

Survey of Cefn yr Ogof

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The Team:

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1) Introduction

Cefn yr Ogof (Hill 7525, Section 30C, OS 1:50000 Map 116, OS 1:25000 Map 264N, Grid Ref SH916773) is situated in North Wales near Abergele and above the village of Rhyd-y-foel. It is listed as a HuMP with a drop of just 101m. (A HuMP is any hill in England, Scotland, Wales, Isle of Man and Ireland with a minimum drop of 100m). The value of drop has been measured from maps with the summit value derived from a spot height (205m) and the bwlch from interpolation of contours supported by a nearby 102m spot height on a road that passes very close to the bwlch. Consequently there is a significant chance that the drop could be less than 100m.

The purpose of this survey was to measure the drop for Cefn yr Ogof and thus clarify its status.

2) Equipment used and Conditions for Survey

Ground surveys to determine the positions of the bwlch and summit were carried out using a Leica NA730 Professional Automatic level (X30 telescopic system)/tripod system and a “1m” E-staff extendable to 5m.

Absolute heights were measured using a Leica Geosystems Viva GS15 Professional receiver and a Trimble GeoXH 6000 receiver. Both instruments are dual-frequency, multi-channel instruments, which means they are capable of locking on to a maximum of 12 GPS and 8 GLONASS satellites as availability dictates, and receive two signals (at different frequencies) from each of these satellites. The latter feature reduces inaccuracies that result from atmospheric degradation of the satellite signals. As stand-alone instruments they are capable of giving position and height to an accuracy of about two metres and five metres respectively. Note that small hand-held GPS receivers used for general navigation can only receive up to 12 GPS satellites and each at a single frequency and therefore these instruments have a poorer positional accuracy of +/-5metres and a height accuracy of no better than +/-10 metres. Some recently produced hand held GPS Garmin receivers can also receive signals from GLONASS satellites which greatly improve the speed at which these units can achieve a satellite “fix”. Despite the on-board features of the Viva GS15 and GeoXH 6000 receivers, there are still sources that create residual errors. To obtain accurate positions and heights, corrections were made to the GNSS (Global Navigation Satellite System) data via imported RINEX data from the Ordnance Survey which were post-processed using Leica Geo Office 8.3 software for the GS15 data and Trimble GPS Pathfinder Office processing software for the GeoXH 6000 data.

Conditions for the survey, which took place between 11.00hr and 16.00hr, were fair. The weather was overcast at the beginning of the survey, but sunny periods developed during the

day and the cloud-base was always above the summit of the hill. The temperature was 5 degrees Celsius, although it much felt colder in the moderate wind.

3) **The Survey**

3.1) **Character of Hill**

Cefn yr Ogof is only 205m high according to the map, but limestone scree and outcrops seen from the West give the impression of a higher hill. From the main A55 coast road the steep Northern flanks of the hill are clad in mixed deciduous and conifer woodland and set within the trees is a stone tower, a folly that enhances the character of the landscape from this viewpoint. The hill may be climbed from the North following the edge of the forest. For this survey parking at Rhyd-y-foel was chosen and from there the minor road to the bwlch between Cefn yr Ogof and Penycorrdyn-mawr was followed on foot. We were given permission to access a small caravan park off the private track to Henblas which gave access directly to the upper slopes of the hill. The summit comprises a trig point and just a few metres North-West of it are the remains of an ancient tumulus. Protruding from this is a large limestone boulder. Just to the North-East and slightly down the hill from the trig point there is a fence that encloses woodland. The trees do not significantly block the sky as seen from the summit and so did not interfere with satellite reception.

