73m higher than in September 2025. Groundwater levels during the step-test are presented in the graph included as Figure 2-4.

Figure 2-4 Existing Borehole Step-Test



Groundwater levels appear to rapidly drawdown at initial increases in borehole flowrates, indicative of the borehole storage volume being de-watered (borehole standpipe and filter pack surround). As the step progresses, the groundwater level begins to reach an equilibrium as seen by the flattening of the curve at Q2 and Q3. Pumping at Q4 reached the indicated maximum design flow rate of the installed submersible borehole pump of 8m^3/hour.

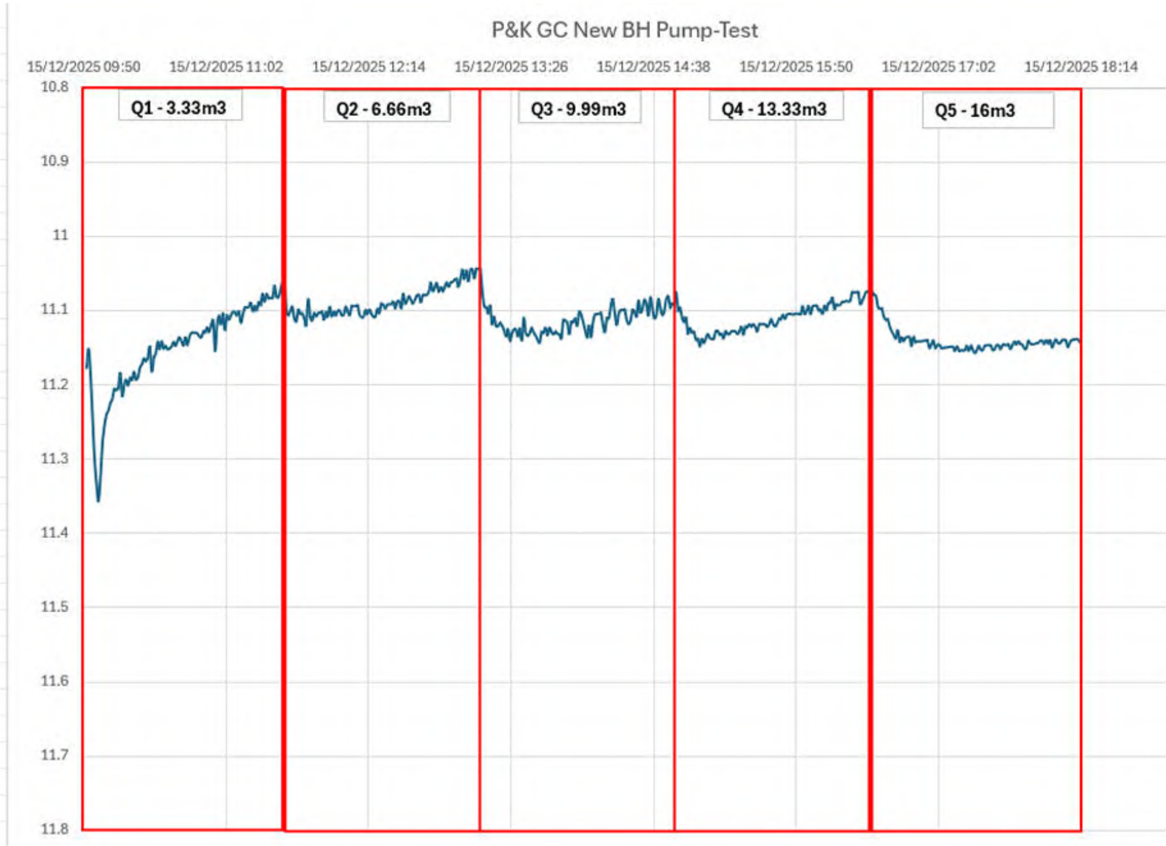
Following completion of the step-test it was determined that the constant rate test at the existing borehole would be progressed at an abstraction rate of 8m^3/hour.

New Borehole Step-Test

The step-test conducted on the new borehole consisted of 5 no. steps at borehole flow rates of 3.33m^3/hour (Q1), 6.66m^3/hour (Q2), 9.99m^3/hour (Q3), 13.33m^3/hour (Q4) and finally 16m^3/hour (Q5). Prior to testing it had been indicated by APEX Drilling that the specification of the installed submersible borehole pump could pump up to a maximum of approximately 20m^3/hour.

Prior to commencement of the step-test, groundwater levels were recorded at 11.27mBGL. Groundwater levels during the step-test are presented in the graph included as Figure 2-5.

Figure 2-5 New Borehole Step-Test



Step testing was progressed at the new borehole across the period 15th December 2025 09:52 – 15th December 2025 18:14. During the step-test (15th December) 2mm of rainfall was recorded at the closest rain gauge and staff from P&K commented that the weather was exceptionally wet with the golf course closed. During the early steps (Q1, Q2, Q3 and Q4) of the step-test appear to show an initial rapid de-watering of the borehole storage volume (standpipe and surrounding filter pack) indicated by initial rapid drawdown, followed by a period of continued groundwater level recharge, indicating that the flow into the borehole from the surrounding aquifer is greater than the step-test pumping rates up to progressing of Q5 (16m^3/hour).

At Q5 rapid initial drawdown is observed (well storage volume de-watering), however, no notable groundwater level recovery is recorded indicating that the abstraction from the borehole and the flow into the borehole from the aquifer has reached an approximate equilibrium.

Following completion of the step-test it was decided that the constant rate test would be progressed at the desired abstraction rate of 12m^3/hour.

2.6 Constant Rate Test

Following completion of both step-tests and the subsequent groundwater level recovery, constant rate pump tests were progressed at both the existing and new boreholes. The constant rate test at the existing borehole was progressed over a period of 24 hours from 07:30 27th November 2025 – 07:30 28th November 2025, with the constant rate test at the new borehole progressed over the period 10:24 17th December 2025 – 13:26 18th December 2025.

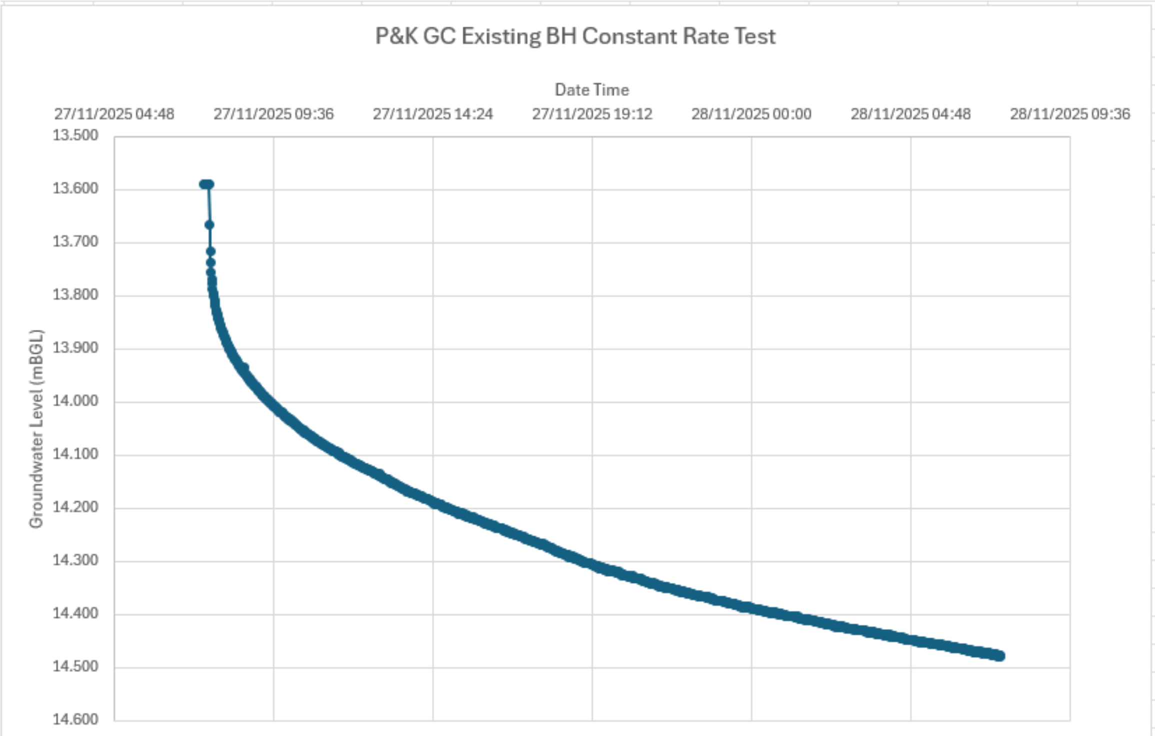
Existing Borehole

The constant rate test was progressed at 8m^3/hour. Initial groundwater level drawdown is rapid, from a pre-test resting groundwater level of 13.59mBGL to the lowest recorded groundwater level during this phase of testing recording 14.48mBGL (0.89m total drawdown). As shown in the graph of the level logger data in Figure 2-6, the groundwater level appears to begin to reach a reduced drawdown state prior to completion of the 24-hour test.

Initial drawdown is rapid, representative of well storage volume loss (well standpipe and surrounding gravel filter pack). As the test progresses, the rate of drawdown progressively decreases, and no sharp drawdowns are observed indicating that no obvious boundary effects have occurred, i.e changes in geology. Toward the end of the test the graphed data appears to begin to indicate the groundwater level reaching an equilibrium.

Whilst the groundwater levels recorded during the test were notably shallower (13.59mBGL) compared to the summer September groundwater levels (20.55 mBGL) the drawdown recorded during both constant rates tests were of the same order being 0.89m in November and 1m in September.

Figure 2-6 Existing Borehole Constant Rate Test

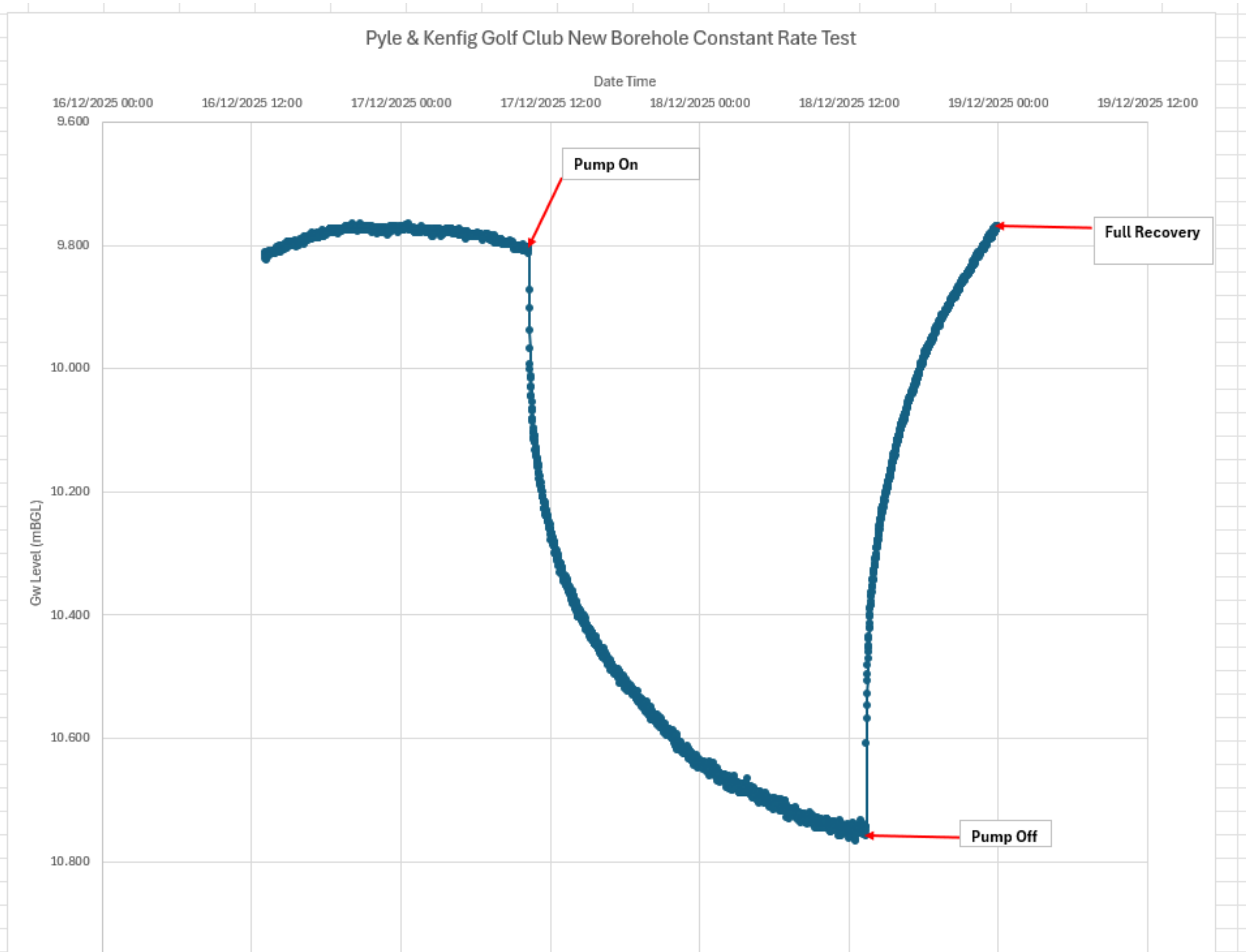


New Borehole

The initial groundwater level drawdown is rapid, from a pre-test level of 9.81mBGL to a maximum reduced groundwater level of 10.77mBGL, indicating a total drawdown of 0.96m over the whole constant rate test progressed at 12m^3/hour. The level of total drawdown observed is comparable to the existing site borehole indicating consistent aquifer properties within each of the boreholes.

As shown in the graph presented in Figure 2-7, the groundwater level appears to approach an equilibrium with reduced drawdown prior to the completion of the constant rate test.

Figure 2-7 New Borehole Constant Rate Test



2.7 Combined Constant Rate Test

As part of the Groundwater Investigation Consent (GIC), constant rate testing of both boreholes simultaneously was required. The combined step-test was progressed beginning 6th January, at an approximate combined flow rate of 20m^3/hour, consisting of 12m^3/hour at the new abstraction borehole and 8m^3/hour at the existing abstraction borehole. As per the GIC the combined test was progressed for a minimum of 48 hours, with both borehole pumps being switched off after 70.5 hours of pumping (6th January – 9th January).

