

MEMORANDUM



TO: Dan Tenardi (Reward Minerals)

CC:

SENDER: Phil Whittle

DATE: 1/12/2017

LAKE DISAPPOINTMENT 2017 FLOODING HYDROLOGY CALCULATIONS

This memorandum presents the results of analysis of various hydrologic parameters for Lake Disappointment over the January to July 2017 period where a significant inflow event occurred (Figure 1 presents rainfall and Figure 2 an image of the lake in flood). Up to 135 mm of rainfall occurred daily, equating to ~130 GL of direct rain onto the lake surface (at 949 km²).

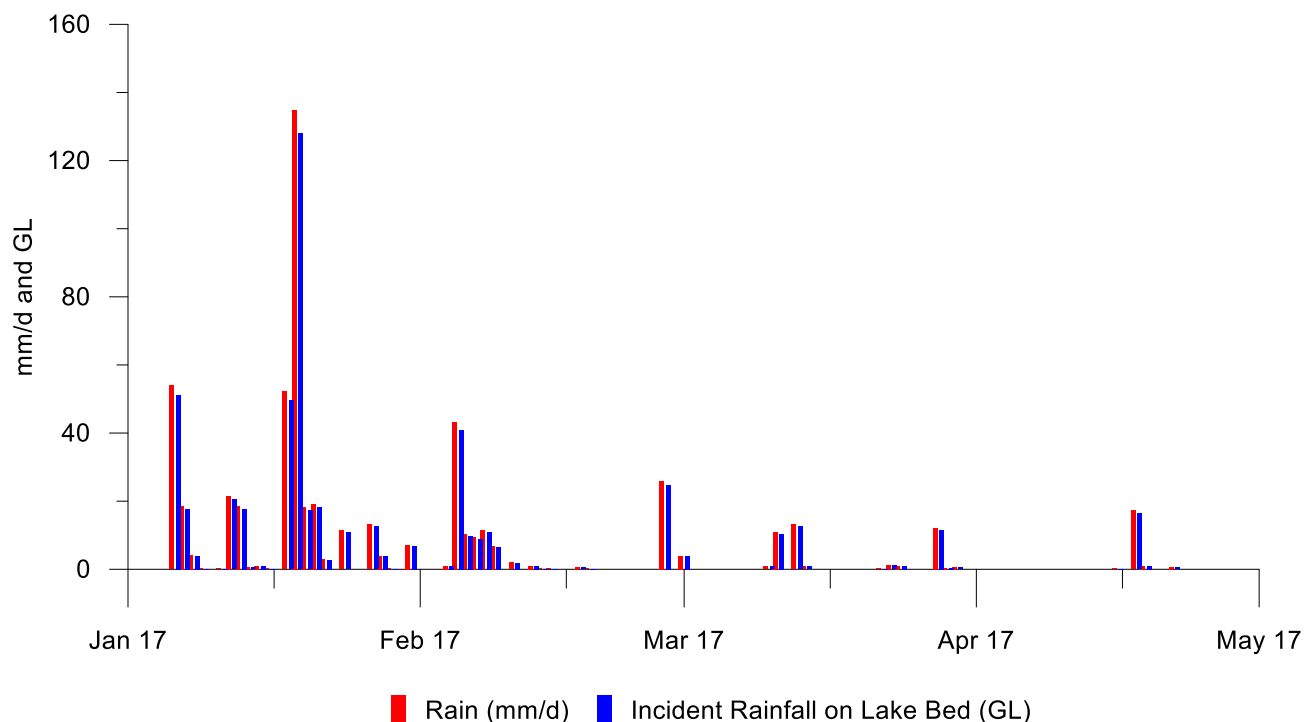


Figure 1 Daily rainfall at Telfer Aero and calculated volume of rainfall onto the lake bed – Jan to Jul 2017

 STREET
7 Forrest Avenue
East Perth 6004
WESTERN AUSTRALIA

 POSTAL
PO Box 6917
East Perth 6892
WESTERN AUSTRALIA

 CONTACT
+61 (0)8 6218 0900 P
+61 (0)8 6218 0934 F
info@hydrobiology.biz



Figure 2 Satellite image of Lake Disappointment in flood – 20th February 2017 (Sentinel 2A)