3.2) **Summary of Survey Method**

The position of the bwlch lies just to the North of the minor road that runs from the Dulas valley to the A548 one kilometre South of Abergele. It is located in a field of short grass and a footpath crosses the field both at its West and East ends. In the hill to hill direction (approximately NNE-SSW) it was quite narrow and by eye could be seen to be less than 30m across. In the valley to valley direction (approximately WNW-ESE) it was flatter for about 60m in this direction. From here the ground fell slightly and then rose to another high point about 80m NNE. To the unaided eye this second point appeared lower. Sightings through the level quickly showed this to be correct and so the survey concentrated on the first and larger area. A grid of flags was laid down with each 10m from its neighbours and orientated in the approximate summit-summit and col-col directions. The position of the bwlch was then determined as described in previous reports. A sub-grid of 5m side was used in the final determination of location.

The summit of the hill required minimal measurement with level and staff. Readings were taken from the top of the boulder, the ground at the base of the tumulus, the flush bracket and the base of the trig point. A tape was used to measure the distance between the top of the trig point and the flush bracket.

The absolute heights of the summit and the bwlch were measured with the Leica Viva GS15 receiver and the Trimble GeoXH 6000 receiver with data from both GPS and GLONASS satellites being collected. The GS15 was set up with tripod support to hold it firmly over the point to be measured. At the bwlch it was mounted on a 2m pole and at the summit it was fixed to the tripod with a clamp and tribrach (the "short tripod" configuration). Its height above the ground was measured with an integral tape measure. For all locations the GeoXH 6000 was put directly on to the feature to be measured. Data were collected by the GS15 for an hour with an epoch time of 15 seconds on both the summit and the bwlch. Data were collected by the GeoXH 6000 for 16min at the bwlch, for 5min and 30min on the trig point and for 10min on the summit boulder. An epoch time of 1sec was used at each position.

3.3) The Bwlch

The bwlch was surveyed with level and staff as described in Section 3.2 and we are confident this was achieved to within +/-0.05m of height.

The ten-figure Grid References for the bwlch were:-

Garmin Montana 600	SH 93550 75712	Height = 98m
Garmin Etrex 20	SH 93544 75715	Height = 103m
Magellan Explorist 100	SH 93552 75706	Height = 111m
Garmin Oregon 450	SH 93555 75710	Height = 109m

The Leica Viva GS15 was set up on a 2m pole at a convenient position prior to the start of the survey which proved to be about 5m North of the bwlch position. The Trimble GeoXH 6000 was laid on the ground at the bwlch position.

The position and height data for the bwlch that were recorded by the Leica Viva GS15 and post-processed with Leica GeoOffice 8.3 using imported OS RINEX data for the seven nearest base stations and the Hopfield model for tropospheric correction are given in the table below. Results for the Trimble GeoXH 6000 processed in Trimble GPS Pathfinder Office using the five nearest base stations are likewise given in this table:-

System	Easting	error(1SD)	Northing	error(1SD)	Height(m)	error(1SD)
GS15	293554.532	0.002	375706.642	0.002	102.837	0.006
GeoXH 6000	293547	<0.05	375706	<0.05	102.870	<0.05

Staff readings to the GS15 and the bwlch were:

GS15 set-up position = 1.947m

Bwlch = 1.945m

The height of the bwlch is $102.837+0.002 = 102.839\text{m}$

3.4) Summit of Cefn yr Ogof

The exact position of the summit was established using the level and staff as described in Section 3.2 and is the top of a large embedded boulder. This boulder is about 5m North-West of the trig point.

The ten-figure Grid References for the summit are:-

Garmin Map60CSx	SH 91690 77309	Height = 206m
Garmin Venture	SH 91687 77307	Height = 205m
Magellan Explorist	SH 91687 77305	Height = 211m
Garmin Oregon 450	SH 91686 77308	Height = 208m

The first three grid references were recorded on a visit in 2012.