An initial issue was noted with frozen flow control valve which resulted in the abstraction rate at the existing borehole being slightly reduced for the first portion of testing. Once identified the valve thawed and existing borehole flow rate could be adjusted to the desired rate of ~8m^3/hour, where it remained for the rest of the test.

The effect of the clearance is clearly shown in Figure 2-8 on both the groundwater level at the existing borehole as well as the new borehole indicating connectivity between the boreholes. Following the adjustment the test was progressed in accordance with the GIC for a minimum of 48 hours.

The groundwater levels in each of the boreholes appear to track each other reasonably well as the constant rate test progresses indicating that the boreholes are targeting the same underlying aquifer unit. The drawdown difference between both wells remains relatively consistent throughout the test suggesting maintained radial flow conditions.

Drawdown at each borehole during simultaneous pumping represents the superposition of two individual components:

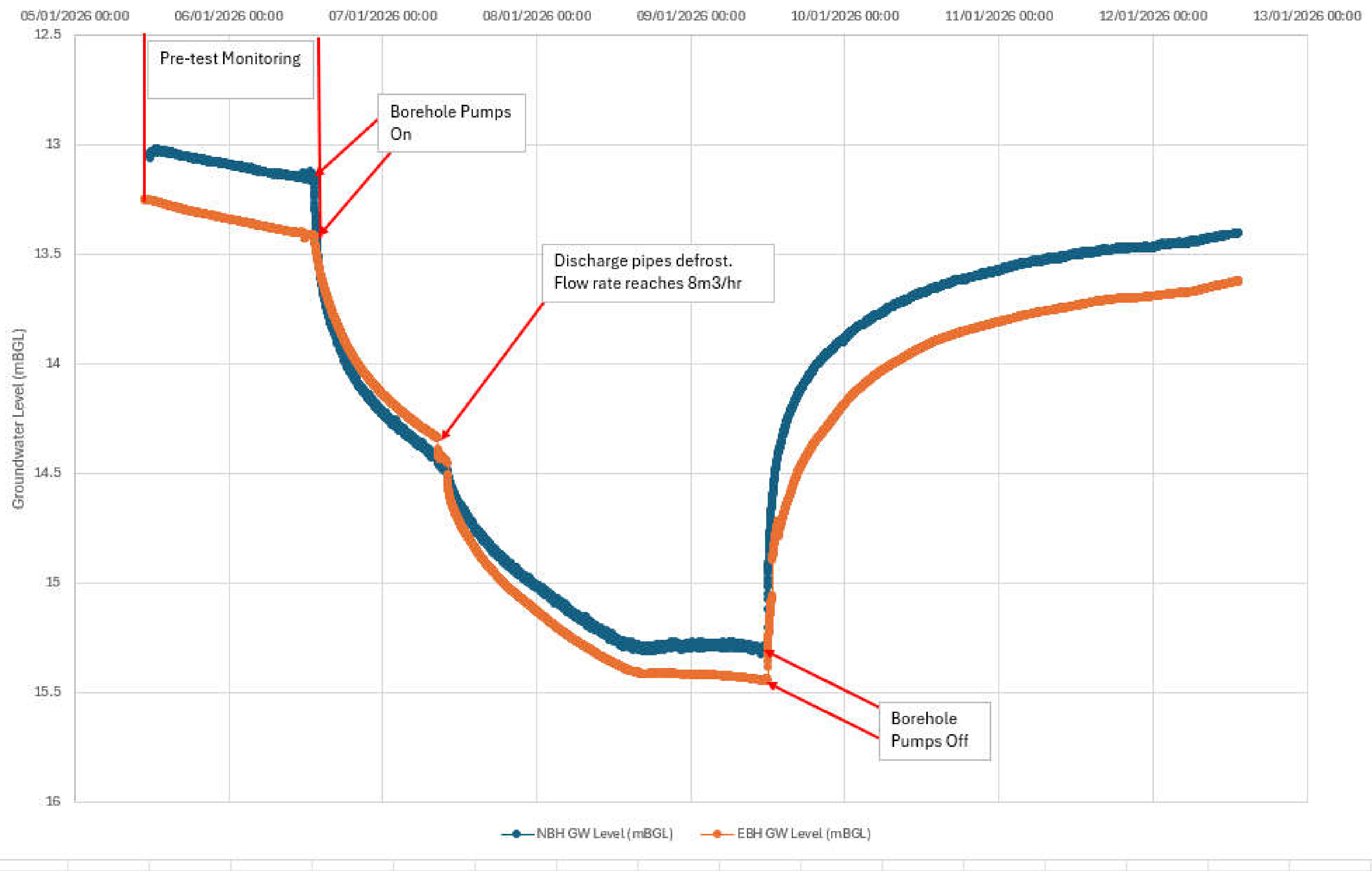
- Drawdown caused by abstraction from the borehole itself; and,
- Interference drawdown induced by abstraction from the adjacent borehole.

As the new borehole was pumped at a higher rate (12m^3/hour) when compared to the existing borehole (with pump capable of a maximum 8m^3/hour), the cone of depression associated with the new borehole is deeper and contributes larger interference to drawdown at the existing borehole than vice-versa. The drawdown doesn't increase disproportionately as the test progresses suggesting that the overlapping cones of depression do not appear to result in compounding drawdown effects. Rather, the cones flatten and stabilise as pumping continues.

Groundwater levels during the combined test are presented in Figure 2-8, which indicates the groundwater levels prior to testing, during testing, and following cessation of pumping.

Continuous pumping of both abstraction boreholes over a period of approximately 72 hours resulted in a maximum drawdown of 2.03m at the existing borehole and 2.11m at the new borehole.

Figure 2-8 Combined Constant Rate Test Groundwater Levels



2.8 Recovery Period

Following the cessation of pumping at both boreholes, the groundwater levels were allowed to recover back toward the initial baseline levels recorded prior to commencement of testing. Complete recovery of the groundwater level was not possible due to elevated baseline groundwater levels prior to the commencement of testing because of the prolonged rainfall period associated with Storm Claudia. However, at least 97% recovery had occurred prior to removal of the groundwater level loggers.

Groundwater level recoveries are presented in Figure 2-8 which shows the groundwater recovery following the completion of the combined constant rate test. Details of groundwater level recovery following the individual borehole tests are detailed in the following sections.

Existing Borehole

Following completion of all testing (step-test, individual constant rate test & combined constant rate test) the groundwater level was allowed to recover toward pre-testing levels. The below bullet points detail the recovery of the groundwater level at the existing borehole following completion of testing.

- **Step Test –** Recovery from 14.028mBGL to 13.590mBGL following recovery (99% recovery of initial groundwater level) in 16 hours 57 minutes;
- **Constant Rate Test** – Recovery from 14.479mBGL to 15.593mBGL in 37 hours 56minutes. (Groundwater level recovered above pre step-test levels following continued wet period);
- **Combined Constant Rate Test –** Recovery from 15.441mBGL to 13.625mBGL (97% recovery) in 73 hours 17minutes.

New Borehole

Upon completion of all testing (step-test, individual constant rate test & combined constant rate test) the groundwater level was allowed to recover toward pre-testing levels. The below bullet points detail the recovery of the groundwater level at the new borehole following completion of testing.

- **Step-Test** – Recovery from 11.143mBGL to 9.86mBGL in 15 hours 16minutes.
- **Constant Rate Test –** Recovery from 10.759mBGL to 9.801mBGL (99% recovery) in 9 hours 44minutes.
- **Combined Constant Rate Test –** Recovery from 15.313mBGL to 13.402mBGL (98% recovery) in 73 hours 16minutes.

As per the NRW GIC, 90% groundwater level recovery was required before progression of any subsequent testing. Following completion of the constant rate test at the existing borehole groundwater levels recovered to 90% in 28 hours 4 minutes, with recovery from the combined constant rate test reaching 90% in 70 hours 3 minutes.

Groundwater levels within the new borehole following individual constant rate testing recovered to 90% in 5 hours and 27 minutes, with 90% recovery from the combined constant rate test taking 9 hours 59 minutes.

2.9 Salinity Monitoring

As part of the GIC and supporting cover letter issued NRW highlighted that the Pyle and Kenfig Golf Course is located within a coastal environment with underlying groundwater potentially subject to tidal influence and saline intrusion. The golf course itself is at its closest point 600m from the coastline. However, both abstraction boreholes are located inland from the coastline by approximately 2km. Monitoring progressed across the summer and winter months did not detect any tidal fluctuations in groundwater monitoring boreholes.

During all pump tests progressed the salinity of the abstracted groundwater was monitored at regular intervals using a calibrated Hanna HI98312 Water Conductivity Meter, with the electrical conductivity (EC) reading in milliSiemens per centimeter recorded.

Salinity was recorded at the point of pipe discharge into the on-site storage tank for both the existing and new boreholes. Table 2-2 presents the salinity readings at intervals over the period 27th November 2025 – 9th January 2026.

Freshwater typically falls within the range of 0 – 1500 milliSiemens per centimeter, all recorded electrical conductivity values during the pump testing of the boreholes fall within this freshwater range. Handheld electrical conductivity readings do not appear to indicate any potential saline intrusion into the underlying aquifer.

Marginal electrical conductivity increases are noted during the test pumping of the existing borehole (26th November 2025 – Step test existing, 27th November – 28th November 2025 constant rate test existing) within electrical conductivity readings increasing from an initial 607mS/cm to a final of 610mS/cm, with the peak electrical conductivity recorded during the constant rate test.

Small electrical conductivity (EC) increases are also noted during the test pumping of the new borehole, with EC levels increasing marginally from 630mS/cm during the step-test to 661mS/cm toward the end of the constant rate pumping test.

When pumped in combination, EC readings marginally decreased from an initial 687mS/cm to a final EC reading of 630mS/cm. This decrease in EC indicates that no saline groundwater is being abstracted by either of the abstraction boreholes.

Table 2-2 Electrical Conductivity Monitoring

Date Time – Electrical Conductivity (mS/cm)	**Existing Borehole GW Level (mBGL)**	**New Borehole GW Level (mBGL)**	**Testing Phase**
27/11/2025 08:43 -- **607**	13.94	23.43	Existing Borehole Constant Rate Test
27/11/2025 09:45 -- **610**	14.02	23.49	Existing Borehole Constant Rate Test
27/11/2025 10:45 – **608**	14.07	23.53	Existing Borehole Constant Rate Test
27/11/2025 11:45 -- **614**	14.11	23.55	Existing Borehole Constant Rate Test
27/11/2025 12:45 – **612**	14.14	23.58	Existing Borehole Constant Rate Test
27/11/2025 14:05 – **611**	14.18	23.62	Existing Borehole Constant Rate Test
27/11/2025 15:17 – **611**	14.21	23.64	Existing Borehole Constant Rate Test
28/11/2025 07:25 – **610**	14.48	23.87	Existing Borehole Constant Rate Test
15/12/2025 13:00 -- **630**	10.75	10.33	New Borehole Step-Test
17/12/2025 13:55 – **656**	9.90	10.37	New Borehole Constant Rate Test
18/12/2025 08:15 -- **660**	10.35	10.73	New Borehole Constant Rate Test
18/12/2025 12:33 – **661**	10.35	10.75	New Borehole Constant Rate Test

Date Time – Electrical Conductivity (mS/cm)	**Existing Borehole GW Level (mBGL)**	**New Borehole GW Level (mBGL)**	**Testing Phase**
06/01/2026 14:40 – **687**	13.63	13.66	Combined Constant Rate Test
06/01/2026 17:44 – **674**	13.87	13.96	Combined Constant Rate Test
07/01/2026 08:07 – **670**	14.33	14.42	Combined Constant Rate Test
07/01/2026 13:43 – **653**	14.81	14.72	Combined Constant Rate Test
08/01/2026 03:55 -- **647**	15.22	15.10	Combined Constant Rate Test
08/01/2026 09:11 – **631**	15.32	15.21	Combined Constant Rate Test
09/01/2026 08:11 – **631**	15.43	15.29	Combined Constant Rate Test
09/01/2026 11:45 – **628**	15.44	15.30	Combined Constant Rate Test
09/01/2026 13:50 -- **630**	14.77	14.40	Combined Constant Rate Test

2.10 Test Summary

A summary of the monitoring and pump test procedures is shown in Table 2-3. An excel data sheet presenting all pump test data is included as a digital appendix to this report (Appendix B).

Table 2-3 Test Summary

Date	Time	Comment
25/11/2025	12:33	Electronic pressure transducer installed into the **Existing Borehole.**
25/11/2025	13:01	Electronic pressure transducer installed into the **New Borehole.**
26/11/2025	08:20	**Existing Borehole** step-test start.
26/11/2025	14:47	**Existing Borehole** step-test end.
27/11/2025	07:30	**Existing Borehole** constant rate test start.
28/11/2025	07:30	**Existing Borehole** constant rate test end.
15/12/2025	09:52	**New Borehole** step-test start.
15/12/2025	18:14	**New Borehole** step-test end.
17/12/2025	10:24	**New Borehole** constant rate test start.
18/12/2025	13:26	**New Borehole** constant rate test end.
06/01/2026	13:28	Combined constant rate test start.
09/01/2026	12:03	Combined constant rate test end.

The Step-test resulted in a maximum drawdown of 0.54m at the existing borehole, and 0.205m at the new borehole. Following conclusion of the step-tests groundwater level recovery was allowed prior to commencement of the individual constant rate tests.

The constant rate test ($8m^3$/hour & $12m^3$/hour) at both the existing and new boreholes individually resulted in maximum groundwater level drawdown of 0.89m & 0.796m respectively.

Following a period of recovery, both abstraction boreholes were then constant rate tested simultaneously ($20m^3$/hour combined).

Continuous pumping of both abstraction boreholes over a period of approximately 72 hours resulted in a maximum drawdown of 2.03m at the existing borehole and 2.11m at the new borehole.

The observed drawdowns at the existing borehole during winter 2025, do not appear to vary significantly from the 1m of maximum drawdown observed during pumping in September 2025.

The observed drawdown at each borehole location during simultaneous pumping appears to represent the additive effect of self-induced drawdown, and interference from the adjacent borehole. Interference effects are variable due to the differing pumping rates but remain small relative to the total drawdown observed. The drawdown does not appear to compound as the constant rate test progresses. The superposition of cones of depression formed at each borehole location therefore do not appear to pose a significant constraint to the proposed abstraction, and rather than continuing to deepen and extend, the cones of depression flatten and remain consistent.

