



# **ANDERSON MARINE SURVEYS**

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**Report To: Scottish Water**

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## **Loch Mhic Charmhiceil – Bathymetric Survey**

Loch Mhic Charmhiceil is used as the fresh water supply for the village of Teangue and nearby areas. This report described a bathymetric survey of the loch as part of Scottish Water's ongoing review of loch and reservoir capacities.

The level of Loch Mhic Charmhiceil is controlled by a small weir, approximately 1.5m in height, which is overtopped under typical winter and spring conditions. The draw-off depth is unknown, but appears to be approximately 1m below the weir top level.

The overall objective of this survey was to gather bathymetric data of the loch bed to enable calculation of the volume of the loch at varying water levels. It was also planned to install a 1m stageboard at a suitable site close to the loch outflow to provide a permanent indicator of loch levels.



**Figure 1. General view of the NE corner of Loch Mhic Charmhiceil**

## Methods

The survey was carried out on 24, 25 and 28 April 2013. Loch level on these dates corresponded to the weir top (see Figure 1). Due to the lack of vehicle access the survey was carried out from a small inflatable boat with electric outboard motor (Figure 2). The bathymetric survey was carried out using a Furuno CV108 colour echo sounder, logging directly to PC. The sounder was calibrated at the start of the survey; resolution and accuracy were within 0.1m. The primary positioning system throughout the survey was provided by a Trimble AG132 sub-metre differential Global Positioning System (dGPS). Positions were recorded in WGS84 datum and converted to OSGB36 using DatumPro software.

A combination of strong winds during the survey, shallow depths and weed in the south and east parts of the loch prevented the running of systematic survey lines. In addition, the echosounder return in water depths <1m was unreliable, probably due to a soft bed. In these areas, spot depths were taken manually (measured against a dinghy oar).



**Figure 2. Bathymetric survey operation.**

The loch perimeter was surveyed on foot, using three GlobalSat Data Loggers; mean position was recorded in WGS84. The loch edge was followed as closely as possible; with the exceptions of a short section of the north shore where the loch edge could not be accessed due to very steep terrain and a diversion on the east side of the loch to cross a tributary watercourse (Figure 3).

Bathymetric data has been incorporated into a 3D geo-referenced model of the loch, constructed using Golden Software Inc. Surfer software, enabling calculation of volume at various loch levels. Contouring was by kriging at 5m resolution; the model grid was blanked to the surveyed perimeter of the loch, adjusted to compensate for the unsurveyed sections.



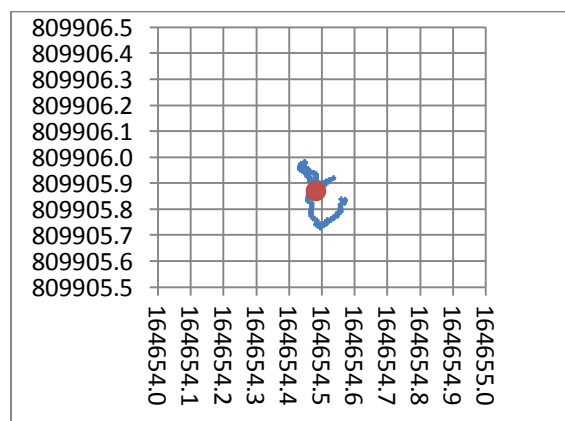
**Figure 3. Un-named tributary watercourse on east side of Loch Mhic Charmhiceil**

### Results

Under the prevailing weather conditions and loch level, it was not possible to permanently locate a stageboard adjacent to the weir. Depths have therefore been related to the top level of the dam. The surveyed position and altitude<sup>1</sup> of the north end of the Loch Mhic Charmhiceil dam top level was:

OSGB36 (mean±SD) 164654.5±0.04, 809905.9±0.09, 166.4±0.11

A scatterplot of surveyed position for this location is shown below:



**Figure 4. Position scatterplot for north end of dam top level**

<sup>1</sup> WGS84 altitude is 2.65m below ordnance datum (Newlyn)

A total of 929 line soundings and 25 manual spot depths were recorded. Minimum recorded depth was 0.7m and maximum 8.5m.