Calculations of the lake volume were made using an improvised Digital Elevation Model (DEM) derived from calibrating the Water Observations from Space (WofS) dataset of percentage water presence with the lower resolution in situ survey data provided by Reward Minerals. It is recognised that this DEM is not derived from actual elevation measurements over substantial portions of the lake and has errors associated with wind-driven water presence recorded in areas of the lake that are known to be higher in elevation (slightly) than up-wind areas which have less water presence. However, consideration of multiple available datasets including ASTER-DEM, ELVIS (GA), SRTM and GTED all provided less accurate models. The WofS derived DEM, once calibrated with the on-site survey data, has a slightly better than 65% accuracy ($r^2 = 0.6633$) against the onsite survey data. This equates to certain parts of the lake being up to 0.4 m in error at the extremes however the majority of the lake bed is within 0.1 m of the survey points.

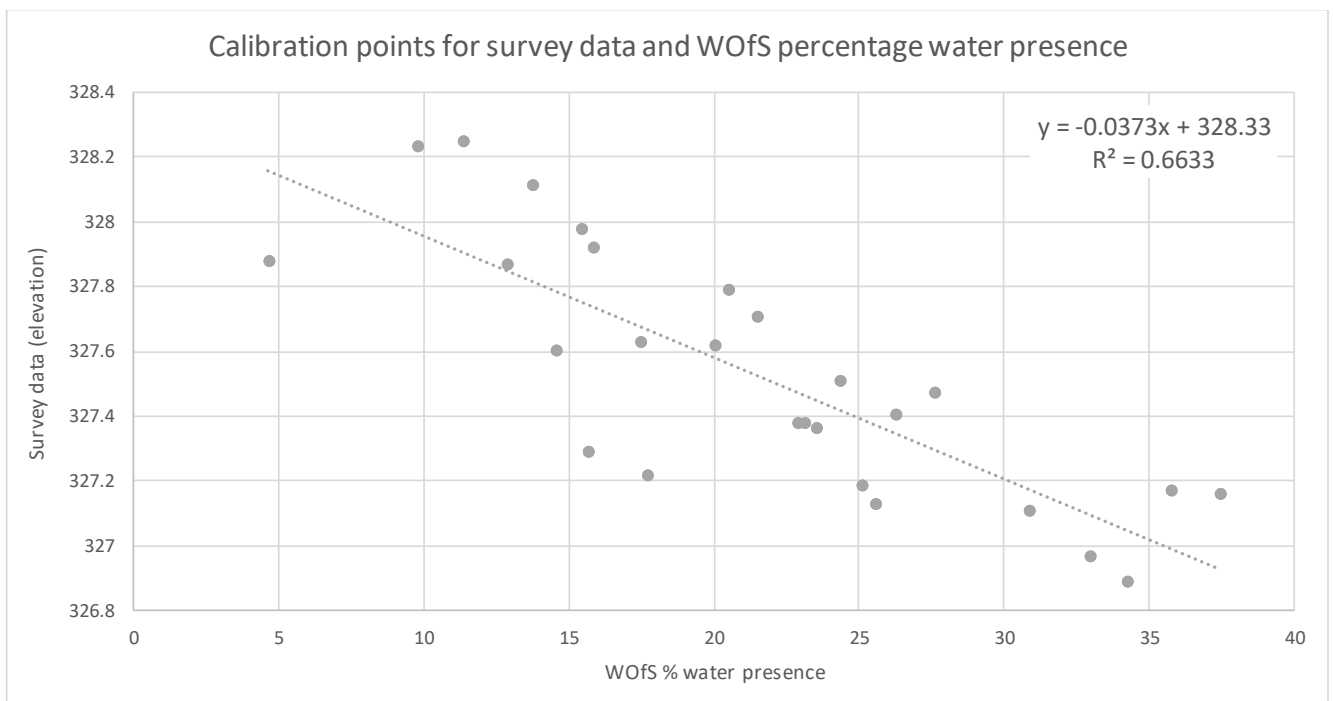


Figure 3 Calibration data for WofS DEM

Figure 4 provides a graph of the change in lake area with lake volume. The maximum lake area was calculated at 949 km² (water surface area) at the start of February 2017. This equated to a volume of 370 GL. There was a rapid drop in the lake volume from February to mid-April to 37 GL, though a rain event on the 18th April 2017 provided a further peak in volume to 253 GL.