3 Monitoring Points Data

3.1 Introduction

As detailed in Section 2.1 of this report, the Groundwater Investigation Consent (GIC) required the agreement and monitoring of several identified key water features both on- and off-site. These water features were monitored over the same period as the abstraction boreholes and included monitoring by electronic pressure transducer at Kenfig Pool and the closest on-site ponds, with additional on-site ponds being monitored with installed gauge boards.

Appendix C includes graphed compensated level logger data collected at both Kenfig Pool and the closest on-site ponds and should be viewed in conjunction with this report section.

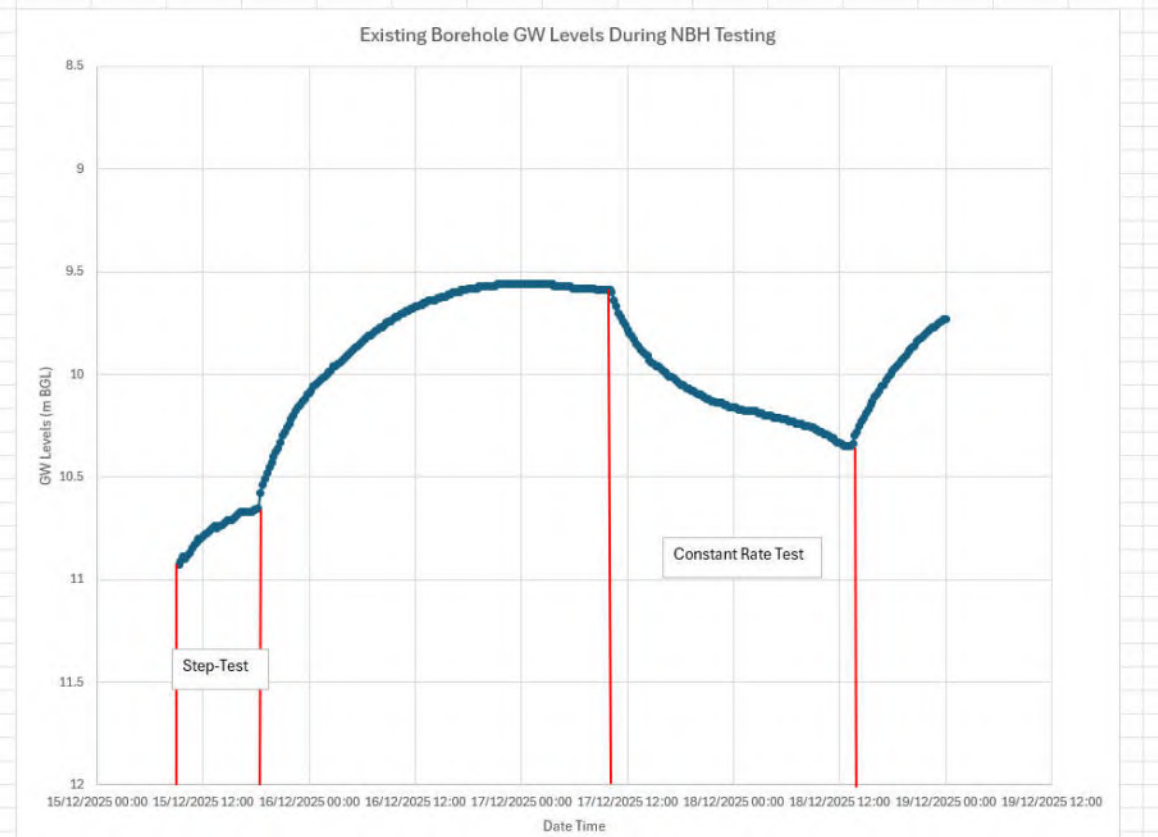
3.2 Existing Borehole

The existing on-site borehole was used as an observation well during the test pumping of the new groundwater abstraction borehole at the Site. Figure 3-1 below presents the groundwater levels within the existing on-site borehole during testing of the new abstraction borehole.

As shown in Figure 3-1, the pump testing at the new borehole has impacted the groundwater level within the existing on-site borehole. The pre-testing groundwater level within the existing borehole prior to testing at the new borehole was recorded at 9.60mBGL, and was drawn down over the course of the constant rate test to a reduced level of 10.35mBGL, indicating a total drawdown of 0.75m.

As shown in Figure 2-3, significant rainfall volumes were recorded within the buildup to, and during the step-testing. During the step-testing groundwater levels were noted as recovering as a result of the groundwater recharge received via rainfall infiltration to the underlying limestone aquifer.

Figure 3-1 Existing Borehole Groundwater Level During New Borehole Testing



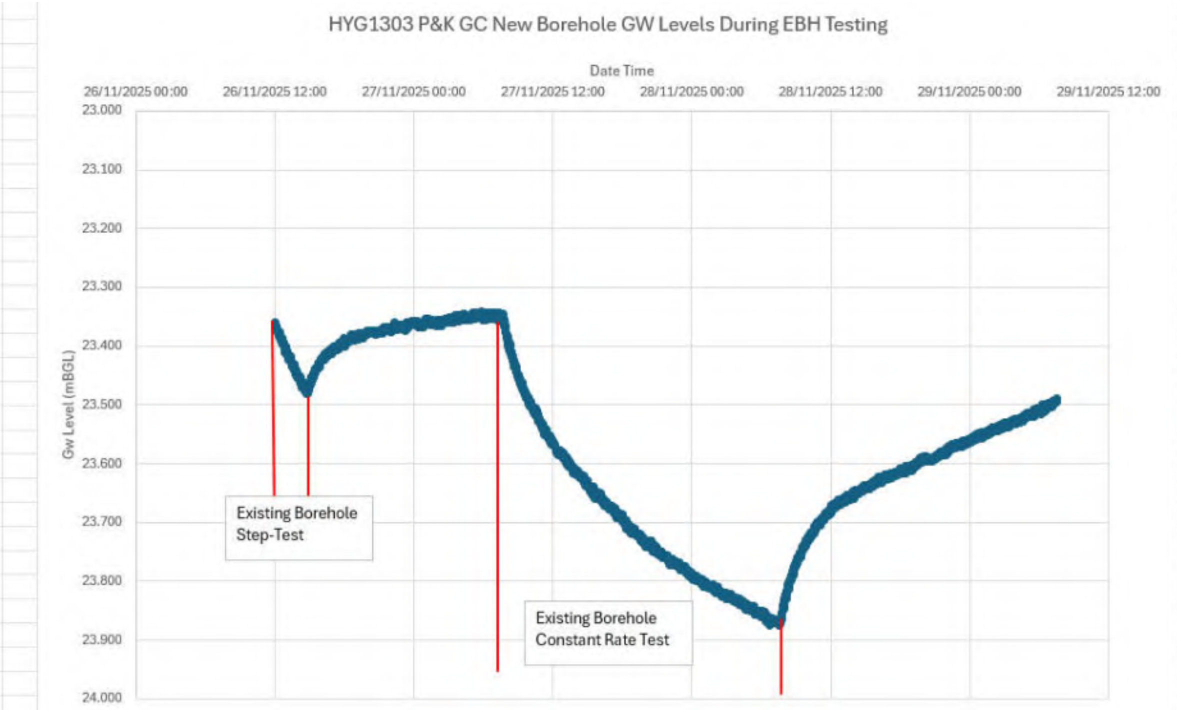
3.3 New Borehole

The new borehole at Site was utilised as an observation well during the test pumping of the existing borehole. Figure 3-2 presents the groundwater levels within the new borehole during the period of testing at the existing abstraction.

As shown in Figure 3-2, pump testing at the existing borehole has impacted the groundwater levels within the new abstraction borehole. The groundwater level within the new borehole prior to constant rate testing at the existing borehole was 23.36mBGL.

Groundwater level was drawn down to a maximum reduced level of 23.875mBGL, indicating a total drawdown of 0.51m because of testing at the existing borehole.

Figure 3-2 New Borehole GW Levels During Existing Borehole Testing



3.4 Kenfig Pool

Kenfig Pool was monitored across the entire monitoring and testing period, with the electronic pressure transducer installed into the pool on 25th November 2025 at 11:00. The monitoring data indicates that the water level at the monitoring point within Kenfig Pool varied from a lowest level of 0.03m on 1st December 2025 to a highest level of 0.65m on 24th December 2025, resulting in a water level range of 0.62m.

At the beginning of the testing period (26/11/2025 – 09/01/2026) the water level within Kenfig Pool was recorded at 0.28m, and upon completion of the testing the water level was recorded at 0.332m, indicating an overall increase in the water level within Kenfig Pool of 0.05m.

Review of water levels across the period, as graphed and presented in Figure 3-3 does not appear to indicate any response of test pumping, individually, or combined, the existing and new groundwater abstraction boreholes at Pyle and Kenfig Golf Club.