Grid summary statistics for the bathymetric model are:

Grid Size:	81 rows x 101 columns
Total Nodes:	8181
Filled Nodes:	2030
Blanked Nodes:	6151

**Grid Geometry**

X Minimum:	164200
X Maximum:	164700
X Spacing:	5

Y Minimum:	809600
Y Maximum:	810000
Y Spacing:	5

**Grid Statistics**

Z Minimum:	-0.39993908812498
Z 25%-tile:	0.697356341856
Z Median:	1.080528167144
Z 75%-tile:	2.2292135251805
Z Maximum:	8.3482368927577

Z Midrange:	3.9741489023163
Z Range:	8.7481759808826
Z Interquartile Range:	1.5318571833245
Z Median Abs. Deviation:	0.58353448198702

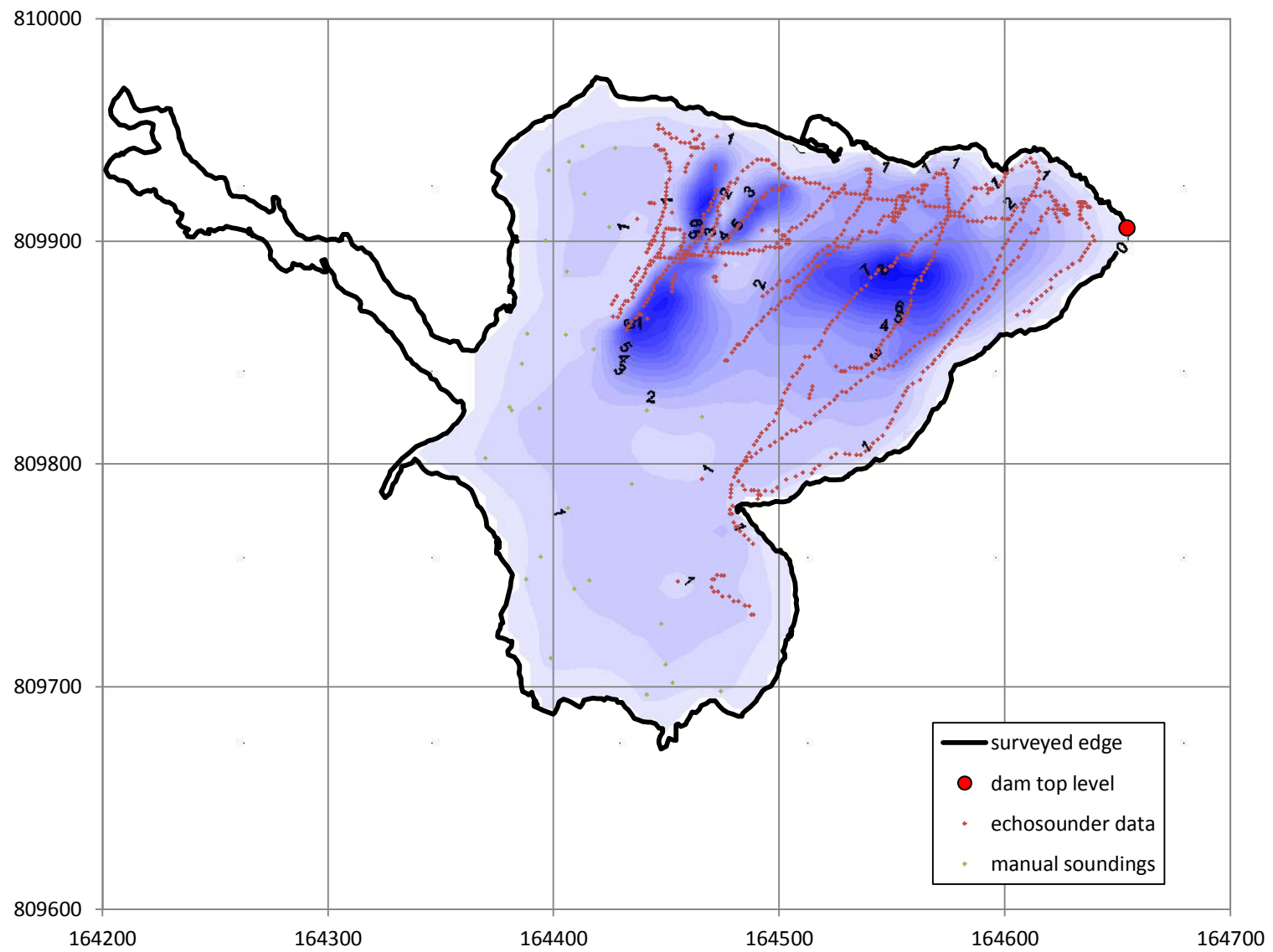
Z Mean:	1.6479851915915
Z Trim Mean (10%):	1.4693192852181
Z Standard Deviation:	1.6132044331349
Z Variance:	2.602428543086