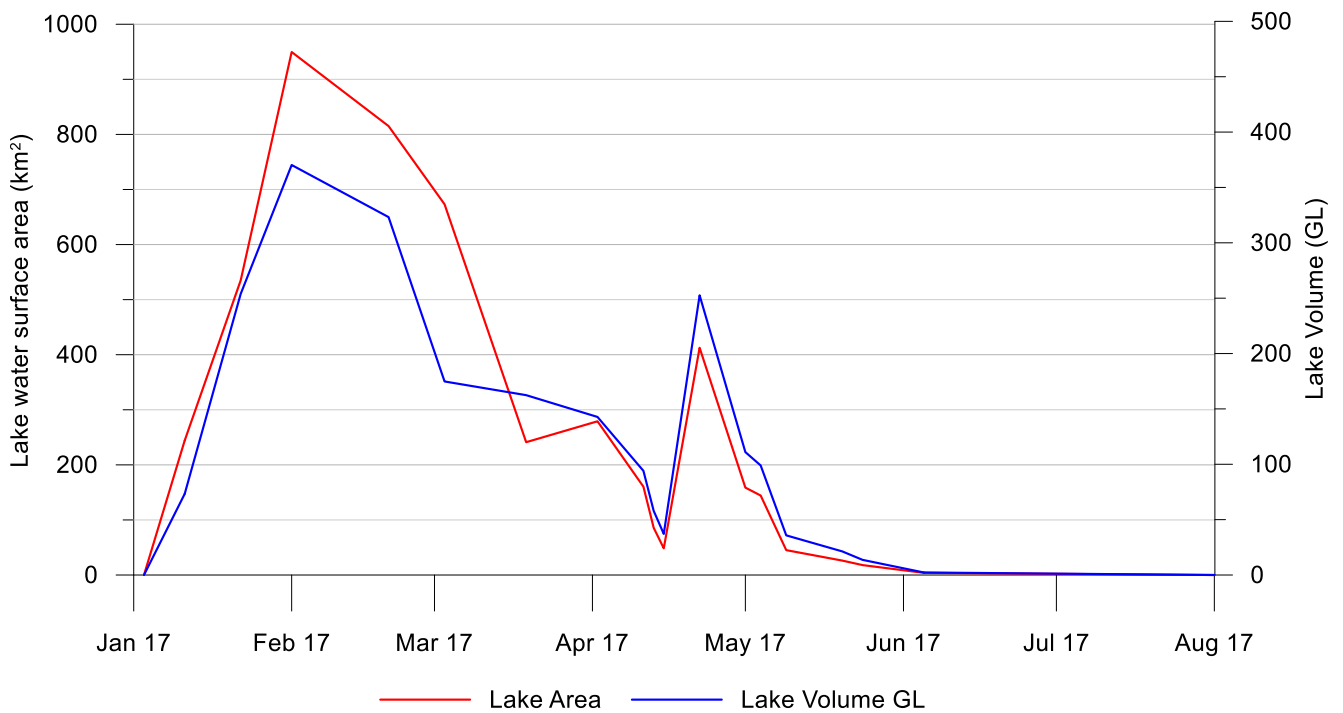


Figure 4 Comparison of the Lake Disappointment water surface area and volume for Jan-Jul 2017

Figure 5 Presents the rainfall and evaporation on Lake Disappointment over the study period showing both the evaporation rate and cumulative evaporation and rainfall. This relationship is further examined in Figure 6, where the cumulative rainfall minus the cumulative evaporation (inputs minus outputs) are compared to the gain and loss of volume as calculated from the WOfS DEM and the lake surface area. It can be seen that the change in lake volume initially followed the gain and loss of water from rain and evaporation, giving some confidence in the order of magnitude of the numbers calculated using two different datasets. However this relationship breaks down towards the end of the receding water period in March 2017, possibly as surface/groundwater inflows contribute water. The April 2017 peak is also much higher than the rainfall figure would predict, suggesting that the wet landscape could enhance contributions from run-off later in the season.