Figure 3-3 Water Levels in Kenfig Pool

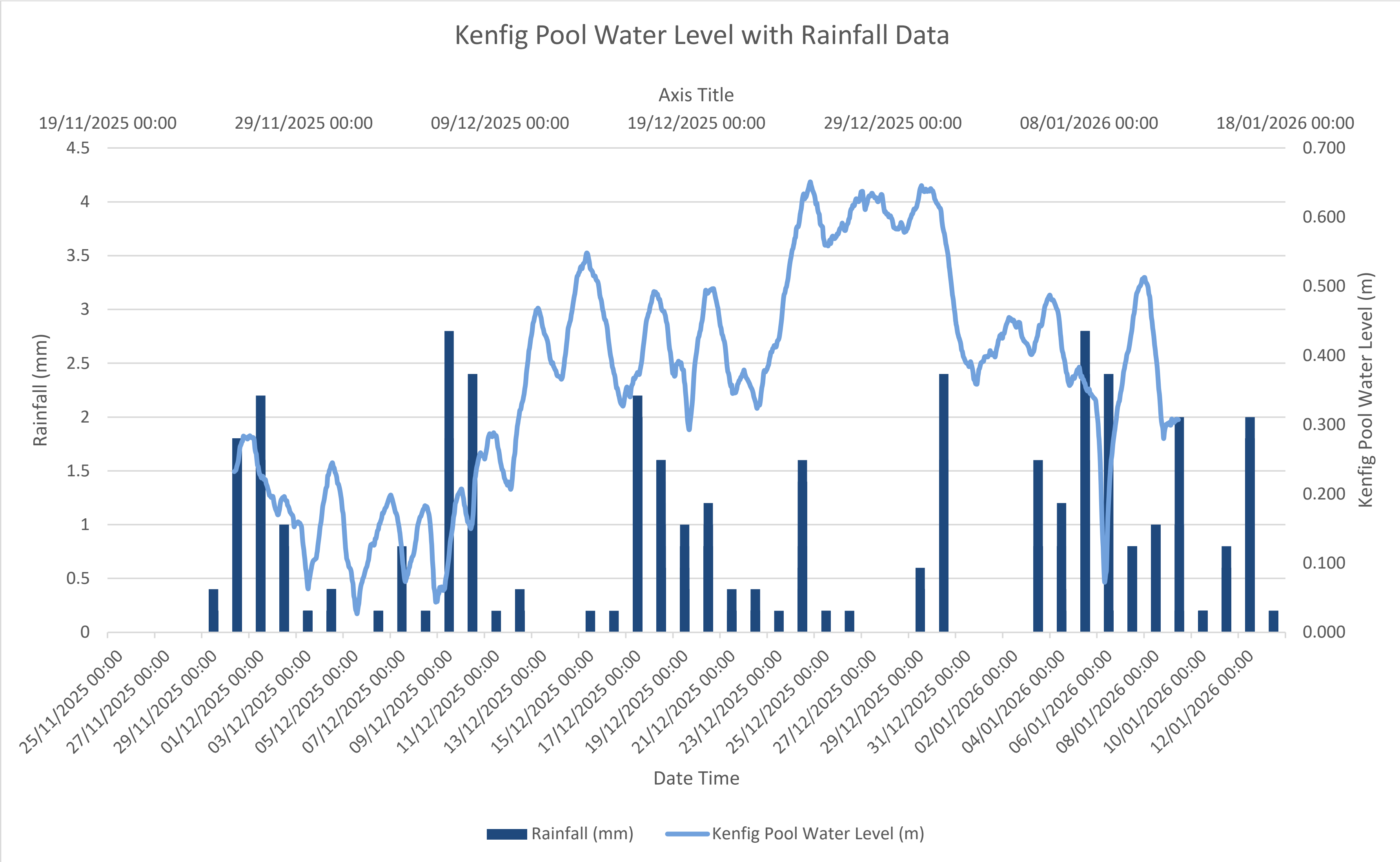


Figure 3-4 Kenfig Pool Water Level (m) during EBH Testing

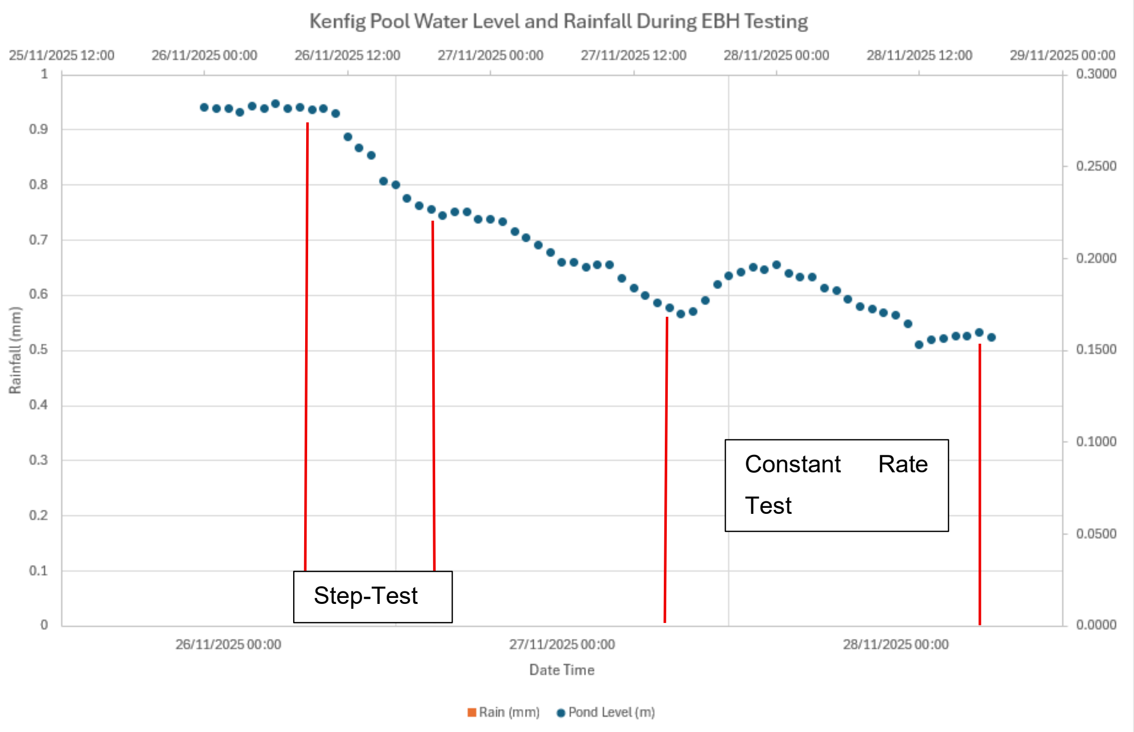
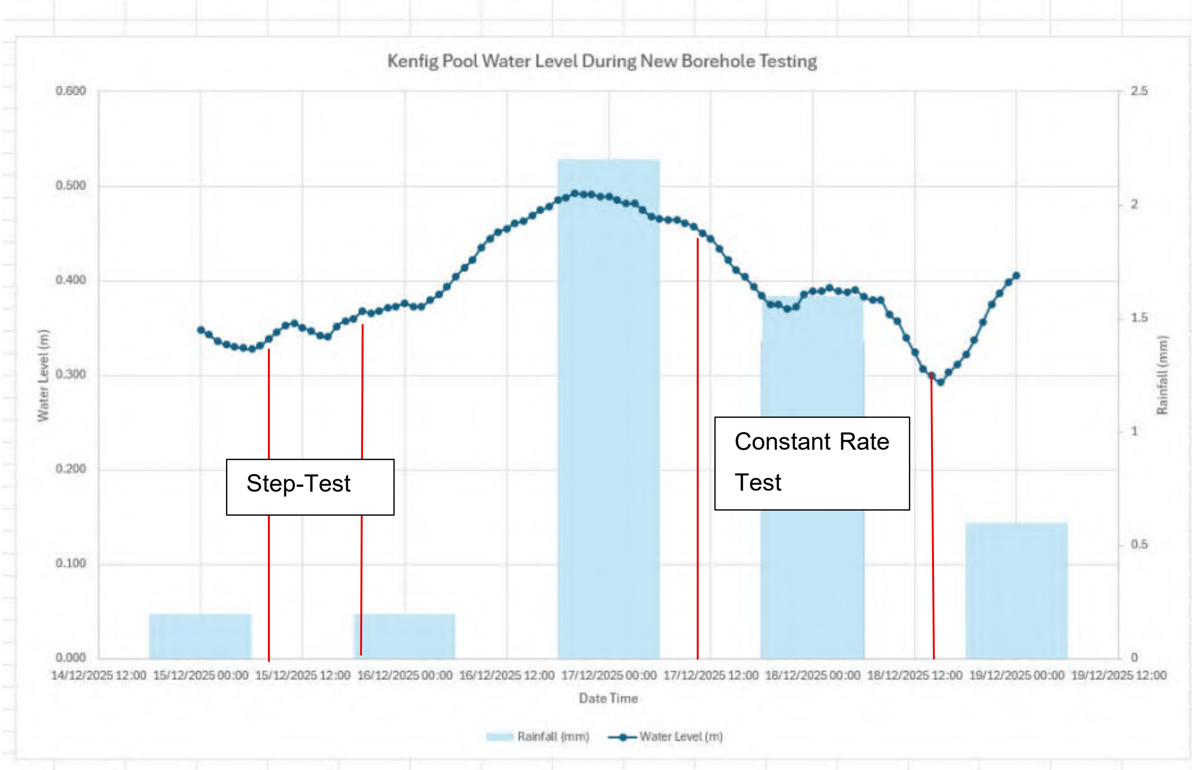


Figure 3-4 provides the water level in Kenfig Pool across the testing period of the Existing Borehole. The pool water level does reduce over the period from an initial level of 0.28m to a level of 0.16m, however, this change in water level is considered to be representative of no rainfall being recorded across the period as opposed to impacts from abstraction at the existing borehole.

Figure 3-5 Kenfig Pool Water Level During New Borehole Testing



As shown in Figure 3-5, the water level in Kenfig Pool appears to be responsive to rainfall and subsequent surface water inflows shown by the increases in levels during rainfall events. No response is identified in the Kenfig Pool water level as a result of test pumping at the New Abstraction Borehole.

3.5 On-Site Tee Box Ponds

The on-site ponds immediately adjacent to the 10th tee box were also monitored across the entire monitoring and testing period of both abstraction boreholes via electronic pressure transducer. The level logger was installed into the ponds on 25th November 2025 and was retrieved on 12th January 2026.

At the beginning of the testing period (26/11/2025 – 09/01/2026) the water level within the on-site ponds was recorded at 0.489m, and on completion of the testing the water level was recorded at 0.285m. Although the water level is recorded lower, there are no obvious trends noted in relation to the ponds water level and the timings of testing at the boreholes. It is thought that these ponds are collecting surface water runoff and additional water from surface waters within drainage ditches in the vicinity.

Figure 3-6 Pyle & Kenfig Ponds with Rainfall Data

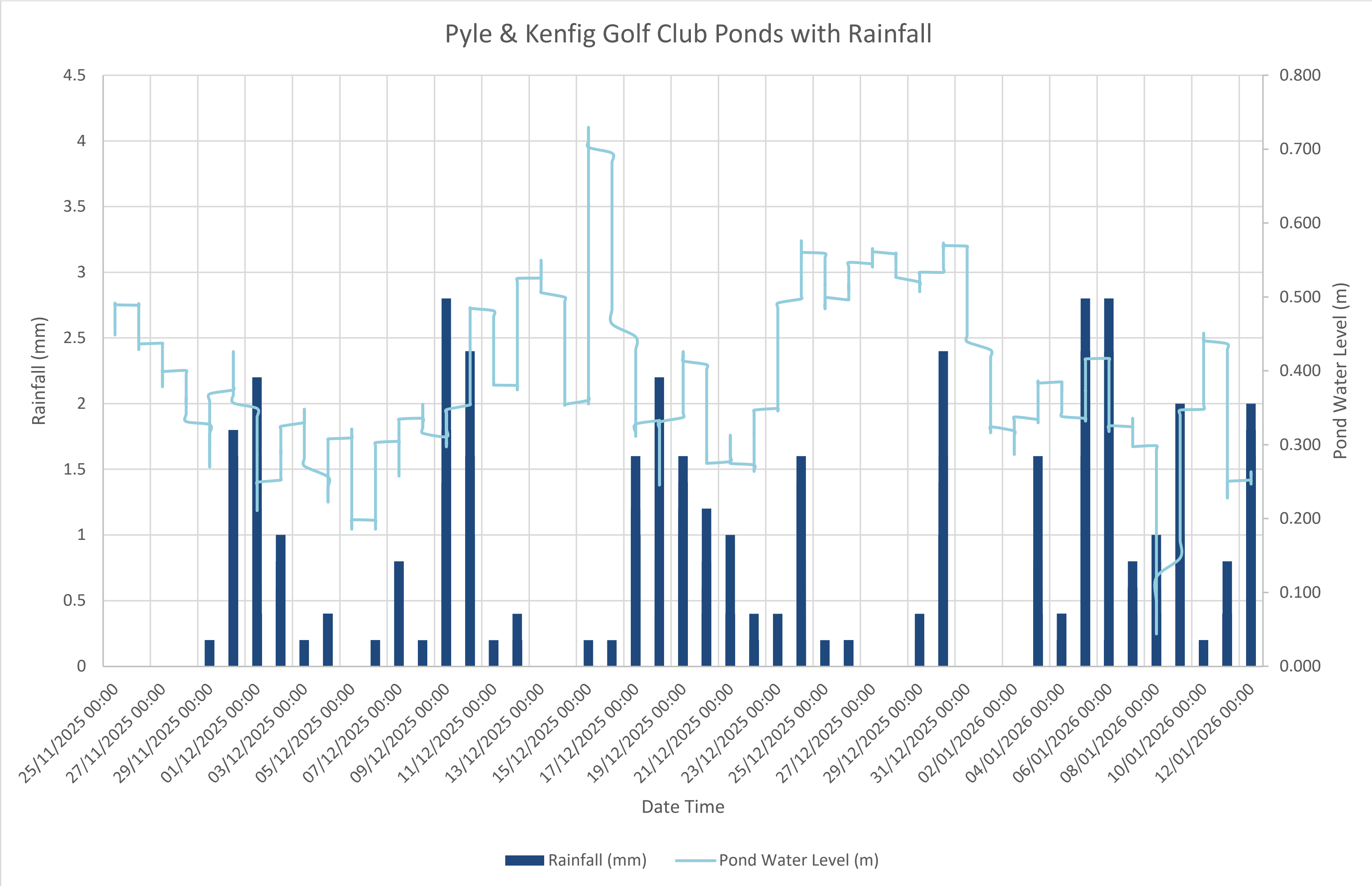
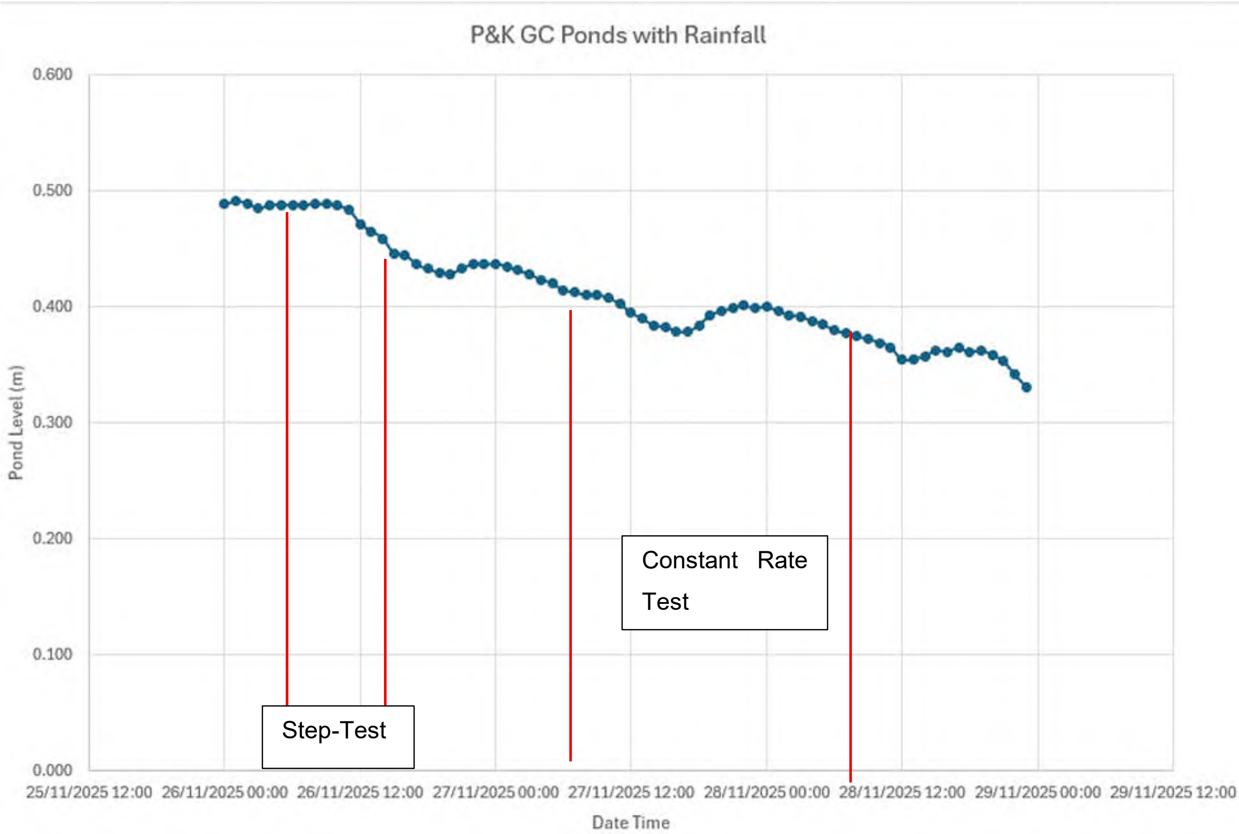
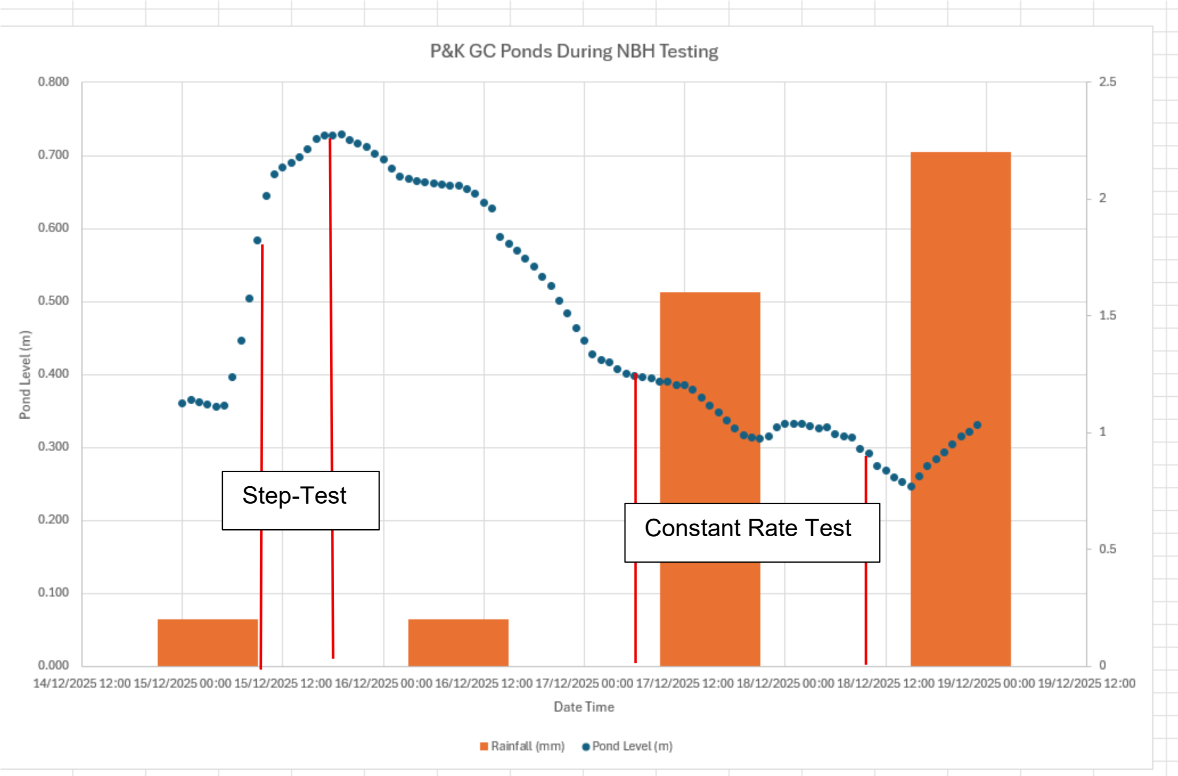


Figure 3-7 P&K GC Ponds During EBH Testing



As shown in the figure above, the on-site pond levels show a reduction in level over the testing period of the existing borehole. The level reduced initially from 0.49m to 0.33m over the testing period, indicating a reduction in level of 0.16m. However, no rainfall was received during this period, and it is therefore likely that the marginal reduction in levels are related to no rainfall or surface water flow inputs as opposed to any abstraction impacts.