The Leica Viva GS15 was set up on the summit position using the “short tripod” configuration described above. The vertical offset from measuring point to the ground was 0.181m (see photograph) plus 0.255m for the tribrach/hook system. The Trimble GeoXH 6000 was placed directly on the summit and also on the trig point

The position and height data for the summit that were recorded by the Leica Viva GS15 and post-processed with Leica GeoOffice 8.3 using imported OS RINEX data for the seven nearest base stations and the Hopfield model for tropospheric correction are given in the table below. Results for the Trimble GeoXH 6000 processed in Trimble GPS Pathfinder Office using the five nearest base stations are likewise given in this table:-

System	Easting	error(1SD)	Northing	error(1SD)	Height(m)	error(1SD)
GS15	291684.239	0.003	377301.489	0.002	204.432	0.013
GeoXH 6000	291684	<0.05	377301	<0.05	204.428	<0.05
GeoXH 6000 TP (5min)	291689	<0.05	377301	<0.05	204.738	<0.05
GeoXH 6000 TP (30min)	291689	<0.05	377300	<0.05	204.753	<0.05

From the set-up position of the level, staff readings for the following features were:

Summit boulder = 0.114m

Flush bracket of trig point = 0.609m

Base of trig point = 0.959m

Base of tumulus at highest natural ground = 0.788m

Flush bracket to top of trig point = 0.875m (measured with tape)

For Leica Viva GS15:

Height of flush bracket = $204.432 + 0.114 - 0.609 = 203.94\text{m}$.

For Trimble GeoXH 6000:

Height of flush bracket = $204.738 - 0.875 = 203.86\text{m}$ (5min dataset)

Height of flush bracket = $204.753 - 0.875 = 203.88\text{m}$ (30min dataset)

(Ordnance Survey lists the height of the trig point flush bracket as 203.97m and our measurements are in good agreement with this value)

The ground at the base of the tumulus is $204.432 + 0.114 - 0.788 = 203.76\text{m}$, that is 0.67m lower than the summit.

The drop is measured to be $204.432 - 102.839 = 101.59\text{m}$

4) Summary of Operating and Process Conditions

	GS15	GeoXH 6000
Data Collection bwlch (min)	60	16
Data collection summit (min)	60	10
Number of Base Stations used in Processing for all points	7	5
Epoch Time (sec)	15	1
Tropospheric Model	Hopfield	Unknown
Cut off Angle (degs)	15	0

5) Discussion of Results

The largest measurement uncertainty was associated with the location of the bwlch ($\pm 0.05\text{m}$) and the instrumental measurements ($\pm 0.06\text{m}$ for the Leica Viva GS15) for summit and bwlch. Therefore the overall uncertainty in drop measurement for the hill is no more than $\pm 0.10\text{m}$.

The drop measurement is $101.59 \pm 0.10\text{m}$ calculated from the Leica GS 15 data and therefore Cefn yr Ogof does achieve the 100m required to retain its HuMP status.

Although the limestone rock identified within the pile of stones at the summit was considered to be a natural feature, there is the possibility that it had been placed there when the summit pile of stones had been constructed. Staff measurements taken around the edge of the pile of stones showed the ground there to be 0.67m lower and the drop from this point would be 100.9m . Therefore the status of the hill would not change even if the limestone rock were excluded from the survey.

The drop calculated from the measurements made by the Trimble GeoXH 6000 is 101.6m and therefore is in excellent agreement with the Leica GS15 derived value.

6) Summary and Conclusions

The **summit** of **Cefn yr Ogof** is at grid reference * SH 91688 77307 and is a large boulder 5m North-West of the trig point. Its height is **204.4m** .

The **bwlch** for Cefn yr Ogof is at grid reference *SH 93547 75711. Its height is **102.9m** .

The **re-ascent** from the **bwlch to the summit** is **101.6m** and therefore **Cefn yr Ogof retains its HuMP status.**

* NB average hand-held Garmin/Magellan GPS grids are quoted in the summary.

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Appendix

View of GS15 set-up at bwlch on 2m pole



GeoXH 6000 at bwlch position



View of GS15 set up on summit boulder



Photograph of tape reading at summit set-up position