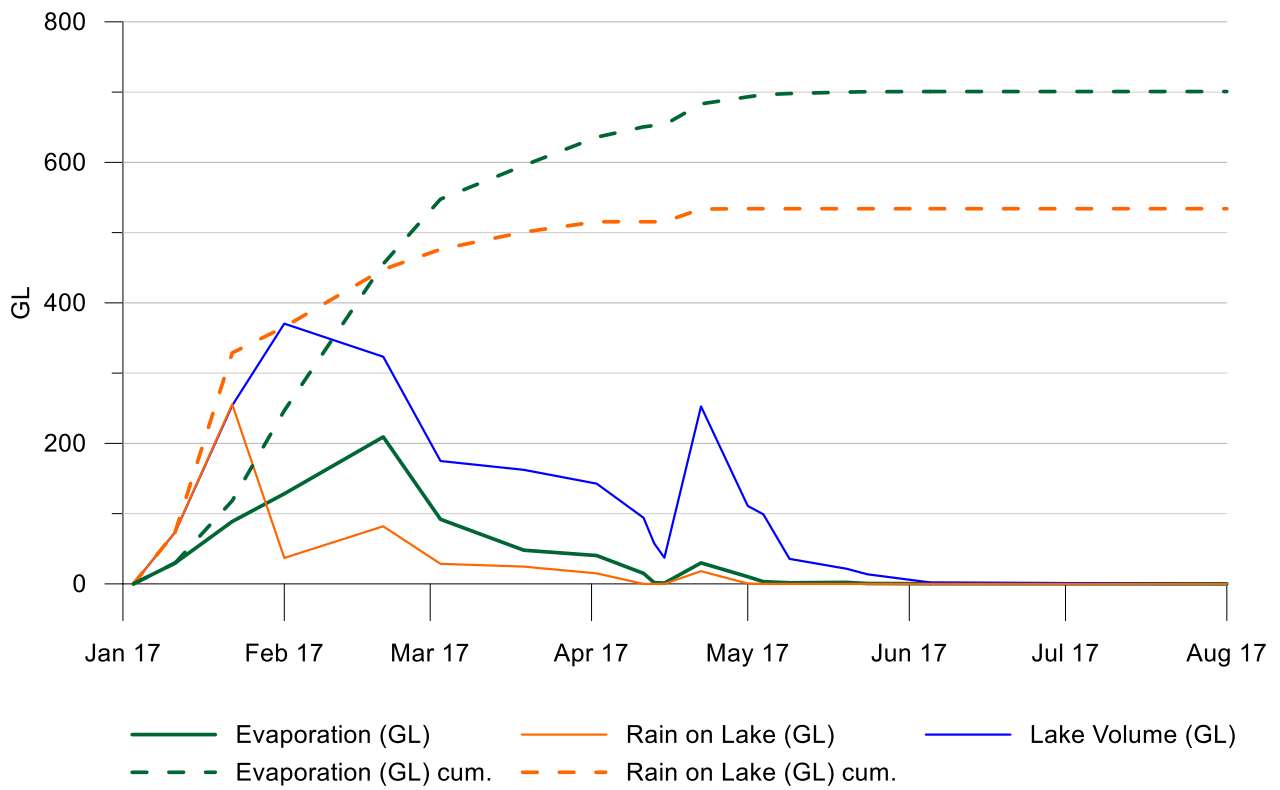


Figure 5 Comparison of Lake Disappointment water volume with incident rainfall and evaporation for Jan-Jul 2017