Figure 3-8 P&K GC Ponds During New Borehole Testing



As the figure above shows the pond level shows no marked response to test pumping at the new borehole, with pond levels rising during the step-test. Levels then fall during groundwater recovery between the step-test and the constant rate test. Pond levels appear unaffected by any groundwater drawdown during the new borehole constant rate test.

3.6 Additional On-site Ponds

Additional on-site ponds were monitored through installation and regular review of gauge board readings during the monitoring and pump-testing period of both the existing and new groundwater abstraction wells. The monitored ponds included the pond adjacent to the 8th hole fairway and the pond located in the farmers field, south of the abstraction boreholes. Review of images taken of the installed gauge boards are provided within Table 3-1.

Table 3-1 Pond Gauge Boards

Farmers Field Pond	**8th Fairway Pond**	**Description**
		Pond gauge boards taken at beginning of the New Borehole Step-Test (15th December 2025). Farmers Pond – 2.4m. Fairway Pond – 5.1m

Farmers Field Pond	8th Fairway Pond	Description
		Pond gauge boards taken following completion of the New Borehole Step-Test (16th December 2025). The boards here also serve as a reference water level for the beginning of the constant rate test at the New Borehole. Farmers Pond – 2.3 m Fairway Pond – 5.4m

Farmers Field Pond	8th Fairway Pond	Description
		Pond gauge boards taken during the New Borehole constant rate test (17th December 2025). Farmers Pond – 2.4m. Fairway Pond – 5.6m
		Pond gauge boards following completion of the New Borehole constant Rate Test (19th December 2025) Farmers Pond – 2.2m. Fairway Pond – 6.4m.

Farmers Field Pond	8th Fairway Pond	Description
		Pond gauge boards at the beginning of the combined constant rate test (06/01/2026/) Farmers Pond – 2.1m. Fairway Pond 4.75m.
		Pond gauge board during the combined constant rate test (08/01/2026) Farmers Pond – 2.1m Fairway Pond – 4.75m

Farmers Field Pond	**8th Fairway Pond**	**Description**
		Pond gauge boards following completion of the combined constant rate test (09/01/2026) Farmers Pond – 2.1m Fairway Pond – 5.1m

4 Pumping Test Analysis

4.1 AquiferWin32 Analysis – Constant Rate Test

AquiferWin 32 has been used to calculate the transmissivity and storage coefficient from the constant rate pumping tests at both the existing and new abstraction boreholes. Both constant rate pumping phases have been analysed using the Theis and Cooper Jacob Straight Line Methods.

Transmissivity values determined vary depending on the analysis methodology and weighting of the data used within the analysis. Where the **whole data range** of the constant rate test has been optimised, transmissivity values range as follows:

- **Existing Borehole -** 79.20m2/day (Neumann Partially Penetrating) to 80.76m^2/day (Theis Unconfined)
- **New Borehole –** 121.45m^2/day (Theis Unconfined) to 160m^2/day (Neuman Partially

Generally, early drawdown data is considered more representative of the aquifer as opposed to whole dataset or late dataset ranges. **Early data** transmissivity values have been modelled as follows:

- **Existing Borehole -** 83.84m^2/day (Neuman Partially Penetrating) to 103.58m^2/day (Theis Unconfined);
- **New Borehole –** 173.29m^2/day (Theis Unconfined) to 184.64m^2/day (Neumann Partially Penetrating)

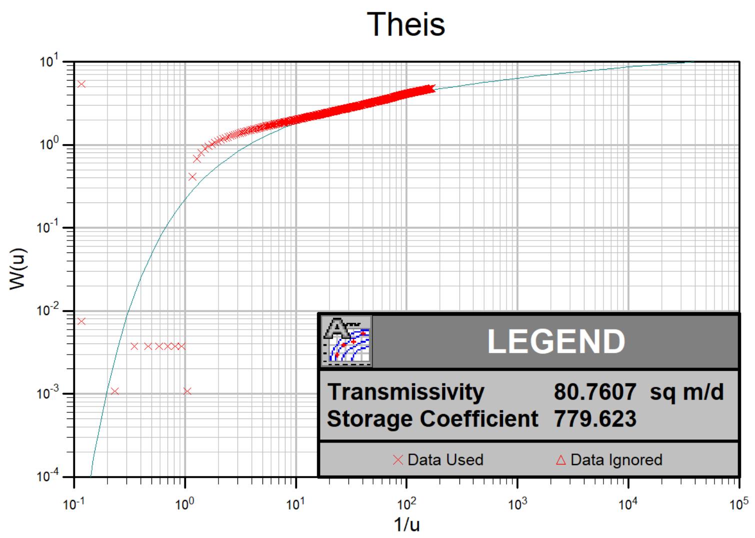
As the longer-term groundwater abstraction scenario at the Site will consist of abstraction from both the Existing Borehole and New Borehole simultaneously, **early data** from the combined constant rate test has also been utilised to provide transmissivity values for the underlying aquifer as follows:

- **Existing Borehole -** 83.26m^2/day (Neuman Partially Penetrating) to 95.29m^2/day (Theis Unconfined);
- **New Borehole –** 105.11m^2/day (Neuman Partially Penetrating) to 127.07m^2/day (Theis Unconfined)

A comparison between the combined constant rate test transmissivities and literature-based values is provided in Table 4-1.

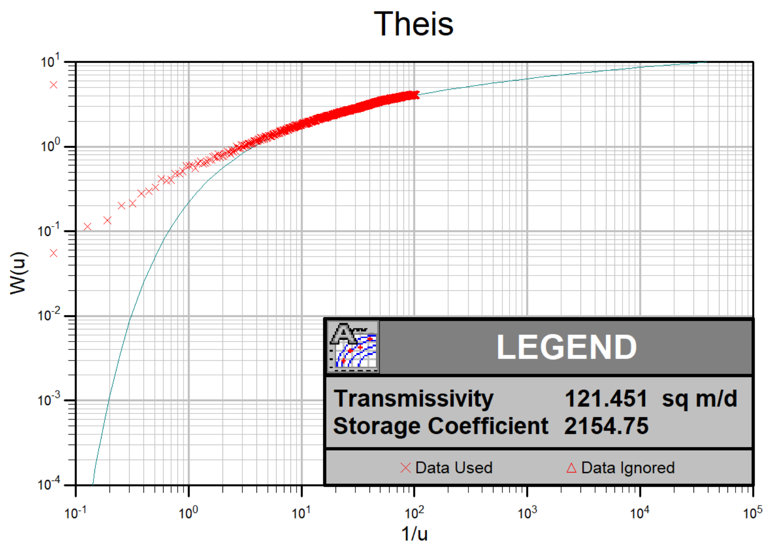
The physical Properties of Major Aquifers in England and Wales literature indicates that transmissivities from 6no. boreholes vary between 4m^2/day and 130m^2/day, with a geometric mean of 34m^2/day. No storage coefficient data from pumping tests exist for the aquifer, but calculations based on water level responses to rainfall suggest a specific yield of 0.06 – 0.08 in the upper 5m – 10m of the limestone, with values of 0.005 – 0.02 below this level.

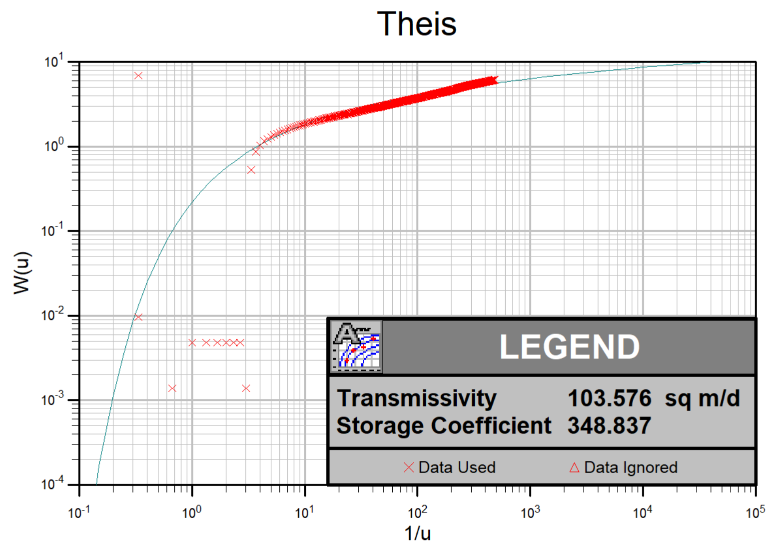
The Aquiferwin32 analysis outputs are presented below.



