

Survey of Littleton Down

05 November 2014

The Team: John and Jenny Barnard

1) Introduction

Littleton Down (Hill Number 2911, Section 42, OS 1:50000 Map 197, OS 1:25000 Map 121, Grid Ref. SU941150) is listed as a sub Marilyn in the Database of British and Irish Hills with just 149m of drop.

The purpose of this survey was to measure accurately the drop for Littleton Down. If the drop were to exceed 150m then Littleton Down would be reclassified as a Marilyn.

2) Equipment used and Conditions for Survey

A Leica NA730 Professional Automatic level (X30 telescopic system)/tripod system and a “1m” E-staff extendable to 5m were used to determine the positions of the col and summit.

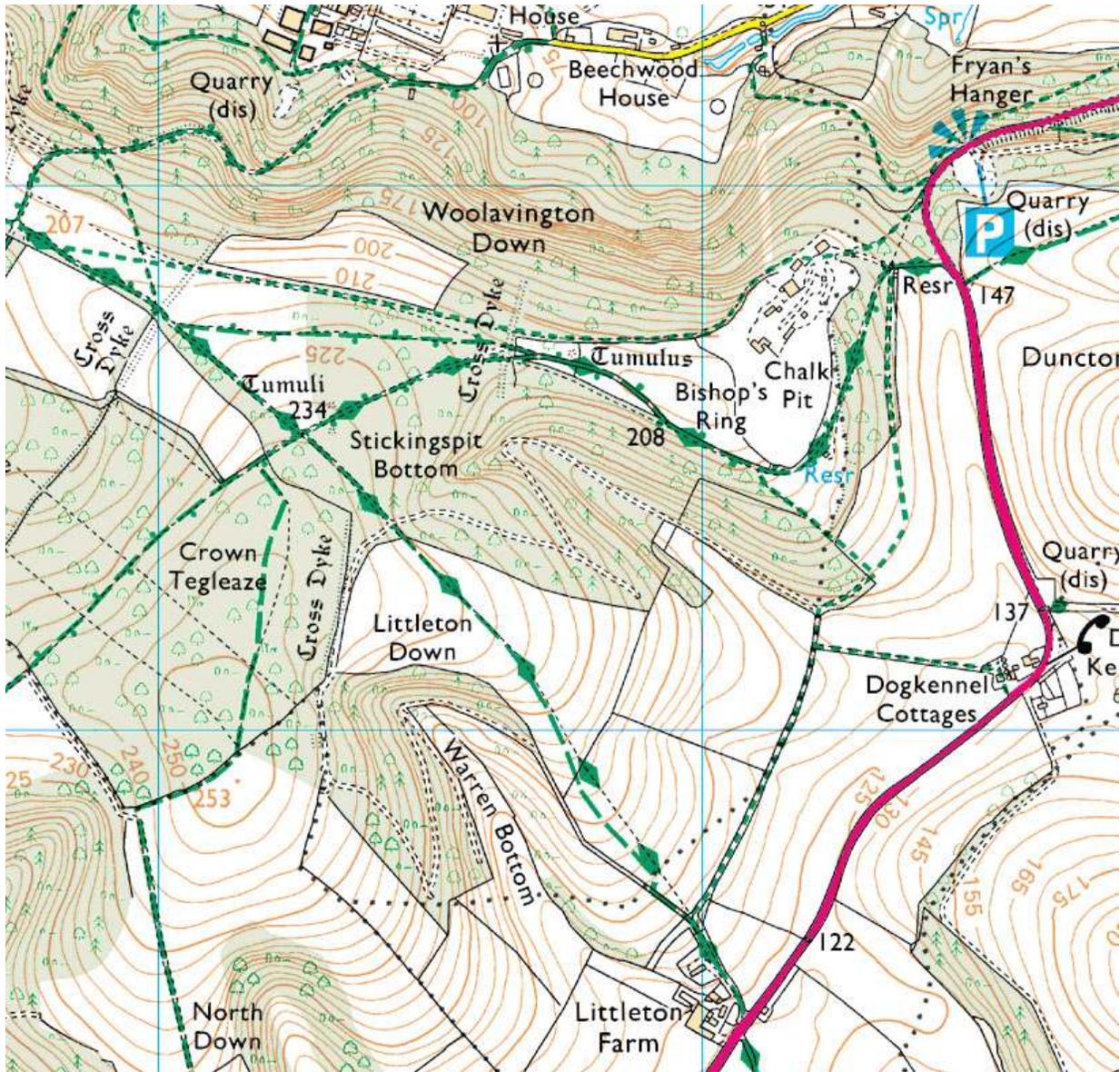
Absolute heights were measured using a Leica Geosystems Viva GS15 Professional receiver. This instrument is a dual-frequency and multi-channel instrument, which means it is capable of locking on to a maximum of 12 GPS and 8 GLONASS satellites as availability dictates, and receive two signals (at different frequencies) from each of these satellites. The latter feature reduces inaccuracies that result from atmospheric degradation of the satellite signals. As a stand-alone instrument it is 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, 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.