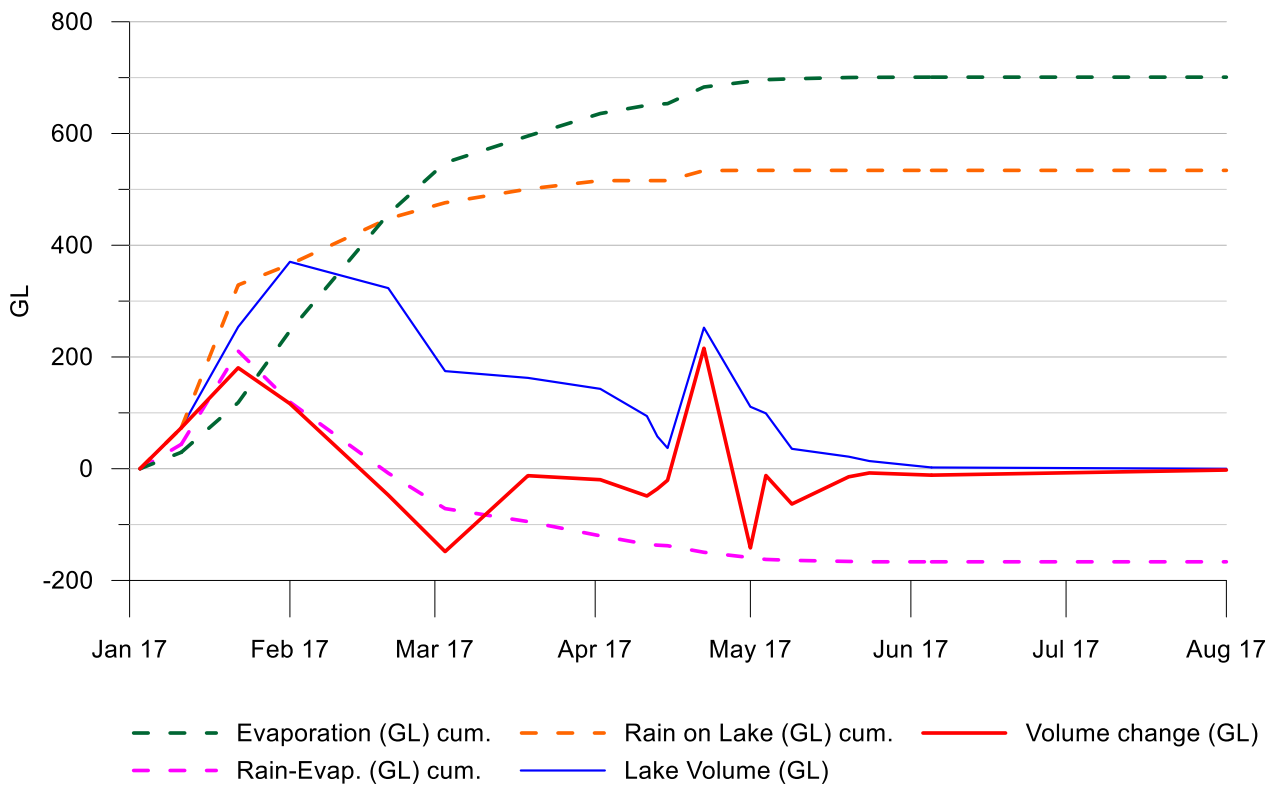


Figure 6 Relationship between cumulative rainfall minus cumulative evaporation and the change in lake volume – Jan to July 2017

Table 1 provides the raw data behind the figures.