Theis – Unconfined Approximation – Whole Data Optimised

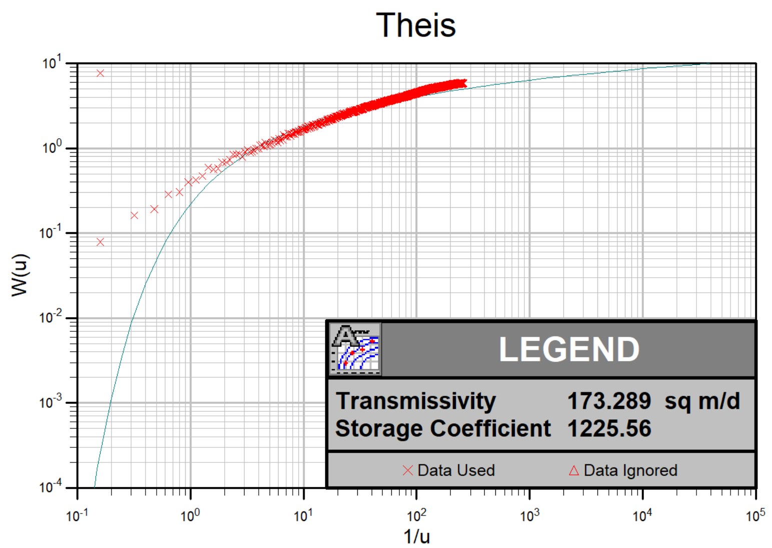
Existing Borehole – New Borehole

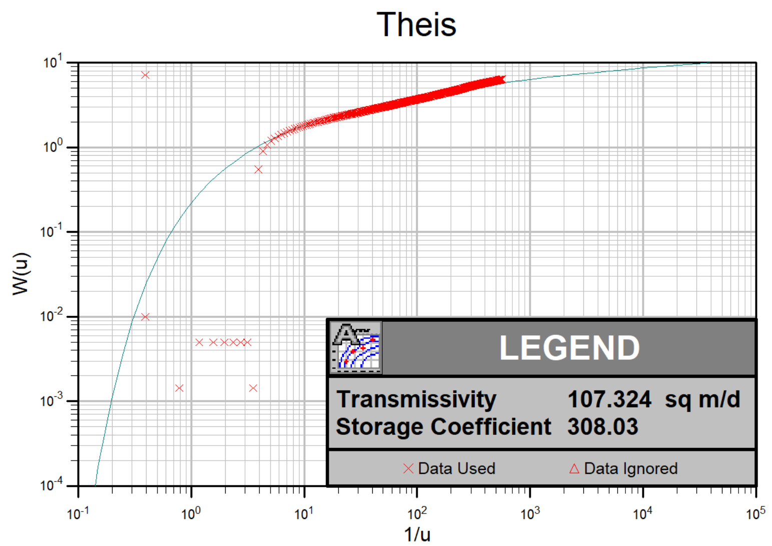




Theis – Confined Analysis – Early Data Optimised

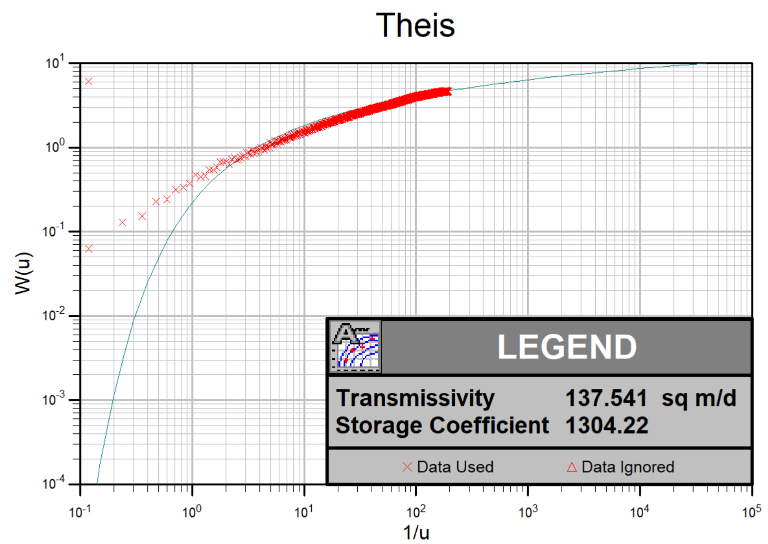
Existing Borehole – New Borehole

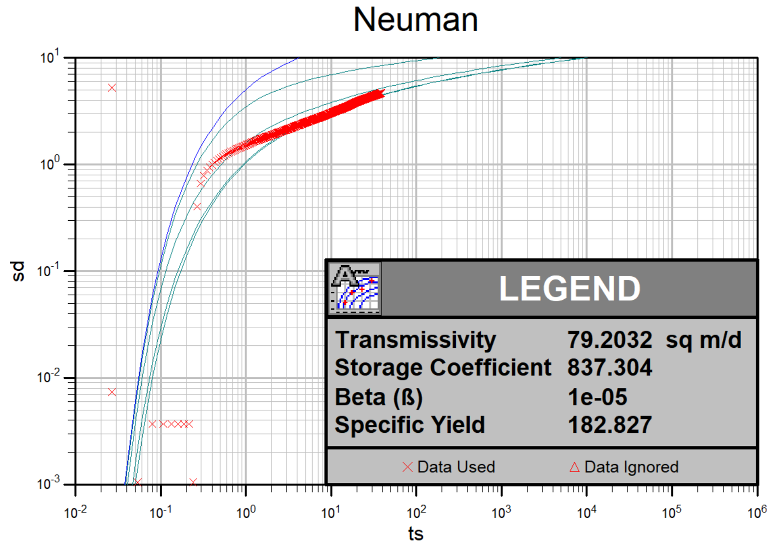




Theis – Unconfined Approximation – Late Data Optimised

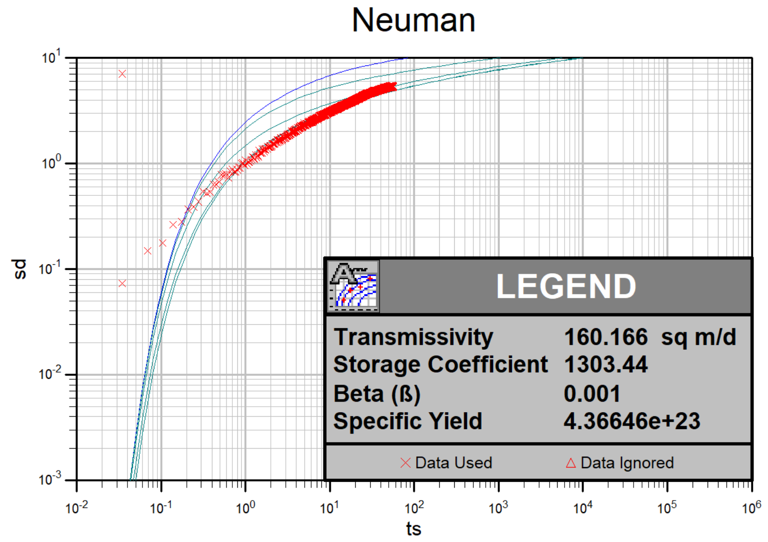
Existing Borehole – New Borehole

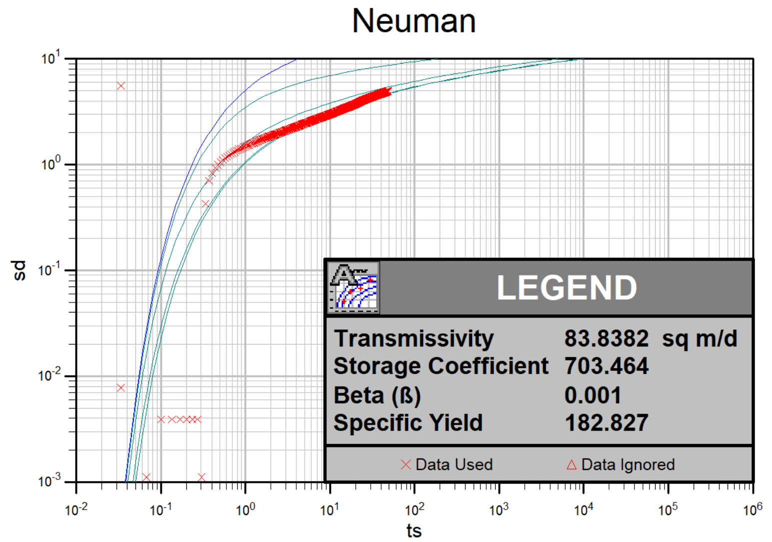




Neuman Unconfined Partially Penetrating– Whole Data Optimised

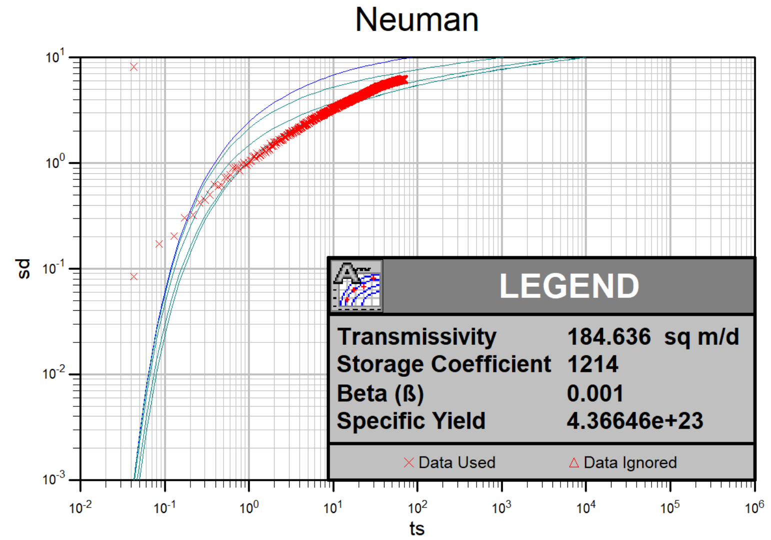
Existing Borehole – New Borehole

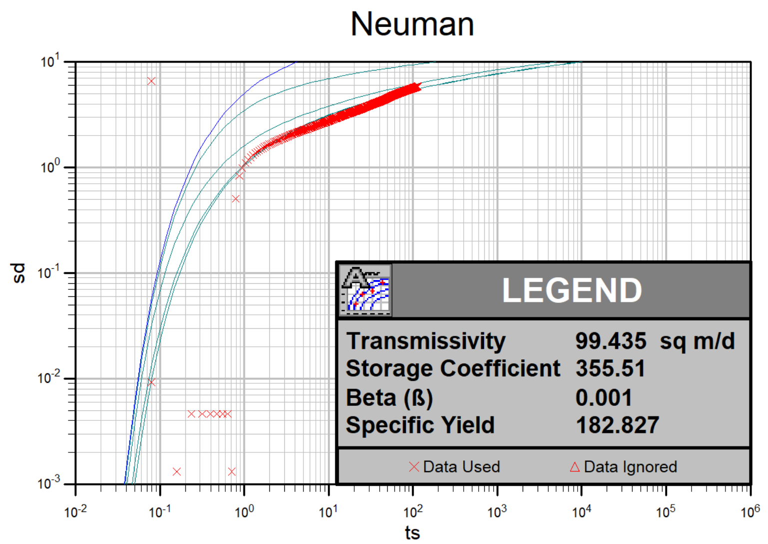




Neuman Unconfined Partially Penetrating– Early Data Optimised

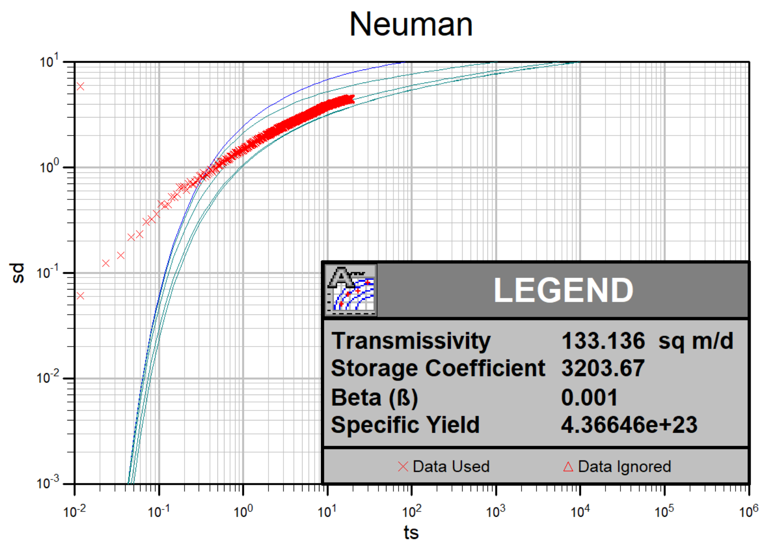
Existing Borehole – New Borehole





Neuman Unconfined Partially Penetrating – Late Data Optimised

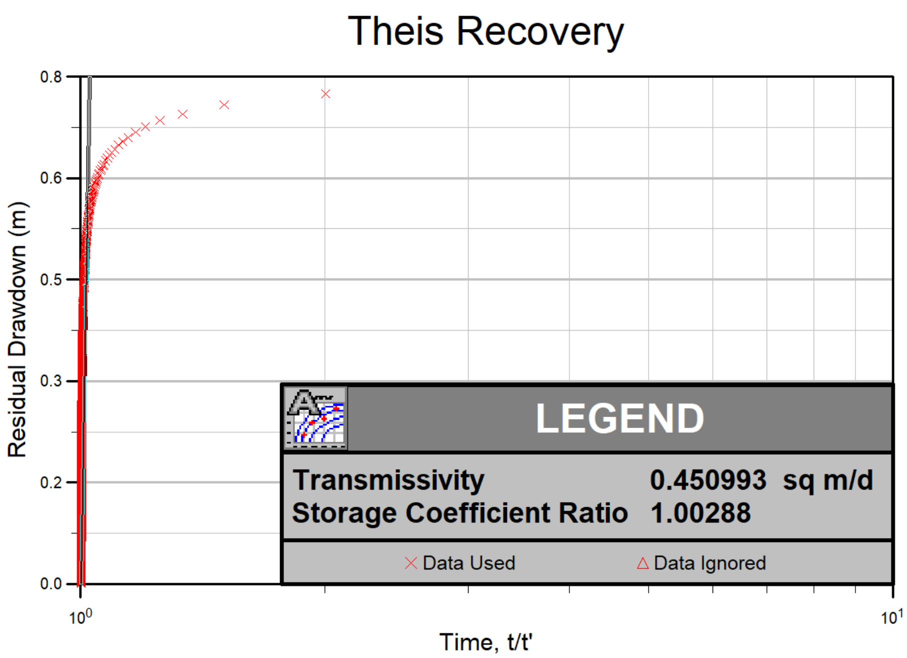
Existing Borehole – New Borehole



4.2 Existing Borehole – Recovery Phase

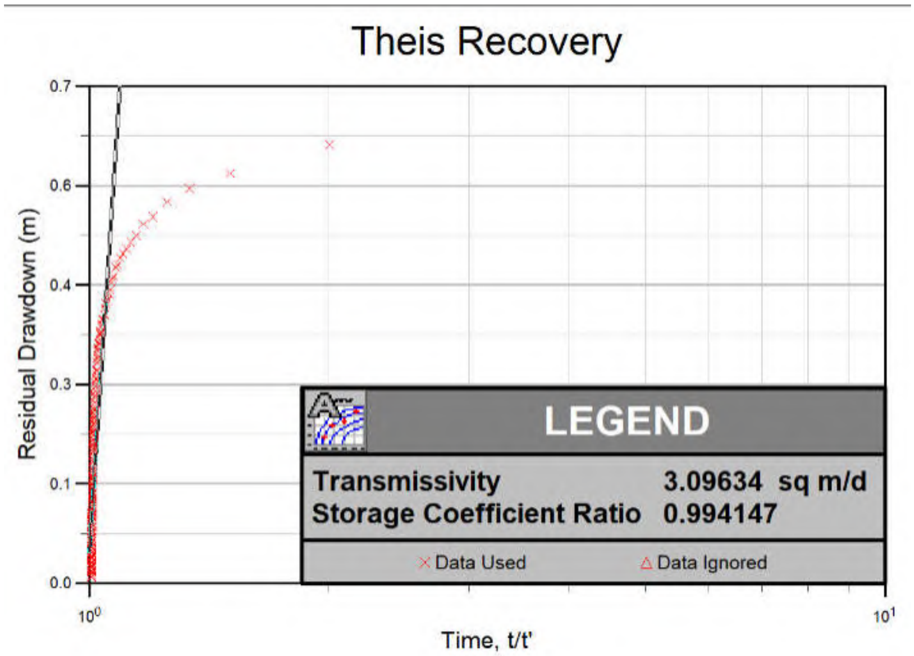
The recovery phase of the test was analysed in AquiferWin 32 using the Theis recovery method, shown in Figure 4-1.