Z Coef. of Variation:	0.97889498119636
Z Coef. of Skewness:	1.7635685732921

Z Root Mean Square:	2.3061404412548
Z Mean Square:	5.3182837347909

A bathymetric contour plot for Loch Mhic Charmhiceil is shown below:

Tabulated draw-down areas and volumes, derived from the bathymetry model, are:



level <sup>2</sup>	Area m <sup>2</sup>	Volume m <sup>3</sup>	drawn volume m <sup>3</sup>
0.0	47220	83765	
-0.5	41041	61205	22560
-1.0	30268	42827	18378
-1.5	17081	32347	10480
-2.0	14165	24573	7774
-2.5	10857	18269	6304
-3.0	7825	13640	4629

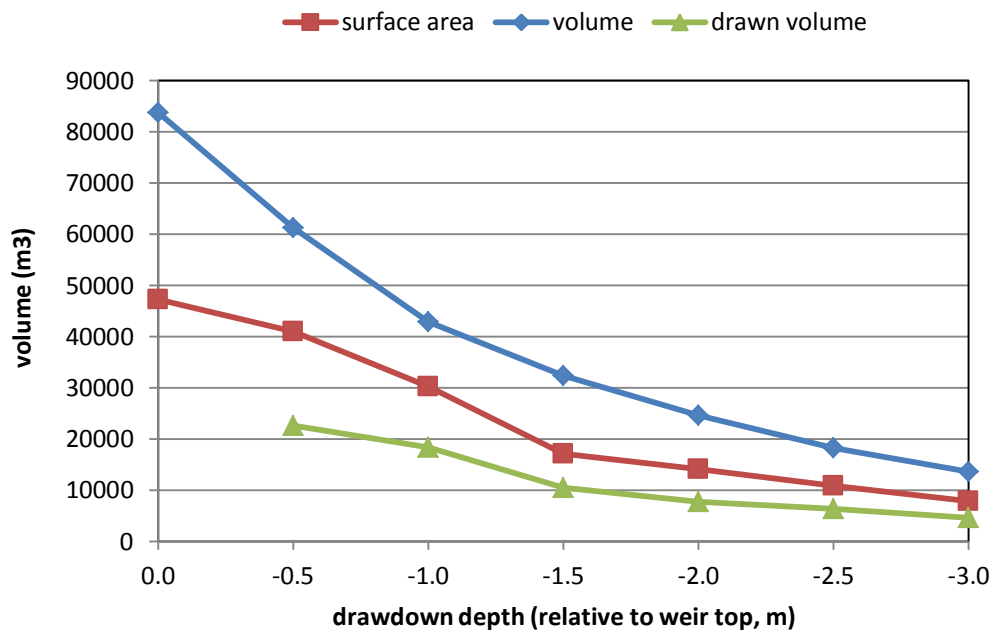


Figure 5. Draw-down planar surface areas and volumes for Loch Mhic Charmhiceil (drawn volume indicates available volume in 0.5m increments)

<sup>2</sup> Relative to dam top level