Table 1 Calculations of lake area, volume, rainfall, evaporation and associated parameters – Jan to Jul 2017

Date	Lake Area (km ²)	Lake Volume (GL)	Evaporation (GL) from Lake Surface	Rain mm	Rain GL Lake	Rain GL Lake cum	Evap GL cum	Depth (Avg. m)
3/1/2017	0	0	0.0	0	0.0	0	0	0.00
11/1/2017	244	73	29.5	77.2	73.3	73	29	0.30
22/1/2017	535	254	88.8	269.4	255.7	329	118	0.47
1/2/2017	949	370	128.2	38.8	36.8	366	247	0.39
20/2/2017	815	323	209.1	86.4	82.0	448	456	0.40
3/3/2017	673	175	92.0	30	28.5	476	548	0.26
19/3/2017	241	162	47.9	25.8	24.5	501	595	0.67
2/4/2017	279	143	40.3	15.6	14.8	515	636	0.51
11/4/2017	160	94	14.9	0	0.0	515	651	0.59
13/4/2017	86	58	1.8	0	0.0	515	652	0.67
15/4/2017	49	37	1.0	0	0.0	515	653	0.76
22/4/2017	413	253	29.7	19	18.0	534	683	0.61
1/5/2017	159	111	10.2	0.6	0.6	534	693	0.70
4/5/2017	144	99	3.1	0	0.0	534	696	0.69
9/5/2017	45	36	1.6	0	0.0	534	698	0.79
20/5/2017	26	21	2.1	0	0.0	534	700	0.81
24/5/2017	18	14	0.5	0	0.0	534	701	0.76
5/6/2017	4	2	0.3	0	0.0	534	701	0.55
1/8/2017	0	0	0.0	0	0.0	534	701	0.00

As an additional dataset, Figure 7 shows the change in average lake depth over the study period for a given volume, as calculated from the WOfS DEM. The daily rate of lake volume change is compared to the total lake volume in Figure 8.