Figure 4-1 Recovery test analysis - Theis

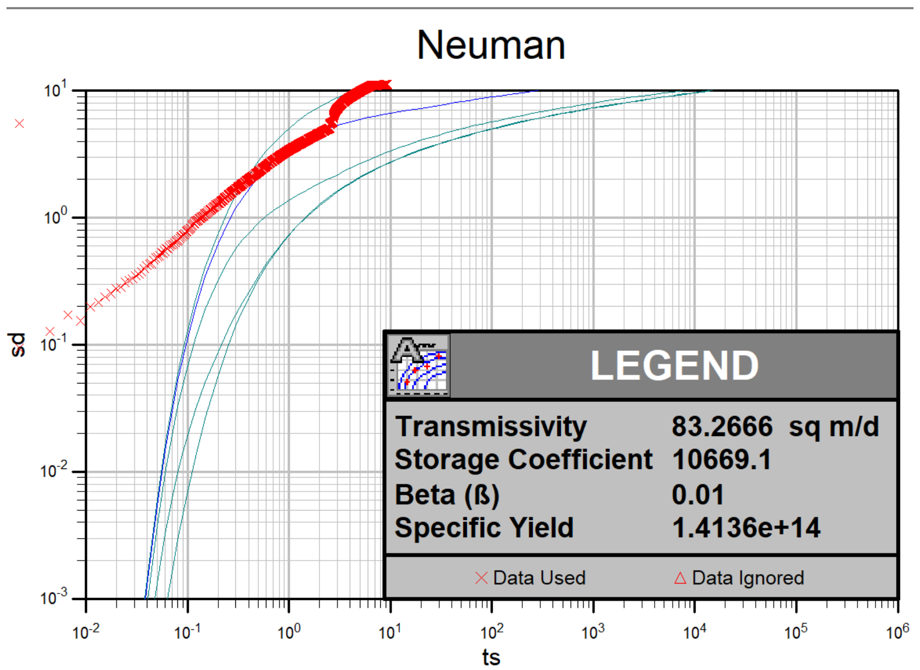


4.3 New Borehole Recovery Phase

Figure 4-2 New Borehole Theis Recovery

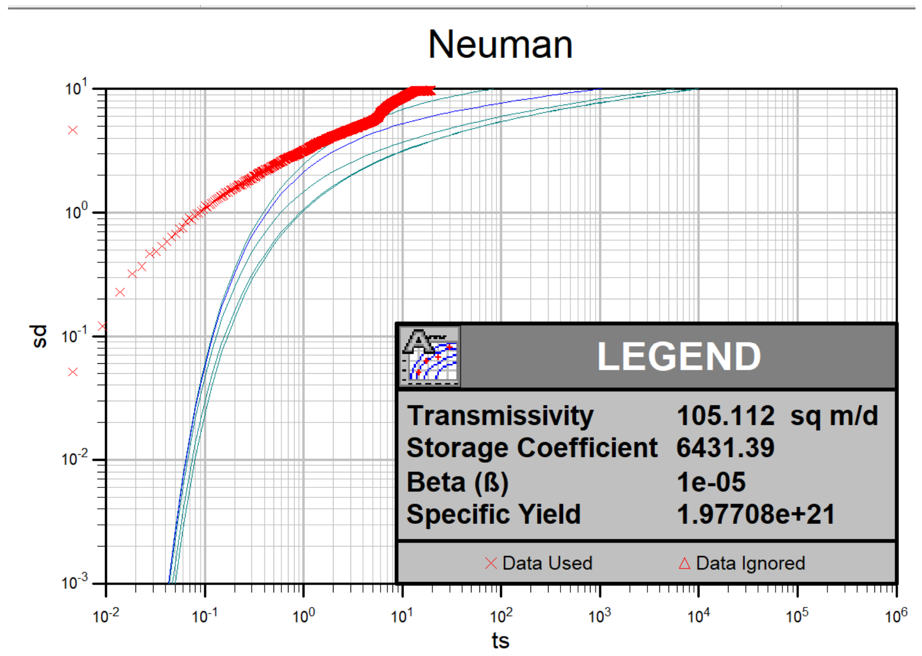


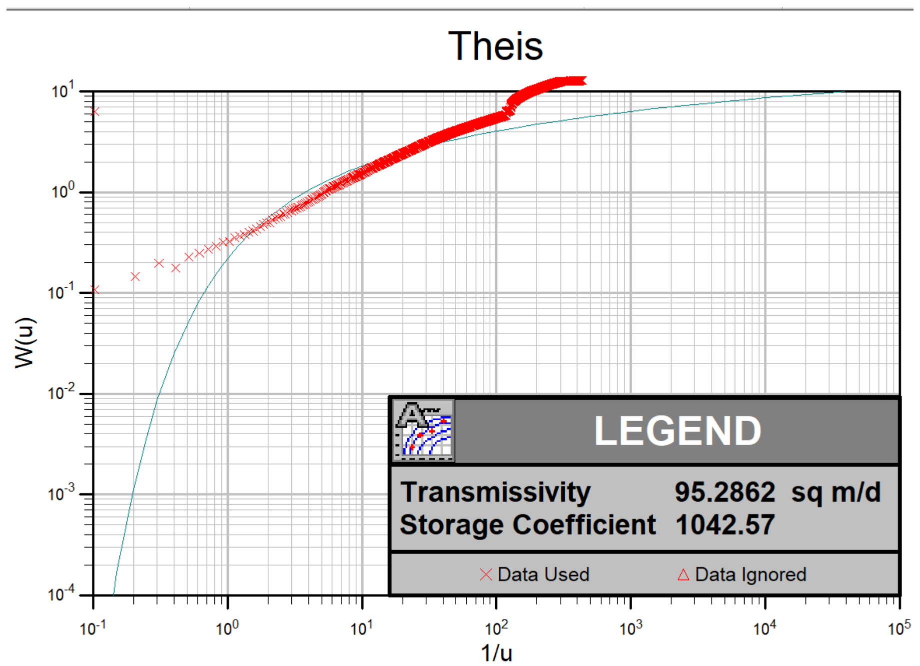
4.4 Combined Constant Rate Test Analysis



Neuman Unconfined Partial Penetration

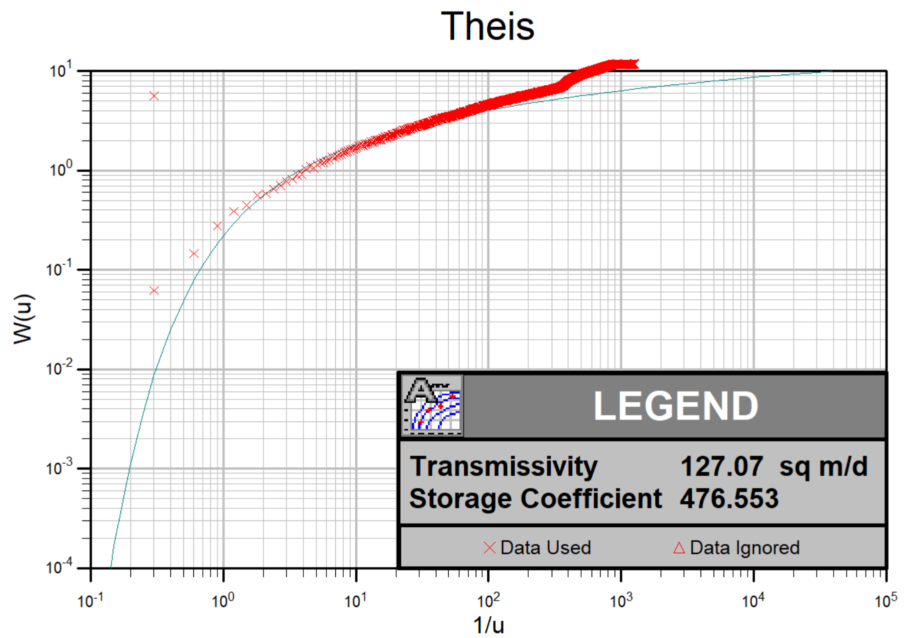
Existing Borehole – New Borehole





Theis Unconfined Approximation

Existing Borehole – New Borehole



4.5 Analysis Summary

The calculated aquifer transmissivities are presented in Table 4-1. The table presents the transmissivities calculated from the combined constant rate test as this testing scenario is representative of the longer-term abstraction proposal at the Site, with both boreholes operating simultaneously at a combined abstraction rate of 20m^3/hour.

Literature values from ’The Physical Properties of Major Aquifers in England and Wales’ to allow comparison to published aquifer properties.

Table 4-1 Comparison of Aquifer Properties

Source	Value
Transmissivity	
Combined Constant Rate Test (Existing Borehole) – Theis Unconfined Approximation	95.29m^2/day
Combined Constant Rate Test (Existing Borehole) – Neumann Confined Partially Penetrating	83.26m^2/day
Combined Constant Rate Test (New Borehole) - Theis Unconfined Approximation	127.07m^2/day
Combined Constant Rate Test (New Borehole) – Neumann Confined Partially Penetrating	105.11m^2/day
Literature value - Range	4m^2/day to 130m^2/day
Literature Value – Geometric Mean	34m^2/day.
Specific Capacity	
Existing Borehole – Specific Capacity (Combined Constant Rate Test)	67.3m^3/day/m
New Borehole – Specific Capacity (Combined Constant Rate Test)	126m^3/day/m

5 Hydrogeological Impact Appraisal

5.1 Introduction

This section of the report provides a Hydrogeological Impact Appraisal (HIA) following completion of pump testing of the abstraction boreholes, and monitoring of identified sensitive environmental receptors within the vicinity of the Site.

The HIA assess the following features in regard to potential impacts as a result of proposed abstraction at Pyle & Kenfig Golf Club.

- Saltwater Intrusion;
- Drawdown impacts on identified sensitive environmental receptors (Kenfig Pool, Farmers Field Pond and 8th Fairway Pond).

5.2 Saltwater Intrusion

As presented in Section 2.9 of this report, EC monitoring throughout the testing period of both boreholes has not identified the abstraction of any saline waters within the boreholes. Additional assessment has been carried out in this report section to address the longer-term pumping scenario at the Site, and the potential for future saltwater intrusion.

It is assumed that there will be a wedge of saline groundwater beneath fresh groundwater at coastal areas that reflects the influence of seawater and that there is an interface between fresh and saline groundwater. The Ghyben – Herzberg (H-G) relationship indicates that for every 1 meter of freshwater head above sea level in an unconfined coastal aquifer, there are approximately 40 meters of freshwater extending below sea level. This ration arises from the density difference between freshwater and saltwater.

The Formula is expressed as:

Formula: $$z = \frac{\rho_f}{\rho_s - \rho_f} h$$

- $\boldsymbol{z}$: Depth of the interface below sea level.
- $\boldsymbol{h}$: Height of the water table above sea level.
- $\boldsymbol{\rho_f}$: Density of freshwater (≈ 1.000 g/cm^3).
- $\boldsymbol{\rho_s}$: Density of saltwater (≈ 1.025 g/cm^3).

In terms of the site monitoring borehole at Pyle and Kenfig Golf Club, the existing borehole is closest to the coast and is understood to have been drilled and installed to 40 mbgl. The ground level at the borehole is approximately 27 mAOD. The rest groundwater level measured at site during the September 2025 groundwater monitoring was approximately 20.55 mbgl or approximately 6.45 mAOD.

$$z = \frac{1.000}{(1.025 - 1.000)} 6.45$$

Applying the Ghyben – Herzberg (H-G) formula to available site data would indicate that the depth of freshwater below sea level (z) would equate to 258 meters. In practice a 1-meter drop in the water table (due to pumping) could cause a 40-meter rise in the saltwater interface. The maximum drawdown observed during the pump testing on site resulted in a drawdown of 2m. As a basic approximation using the Ghyben – Herzberg principles, 2m drawdown in groundwater level could cause a 80m rise in the freshwater / saltwater interface. As a worst case scenario this would still indicate that the depth of freshwater below sea level (z) would equate to 178 meters.

Groundwater abstraction at the wells, produces an up-coning effect of the underlying saline groundwater. For saltwater up coning based on the Ghyben-Herzberg relationship, a commonly used form of the critical (maximum) pumping rate is:

$$Q_{\max} = \frac{2\pi K d^2}{\alpha}$$

Where:

- $Q_{\max}$ = maximum safe pumping rate (m^3/day)
- K = hydraulic conductivity (m/day)
- d = distance from well bottom to initial freshwater–saltwater interface (m)
- α = density ratio factor ≈ **40** (from Ghyben–Herzberg: $z \approx 40h$)

Based on hydraulic conductivity (K) ranges calculated from lowest to highest transmissivity we calculate a range of 4.3 – 6.5 m/day. With the distance from well bottom (40 mbgl) to the freshwater / saline interface calculated above being 218m we arrive at

Qmax of 32,100 – 48,500 m^3/day. This is far in excess of the volume which P&K are seeking to abstract at the site.

The Ghyben – Herberg up-coning approximation has been used to calculate the theoretical rise in saline interface from the K value range based on the desired abstraction of 421 m^3/day. The freshwater / saltwater interface rise would equate to 1.9 - 2.9m.

Pyle & Kenfig Golf Club are seeking in the order 421m^3/day to supply sufficient water for tee box, green and fairway irrigation. Waters are to be abstracted from the two on-site abstraction boreholes and stored within a new 500m^3 storage tank from where the water will be pumped out across the golf course. The golf course irrigation is proposed to occur through an 8-hour evening period as such groundwater abstraction in practice will be progressed intermittently in order to top up the holding tank.

Discontinuous abstraction will also allow the aquifer to recover and will further ensure that any effects of up-coning are limited

5.3 Drawdown Impacts on Sensitive Environmental Receptors

Monitoring of Kenfig Pool, on-site water features and the adjacent Farmers Field Pond during pump testing of both abstraction boreholes has not identified any changes in water levels associated with the groundwater abstraction at Pyle & Kenfig Golf Club. Water levels within these features appear to be controlled by rainfall volume and associated surface water inflows.

The abstraction boreholes have been constructed so that groundwater flows into the wells via slotted sections present within the underlying Oxwich Head Limestone Formation, with plain borehole liner positioned in the overlying Mudstones and superficial deposits (where present), therefore preventing the flow of water from any overburden into the boreholes.

Kenfig Pool is considered a large flooded sand dune-slack. The Pool has been subject to detailed investigation associated with quarrying and quarry extensions within nearby carboniferous limestones. Studies found little evidence of a hydraulic connection between the dune sand that supports Kenfig Pool and the underlying limestone bedrock. Groundwater flow modelling and dye tracer tests have indicated that the carboniferous limestone is not a significant source to the dune aquifer.

Available studies suggest some inflow to Kenfig Pool from perched aquifers on higher grounds immediately east may occur, but direct rainfall recharge to the dune sands system and the underlying and adjacent raised-beach aquifers are sufficient to sustain water levels within Kenfig Pool. A study of the hydrochemistry of Kenfig Pool also suggests that this water is almost entirely sourced from the Blown Sands, with small amounts of flow from ephemeral springs to the east.

6 Existing and Proposed Water Uses

6.1 Introduction

Pyle & Kenfig Golf Club has provided Hydrogeo with the existing groundwater abstraction license for the Site associated with the existing on-site abstraction borehole which has been used for irrigation of the golf course greens and tee boxes. The license was issued on 10th February 2017 and remains active until 31st March 2029.

This section of the report provides a summary of the previous abstraction volumes for the Site which gives an indication of the water usage volume across the golf course. The volumes will then be compared against the new required volumes to satisfy the upgrading of the golf course irrigation system to supply irrigation water to the fairways, as well as the greens and tee boxes.

6.2 Existing Water Use

The existing groundwater abstraction license (REF:21/58/33/0010/R001) allows for the licensed abstraction of 28,000m^3 of groundwater per season, abstracting from a borehole not exceeding 41 metres in depth and 150 millimetres in diameter. The season covers the period 1st March to 31st October.

Most recent abstraction returns provided to Hydrogeo by the client team – 2024 Season (1st March 2024 – 31st October 2024) indicates that a total volume of 5647m^3 was abstracted over the season, significantly less than the license limit of 28,000m^3.