Conditions for the survey, which took place between 11.00hr and 17.00hr GMT were good. The weather was mild, sunny, 10-15 degrees Celsius with a very light wind and visibility was excellent. Although work with level and staff at the col was carried out in fading daylight the GNSS data were collected in the dark and therefore no useful photographs were taken of the col area.

3) The Survey

3.1) Character of Hill

Littleton Down is situated in the South Downs just south of the “South Downs Way” and about 9km South South West of the Sussex village of Petworth. An extract from the 1:25000 scale OS map is shown below.



This part of England is characterised by rolling countryside largely comprising chalk down land. Littleton Down is no exception and indeed there is a chalk pit about 1km North East of the hill. The whole area is extensively wooded with deciduous trees which shelter a dense understorey thus making access quite difficult unless one stays on the footpaths of which there are many. In between the wooded areas there is farm land either put down to grass or root crops.

Access to the hill can be gained from a number of directions. To the North East of Littleton Down on the A285 there is a viewing point with a car park. From there a wide, but very wet at the time of the survey, track leads around the South side of the chalk pit. After about 1.5km, another track leads SSE through woods to the summit of the hill. Just near the summit there is a War Memorial set up in memory of the crew of a Lancaster Bomber from 617 Dambuster Squadron.

The critical col for Littleton Down is about 7km WNW of the hill, just South of the small village of Cocking. This area is agricultural land and although the South Downs Way runs East to West here giving easy access, the col lies on private land and permission, which was granted, was obtained

from the landowner at the adjacent farm. There is a car park on the West side of the road just South of the junction where the South Downs Way crosses the A286 and this gives convenient access to the col.

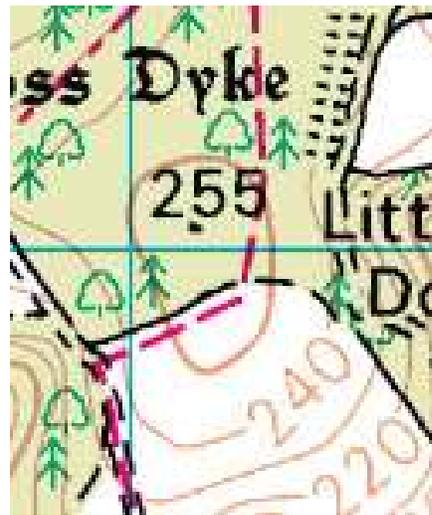
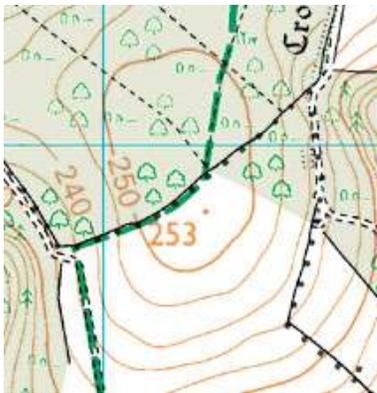
3.2) Summary of Survey Method

The survey commenced at the summit where its position was found using level and staff. Since the highest point was located within trees, the Leica GS15 was set up in a field to the South with a height correction made from this point to the summit.

The survey then continued at the col where a visual inspection indicated that the col lay in the field on the South side of the South Downs Way. Since the slope of the ground may have been visually misleading, a grid of flags was set up in this field and the level and staff was used to take height measurements from them. These measurements indicated that the col was adjacent to a tall hedge and so the GS15 was set up some distance from this point to ensure that satellite reception was not impaired. A height correction was made from this point to the col.