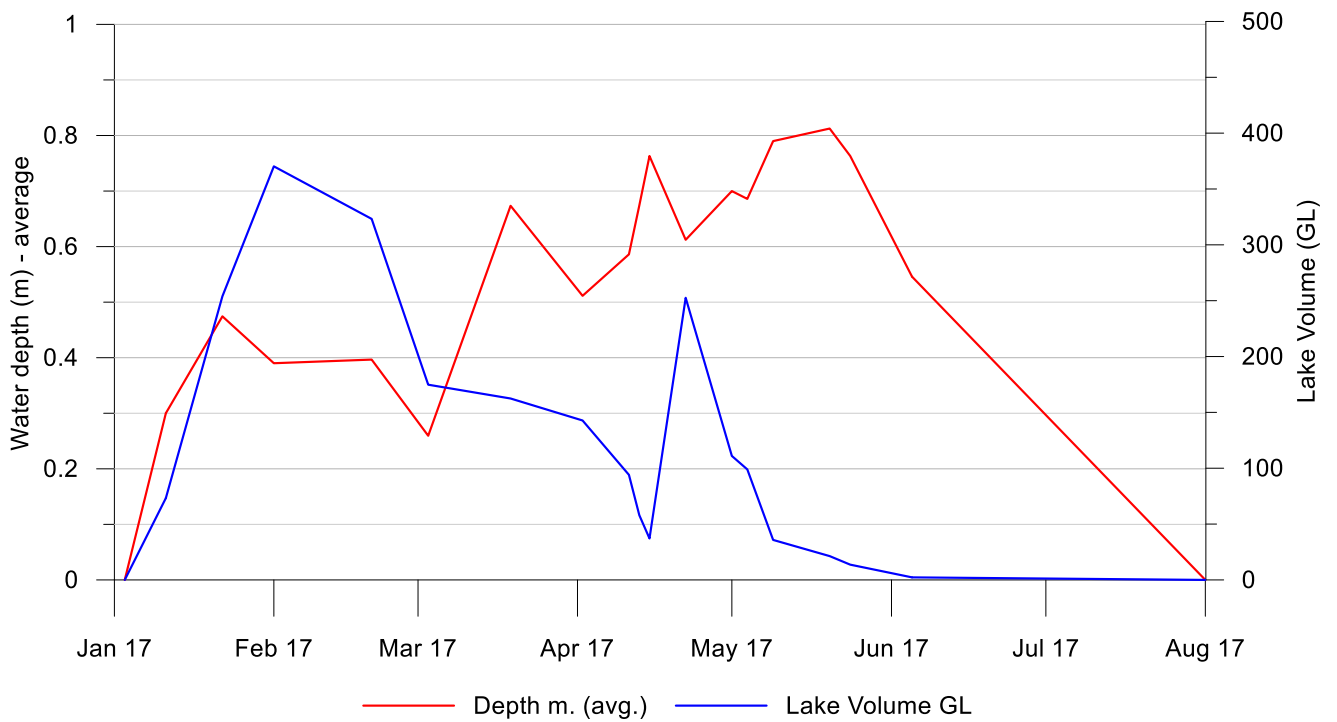


Figure 7 Average water depth compared to lake volume for Jan-Jul 2017

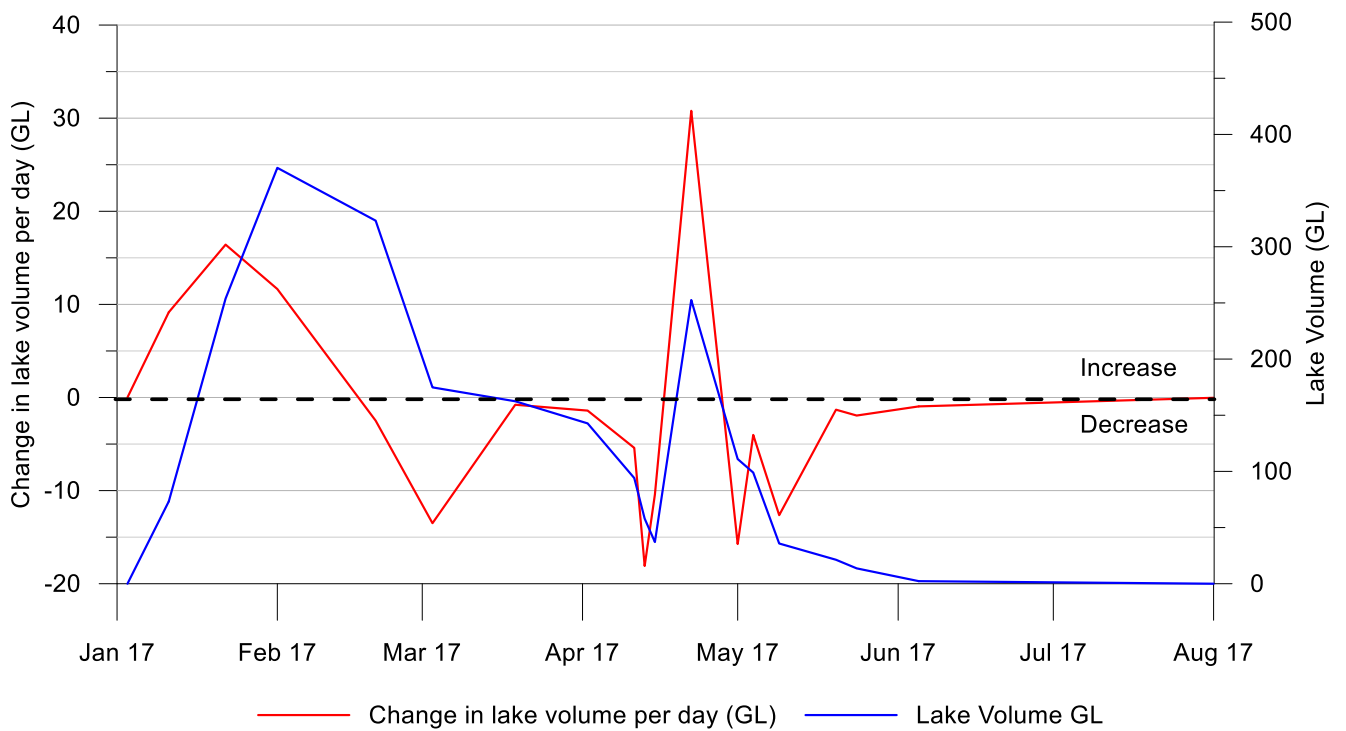


Figure 8 Daily change in lake volume (rate) compared to total lake volume - Jan to Jul 2017