Based on the Adrian Mortram Associates Ltd (AMA LTD) Proposed Irrigation System Specifications & Conditions Document – November 2022, the existing system currently requires a maximum of 168.2m^3/day for irrigation waters.

6.3 Proposed Water Use

The AMA LTD Document notes that the addition of the fairways to the irrigation schedule will require an additional 253m^3/day of water, bringing the daily total to 421m^3/day from the current 168.2m^3/day.

As part of the works a new irrigation storage tank and pump station will be located behind left of the 9th Hole. Water storage will consist of a 500m^3 (useable capacity) above ground storage tank.

7 Conclusions

Groundwater abstracted by both the existing and new abstraction boreholes on-site is drawn from the underlying Oxwich Head Limestone Formation which underlies the sub-cropping Conglomerate Marginal Facies of the Mercia Mudstone Group across the Site. The bedrock aquifers are confined by the presence of glacial till deposits at surface level across both borehole locations.

In accordance with the GIC both boreholes were initially subjected to a step-test with the existing borehole pump used within the existing golf course borehole. Step-testing indicated sustainable abstractions at ~8m^3/hour for the existing borehole, and rates between 12m^3/hour – 16m^3/hour for the new borehole. Both boreholes were then constant rate tested individually, and in combination at 8m^3/hour and 12m^3/hour respectively, providing a combined abstraction volume of 20m^3/hour.

Monitoring data analysed from identified water features in the vicinity of the abstraction boreholes, including; Kenfig Pool SAC & SSSI, 8th Fairway Pond, 10th Tee Box Pond and Farmers Field Pond has not identified any notable response as a result pump testing.

Monitoring of electrical conductivity throughout the individual borehole testing indicated no sharp increases to electrical conductivity that would indicate potential saline intrusion. Reductions in EC were recorded during the combined constant rate test as groundwater flow was dominated by higher transmissivity, better flushed portions of the underlying aquifer.

Continuous pumping of both abstraction boreholes over a period of approximately 72 hours resulted in a maximum drawdown of 2.03m at the existing borehole and 2.11m at the new borehole.

Calculations and modelling of saline intrusion and up-coning were progressed based on site data and expected maximum abstraction volume of 421m^3/day. Ghyben – Herberg up-coning approximation calculated that the freshwater / saline water interface would rise by approximately 1.9m – 2.9m. It is therefore considered unlikely that any up-coning impacts will occur as a result of groundwater abstraction at the Site.

The proposed irrigation system will irrigate the golf course through an 8hr period during the evenings with water drawn from a 500m^3 holding tank. This will ensure that boreholes are not pumped continuously for extended periods of time. When pumping is required, intermittent pumping intervals can be implemented. A carefully structured pumping regime will help minimise the potential of any up-coning of saline groundwaters. The groundwater abstraction boreholes have been installed with permanent dip tubes and the golf club have purchased a Water Conductivity Meter. Given the sensitivity of the site setting it is proposed that groundwater level and quality (conductivity) is routinely monitored at site..

Aquifer parameters have been derived from the combined constant rate test pumping data at both the existing and new abstraction boreholes using AquiferWin32. Transmissivity results were found to be toward the high end published literature value range (4m^2/day to 130m^2/day), with calculated transmissivities of 95.29m^2/day (existing borehole) and **127.07m^2/day** (new borehole).

The specific capacity for each borehole has been calculated as follows:

- **Existing Borehole –** 67.3m^3/day/m;
- **New Borehole -** 126m^3/day/m

Based upon the testing completed, and associated monitoring of identified water features within the vicinity of the Site, Hydrogeo believe that combined abstraction of 20m^3/hour, consisting of 8m^3/hour at the existing borehole and 12m^3/hour at the new borehole does not result in any extensive drawdown impacts on the underlying aquifer, or have any impacts on surrounding sensitive water features, including Kenfig Pool SSSI/SAC and on-site features including the 8th Fairway Ponds, 10th Tee Box Pond and the off-site Farmers Field Pond.

This Hydrogeological Impact Appraisal and Groundwater Pumping Test Report will be issued to Natural Resources Wales (NRW) to support the application for the new abstraction borehole supplementing the existing abstraction license at Pyle & Kenfig Golf Club.

Drawings

Drawing 1

Bedrock Geology Map

HYDROGEO

HYG1303 Pyle & Kenfig Golf Club

DRAWING 1
Bedrock Geology Map

KEY

- Borehole Positions
- Mercia Mudstone Group - Conglomerate
- Oxwich Head Limestone Formation
- Fault

Contains Bing Satellite imagery
© Microsoft [2026]

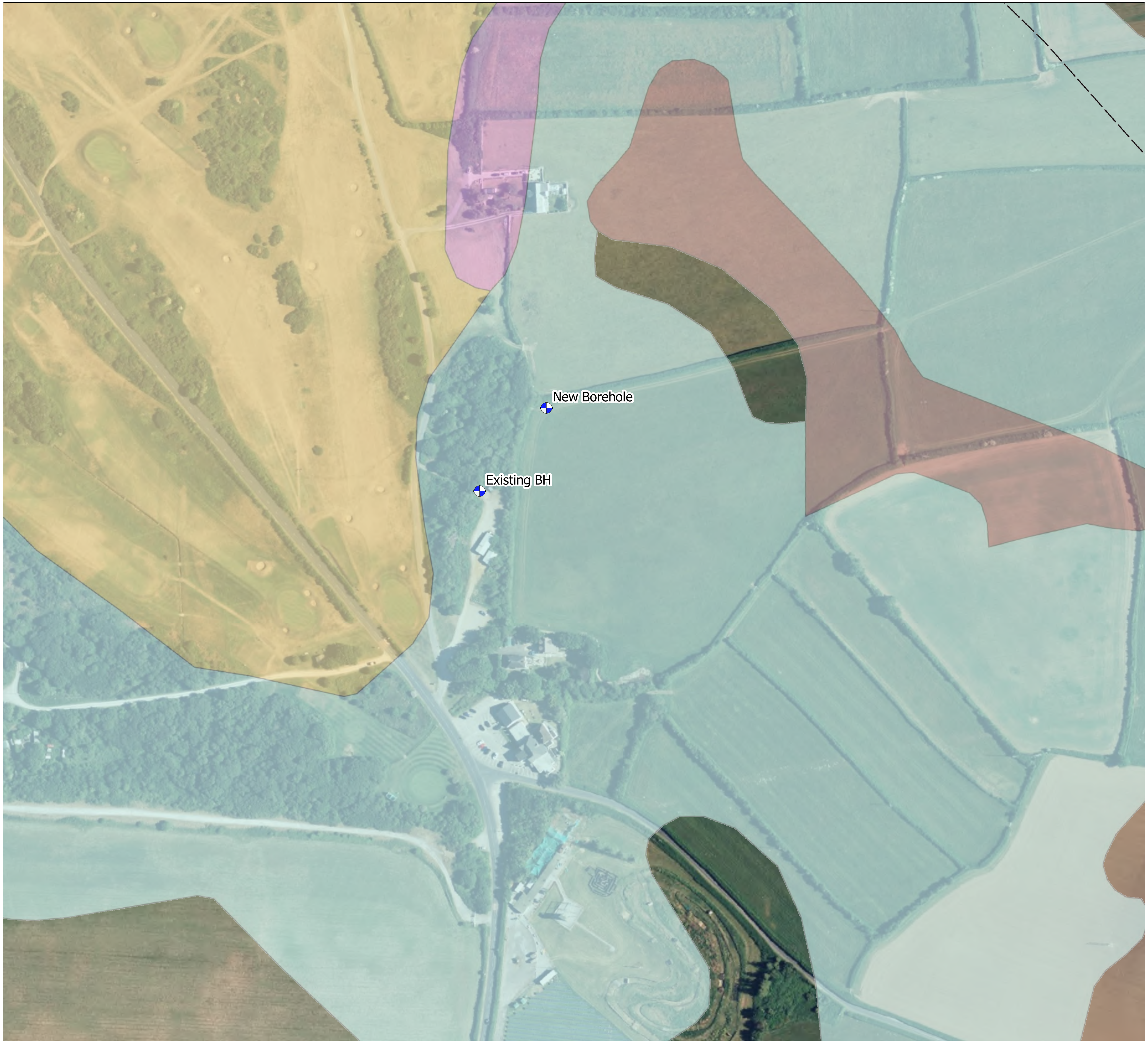
0 25 50 75 100 m

N

Date	By	Paper	Scale	Rev
03 2026	SG	A3	1:2500	1

Drawing 2

Superficial Geology Map



HYDROGEO

HYG1303 Pyle & Kenfig Golf Club

DRAWING 2
Superficial Geology Map

KEY

- Borehole Positions
- Fault
- Glacial Head
- Glacial Till
- Glaciofluvial Deposits
- Blown Sand

Contains Bing Satellite imagery
© Microsoft [2026]

0 25 50 75 100 m

N

Date	By	Paper	Scale	Rev
03 2026	SG	A3	1:2500	1

Appendices

Appendix A

APEX Drilling Borehole Log

APEX DRILLING SERVICES

DAILY DRILLING LOG

Tel: 01656 749149
E-mail: admin@apex-drilling.com

Contract Name: Pyle Kenfig Golf Club
Contract No: 14116
Date: 7. 11. 25.
Sheet 1 of 1. Working Day 3.

Client: Parkers
Order No: Simon
Drill Crew: G. Jones. A. Rees
Rig Type: Fraste. Kleman.

Bore Hole	Top Depth	Base Depth	Thickness	Recovery	Strata Description	Standing Time — Reason
1	Flush. BH clean.					
	extract 50.00 Mts. drill rods.					
	install. UPVC. Casing to. 50.00 Mts.					
	10.00	50.00	40.00		Slotted Casing with end Cap.	
	0.00	10.00	10.00		Plain Casing.	
		50.00			Gravel.	

INSTALLATION DETAILS

Borehole

Diameter .... Ø
Well Casing 10.00 m
Well Screen 40.00 m
Gravel .... m
Bentonite .... m
Gas Bung .... (No)
End Cap .... (No)
Cover Type RAISED / FLUSH
Water Level 14.00 m
Remarks ....

QUANTITIES

Site Moves .... (No)	Casing .... m	Core Boxes .... (No)	Fixed Plant ....
Bore Moves .... (No)	Open Hole .... m	Core Liner .... m	
Return Moves .... (No)	W. Samples .... m	SPT/CPT .... (No)	Standing Times .... (hrs)
Security YES / NO	Coring .... m	Installation 50.00 m	Breakdown .... (hrs)

British Drilling Association · ACM · UKAS
Certificate No: 08750A

Signed by Apex: G. Jones.
Signed by Client .... Date ....

Blue – Client's Copy Yellow – QS Copy White – Site Copy

APEX DRILLING SERVICES
DAILY DRILLING LOG
Tel: 01656 749149
E-mail: admin@apex-drilling.com

Contract Name: Pyle Kenfig Golf Club
Contract No: 14116
Date: 6. 11. 25.
Sheet: 1 of 1
Working Day: 2.
Client: Pokenfig
Order No: Smo-
Drill Crew: G. James. A. Rees
Rig Type: Klemm.

Bore Hole	Top Depth	Base Depth	Thickness	Recovery	Strata Description	Standing Time — Reason
4	30.00	50.00	20.00		Lime Stone Clay bands.	
	Flush BH clean. extract 50.00 Mts drill rods.					
	install. uPVC Casing to 23.00 Mts.					
	Due to obstruction at 23.00 Mts.					
	extract uPVC Casing.					
	Reinstall drill Rods. to 50.00 Mts.					
	Flush BH. Clean. 4. Hrs.					

INSTALLATION DETAILS

Borehole

Diameter .... Ø
Well Casing .... m
Well Screen .... m
Gravel .... m
Bentonite .... m
Gas Bung .... (No)
End Cap .... (No)
Cover Type RAISED / FLUSH
Water Level .... m
Remarks ....

QUANTITIES

Site Moves .... (No)	Casing 20.00 m	Core Boxes .... (No)	Fixed Plant ....
Bore Moves .... (No)	Open Hole .... m	Core Liner .... m	
Return Moves .... (No)	W. Samples .... m	SPT/CPT .... (No)	Standing Times .... (hrs)
Security YES / NO	Coring .... m	Installation .... m	Breakdown .... (hrs)

Signed by Apex: G. James.
Signed by Client .... Date ....

Certificate No: 08750A

Blue – Client's Copy   Yellow – QS Copy   White – Site Copy

APEX DRILLING SERVICES
DAILY DRILLING LOG
Tel: 01656 749149
E-mail: admin@apex-drilling.com

Contract Name: Pyle Kenfig Golf Club.
Contract No: 14416
Date: 5. 11. 25.
Sheet 1. of 1. Working Day 1

Client: [illegible]
Order No: [illegible]
Drill Crew: G. James. A. Rees.
Rig Type: Klemm.

Bore Hole	Top Depth	Base Depth	Thickness	Recovery	Strata Description	Standing Time — Reason
1	Move to Site				BH Cased to 9-00 mts.	
	Move to BH 1.					
	0.00	7.20	7.20		Clay.	
	7.20	11.80	4.60		Lime Stone. Clay bands.	BH wet
	11.80	13.80	2.00		Cavity.	from 19.80 Mts
	13.80	15.60	1-80		Lime Stone.	
	15.60	16.00	0.40		Broken Lime Stone.	
	16.00	30.00	14.00		Lime Stone. Clay bands.	

INSTALLATION DETAILS

Borehole

Diameter ....Ø
Well Casing ....m
Well Screen ....m
Gravel ....m
Bentonite ....m
Gas Bung ....(No)
End Cap ....(No)
Cover Type RAISED / FLUSH
Water Level ....m
Remarks ....

QUANTITIES

Site Moves 1 (No)	Casing 9-00 m	Core Boxes (No)	Fixed Plant
Bore Moves 1 (No)	Open Hole 30.00 m	Core Liner m	
Return Moves (No)	W. Samples m	SPT/CPT (No)	Standing Times (hrs)
Security YES / NO	Coring m	Installation m	Breakdown (hrs)

BRITISH DRILLING ASSOCIATION
ACM UKAS
Certificate No: 08750A

Signed by Apex: G. James

Signed by Client .... Date ....

Blue – Client's Copy Yellow – QS Copy White – Site Copy

Appendix B

Pumping Test Monitoring Results (electronic)