3.3) The Summit

Below are extracts from the 1:25000 and 1:50000 Ordnance Survey maps of the summit of Littleton Down that have been reproduced to approximately the same scale. The 1:25000 map shows a spot height of 253m, assumed to be the summit, which is in a field south of the wood's boundary. However, the 1:50000 map indicates that the spot height of 255m, which again is assumed to be the summit, is further to the North within the wood and about 150m North West of the 253m spot height.



The Leica NA730 level was set up on a tripod adjacent to the war memorial and staff readings were taken systematically in the field to the South. All these readings showed that the ground sloped down to the South and the 253m spot height marked on the 1:25000 OS map could not be the highest point of Littleton Down. Staff readings were also taken in a West to East direction in the scrub on the edge of the wood and the area around the war memorial was measured to be the highest point on this line. However, from this point it was not possible to see into the wood because

this area was shielded by high vegetation. Therefore the Leica NA730 was moved further to the West directly opposite a gap in the vegetation so that staff readings could be taken at the war memorial and to ground inside the wood. These readings showed ground within the wood to be higher.

Next the Leica NA730 was moved into the wood and set up at a convenient position to maximise visibility in all directions. A small ridge a few metres from it and running parallel to the wood' edge culminates at a high point. It is difficult to know if this ridge is the result of upturned ground due to a large tree being previously blown down – there were examples of this in the wood. However, there were no visible signs of trees being uprooted at this point and the composition of the ridge matched the surface surrounding it. Therefore the decision was made to include this as part of the hill. Staff readings were then taken and the highest point on this ridge was identified as the summit of the hill. The assumption that the 255m spot height on the 1:50000 OS map is the summit of the hill also seems to be incorrect. Although there were copious quantities of waist high brambles in the wood making it almost impenetrable for systematic staff measurements, ground to the North was clearly lower and descending and that was confirmed by additional staff measurements where possible. (Subsequently access to this area was attempted from further North in the wood and visually this confirmed that there was no higher ground to the North of the small ridge adjacent to the edge of the wood.)

The highest point on the small ridge was marked with a yellow flag. Then the NA730 level on its tripod was moved once again to opposite a break in the vegetation on the edge of the wood so that a height difference could be obtained through staff readings for the hill's summit and a convenient marked point out in the field to the South where the GS15 could be set up subsequently without obstruction of satellite reception caused by the trees. Finally the GS15 was set up at this point on the "short tripod" configuration and GNSS data were collected for 1 hour. Photographs of this and the hill's summit are shown in the Appendix.

The position and height data recorded by the Leica Viva GS15 were post-processed with Leica GeoOffice 8.3 using imported OS RINEX data for the ten nearest base stations under 100km distance and the Computed model for tropospheric correction. These results are given in the table below:-

| System | Easting | error(1SD) | Northing | error(1SD) | Height(m) | error(1SD) |
|---------------|----------------|-------------------|-----------------|-------------------|------------------|-------------------|
| GS15 | 494136.899 | 0.002 | 114913.685 | 0.002 | 253.435 | 0.012 |

Tape reading for "short tripod" setup = 0.660m

Vertical antenna correction for "short tripod" setup = 0.255m

Therefore vertical correction used in GeoOffice calculation = 0.255 + 0.660 = 0.915m

Staff reading at summit = 0.604m.

Staff reading at GS15 setup position = 2.045m

Height correction to summit = 2.045 – 0.604 = 1.441m

Therefore height of Littleton Down = 253.435 + 1.441 = 254.88m.

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

| | | |
|--------------------|----------------|---------------|
| Garmin Montana 600 | SU 94123 14947 | Height = 259m |
| Garmin Etrex 20 | SU 94125 14941 | Height = 262m |

3.4) The Col

The area for the col of Littleton Down is shown below in the extract of the OS 1:25000 map. The col lies between the 105m and 110m contours and there is a 107m spot height marked on the A286. However, studies from this and other maps suggest that the col maybe further to the West and North of the South Downs Way closer to the farm buildings. The valley to valley direction at this point is approximately North to South.



The survey commenced with a visual inspection along the South Downs Way from the A286 to the farm to the West. The area around the farm was very flat and there were areas of concrete slab that were probably the foundations for previous barns and buildings. However, to the West of the farm the ground is clearly rising and so the col was identified to be East of the farm. Also the ground to the East of the A286 rises and this places the col somewhere between the A286 and the farm to the West. The South Downs Way, which provides access here, has high hedges on both its sides so it was not possible to take staff measurements directly from the fields to the South and North. The only access to these fields was through gates near to the farm.

The survey commenced in the field to the South, where a line of flags was placed about 20m from the edge of the field and running in an East to West direction. Staff measurements taken from these flags with the NA730 level set up on its tripod at a convenient position, clearly showed the ground to be dropping from the A286 and then rising again towards the farm. Staff measurements were

then taken in lines perpendicular to the line of flags, the valley to valley direction, and the ground was found to be rising toward the North to the hedge on the South Downs Way. Another line of flags was then set out parallel to the first one but nearer to the hedge and staff readings were again taken from these. The “col” was found to be close to the hedge and it was marked with flags.

Unfortunately time and the onset of darkness did not allow a line survey to be made from this “col” in the South field, West to the gate, across the South Downs Way, and then through the gate into the North field, in order to determine accurately if this ground here is higher or lower. However visual inspection from near the gates on either side of the South Downs Way indicated that the ground was lower in the North field and dropped away from the South Downs Way. Therefore we were reasonably confident, that the col was as identified in the South field. If the col position had been incorrectly identified then its true position would be higher and not lower than the identified position in the South field.

The Leica GS15 was then set up away from the hedge with the “short tripod” configuration. GNSS data were collected for 1 hr. The position and height data for the col that were recorded by the Leica Viva GS15 was post-processed with Leica GeoOffice 8.3 using imported OS RINEX data for the ten nearest base stations under 100km distance and the Computed model for tropospheric correction. These results are given in the table below:-

| System | Easting | error(1SD) | Northing | error(1SD) | Height(m) | error(1SD) |
|--------|------------|------------|------------|------------|-----------|------------|
| GS15 | 487415.889 | 0.002 | 116679.854 | 0.002 | 105.464 | 0.004 |

Tape reading for “short tripod” setup = 0.608m

Vertical antenna correction for “short tripod” setup = 0.255m

Therefore vertical correction used in GeoOffice calculation = 0.255 + 0.608 = 0.863m

Staff reading at col = 0.556m.

Staff reading at GS15 setup position = 0.790m

Height correction to summit = 0.790 – 0.556 = 0.234m

Therefore height of col for Littleton Down = 105.464 + 0.234 = 105.70m.

The ten-figure Grid References measured for the col were:-

| | | |
|--------------------|----------------|---------------|
| Garmin Montana 600 | SU 87422 16695 | Height = 104m |
| Garmin Etrex 20 | SU 87419 16695 | Height = 384m |

4) Summary of Operating and Process Conditions

| | GS15 |
|---|----------|
| Data Collection col (min) | 61 |
| Data collection summit (min) | 63 |
| Number of Base Stations used in Processing for all points | 10 |
| Epoch Time (sec) | 15 |
| Tropospheric Model | Computed |
| Cut off Angle (degs) | 15 |

5) Discussion of Results

We estimate the measurement uncertainty associated with a 1 hour data set for the Leica GS15 to be +/-0.06m. We also estimated that the uncertainty in height for the location of the summit and col were +/-0.05m and +/-0.2m respectively.

The height of Littleton Down and its col were measured to be 254.8+/-0.08m and 105.7+/-0.2m respectively. Therefore the calculated drop for Littleton Down is 149.2+/-0.2m and therefore this hill retains its classification as a subMarilyn.

As stated in the survey for the col, time did not allow a complete level and staff survey of all the potential ground for the col. However, if the possible area in the field North of the South Downs Way did contain the col then its height would be greater and the calculated drop less. Therefore the hill's subMarilyn status still retained.

6) Summary and Conclusions

The **summit of Littleton Down** is at grid reference * SU 94124 14944 and is the top of a small ridge within the wood and a few metres from the wood's edge. Its height is **254.88+/-0.08m**.

The **col of Littleton Down** is at *SU 87421 16695 and is unfeathered grass. Its height is **105.7+/-0.2m**.

The **drop for Littleton Down is 149.2+/-0.2m** and therefore this hill **retains its sub Marilyn status**.

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

John Barnard, 13 June 2015

Appendix



Leica GS15 set up near summit, war memorial on edge of wood directly behind GS15



Summit position marked with yellow flag