

APPENDIX

A 2017 FLOOD EVENT

A.1 ANNEX A: 2017 Flood Event

The west of Northern Ireland experienced an extreme flood event in August 2017. The Loughs Agency has requested that DGL undertake a review of this event in terms of the return period of the event and whether this large event has any impact on hydrological calculations undertaken at the mine site as part of the Environmental Impact Assessment.

A.2 Summary of Data Obtained

The following data was obtained

Annual Maximum Series Data (AMAX) data (largest flood flow observed during any hydrological year) for 11 selected Rivers Agency gauging stations (provided by Rivers Agency)

Observed flow hydrographs at Croph on Owenkillew River during the 2017 event

Daily Rainfall data from the UK Met Office station at Lough Fea (purchased from Met Office) covering the flood event

FEH 2013 rainfall depth, frequency curves for the site and Lough Fea from <https://fehweb.ceh.ac.uk/>

The analysis focusses on gauged sites with long-term records, so that the 2017 event can be placed in context within historical flow records in Northern Ireland.

The review also considers the NI Department of Infrastructure March 2018 report 'North West Flooding Review. Report on Flooding in the North West – 22nd and 23rd August 2017'. This is referred to as the NIDI Report 2018.

A.3 Analysis of River Flow Data

Flow data was obtained for the 7 Rivers Agency stations that were used in the Surface Water Baseline Study for the project. AMAX data for these sites, including the August 2017 event, were obtained. Following initial analysis of the data from these stations, AMAX data from a further 4 stations were obtained, in the part of the country where the August 2017 event had the largest impact. The stations are listed in Table 1.

Table A1: Rivers Agency gauge stations used in assessment

Station Name	ID	Easting (m)	Northing (m)	Catchment Area (km ²)	Period of Record	Reason for Selection
Agivey at Whitehill	203028	288200	419350	100.5	43 years	Catchment size, although site is some distance from site
Burn Dennet at Burdennet	201007	237250	404750	148.3	44 years	Catchment close to site
Kellswater at Curry's Bridge	203021	310750	397150	126.3	45 years	Catchment size, although site is some distance from site
Faughan at Drumahoe	202002	246400	415050	273.1	43 years	Catchment close to site
Upper Bann at Bannfield	203033	323400	334050	101.7	43 years	Catchment size, although site is some distance from site
Fairywater at Dudgeon Bridge	201002	240500	375650	158.4	42 years	Catchment close to site
Owenkillew at Croph	201009	241900	386650	440.1	39 years	Station is located on Owenkillew River downstream of the site
Drumragh at Campsie Bridge	201006	245937	372207	320	46 years	Close to site and potentially impacted by 2017 flood event
Camowen at Camowen Terrace	201005	246057	373067	276	44 years	Close to site and potentially impacted by 2017 flood event
Derg at Castlederg	201008	226550	395962	336	42 years	Close to site and potentially impacted by 2017 flood event
Mourne at Drumnabuoy House	201010	234750	395962	1,844	36 years	Close to site and potentially impacted by 2017 flood event

The 2017 event was compared to the other high flow events at each gauge. The ranking of the 2017 event compared to previous years data is provided in Table 2.

It is clear that at 6 sites the 2017 event was either the largest or within the two largest events at that site. However, the impact of the 2017 event was relatively localised, with the event either not registering as an annual peak flow, or not being recorded as a significant event at the project site. The geographical area where the event was identified as significant is shown in Figure 1.

Table A2: Ranking of August 2017 event in AMAX record at each Rivers Agency gauging station

Station	Rank of 2017 Event
Fairywater at Dudgeon Bridge	16/42
Agivey at Whitehill	7/43
Kellswater at Curry’s Bridge	Not recorded as AMAX
Faughan at Drumahoe	1/43
Owenkillew at Crosh	1/39
Burn Dennet at Burndennet Bridge	1/44
Upper Bann at Bannfield	Not recorded as AMAX
Drumragh at Campsie Bridge	1/46
Camowen at Camowen Terrace	2/44
Derg at Castlederg	33/42
Mourne at Drumnabuoy House	1/36



Figure A1: Location of Rivers Agency gauging stations used in analysis. Red boundary shows area where the 2017 event appears to have had the largest impact on the AMAX time series

Return period (extreme flood flow) estimates are based on statistical analysis of observed data. This means that if there is a new flood event this can impact on the flood statistics and change the return period estimates at any gauge site.

Flood frequency analyses were undertaken at three key sites where the 2017 event was

identified as the highest on record and where flooding was recorded. The return period of the August 2017 event was calculated based on a single site analysis of the flow records at each gauge with and without the addition of the 2017 event in the historical AMAX record.

The analysis was undertaken using the standard FEH WINFAP software, with the results in Table 3.

Table A3: Rivers Agency gauge stations used in assessment

Station	Return Period of August 2017 event – without 2017 included in data set (years)	Return Period of August 2017 event – with 2017 included in data set (years)
Faughan at Drumahoe	^a 280	115
Owenkillew at Crosh	250	85
Burn Dennet at Burndennet Bridge	^a 300	95

a: Reported in NIDI Report 2018

The results indicate that if the 2017 event is not included in the data set (i.e. using flood data from pre-2017) the return period of the event is calculated as being around a 1 in 250 to 1 in 300 year event. However, once an event has occurred it should be included in the AMAX series, as it results in a re-assessment of the flow statistics at each gauge. Adding the 2017 event to the data sets and re-assessing the flow statistics the results indicate that 2017 event had a return period of around 1 in 100 years, which is consistent with the rainfall data discussed below.

The event on the Owenkillew at Crosh is shown in Figure 2 below, based on flow data provided by the Rivers Agency. The graphs show the isolated nature of the high flow event on the Owenkillew River, with lower flow before and after the event. The average flow in August 2017 (considering flow on every day of the month) was significantly higher than the average August flow from the long-term records at Crosh (25 m³/s in 2017 compared to 10.9 m³/s average). But in the period 1980-2014 there were 3 years with higher average flows in August than in 2017. Therefore, although the average flow in August 2017 was high, being impacted by the flood event, it was not the highest on record.

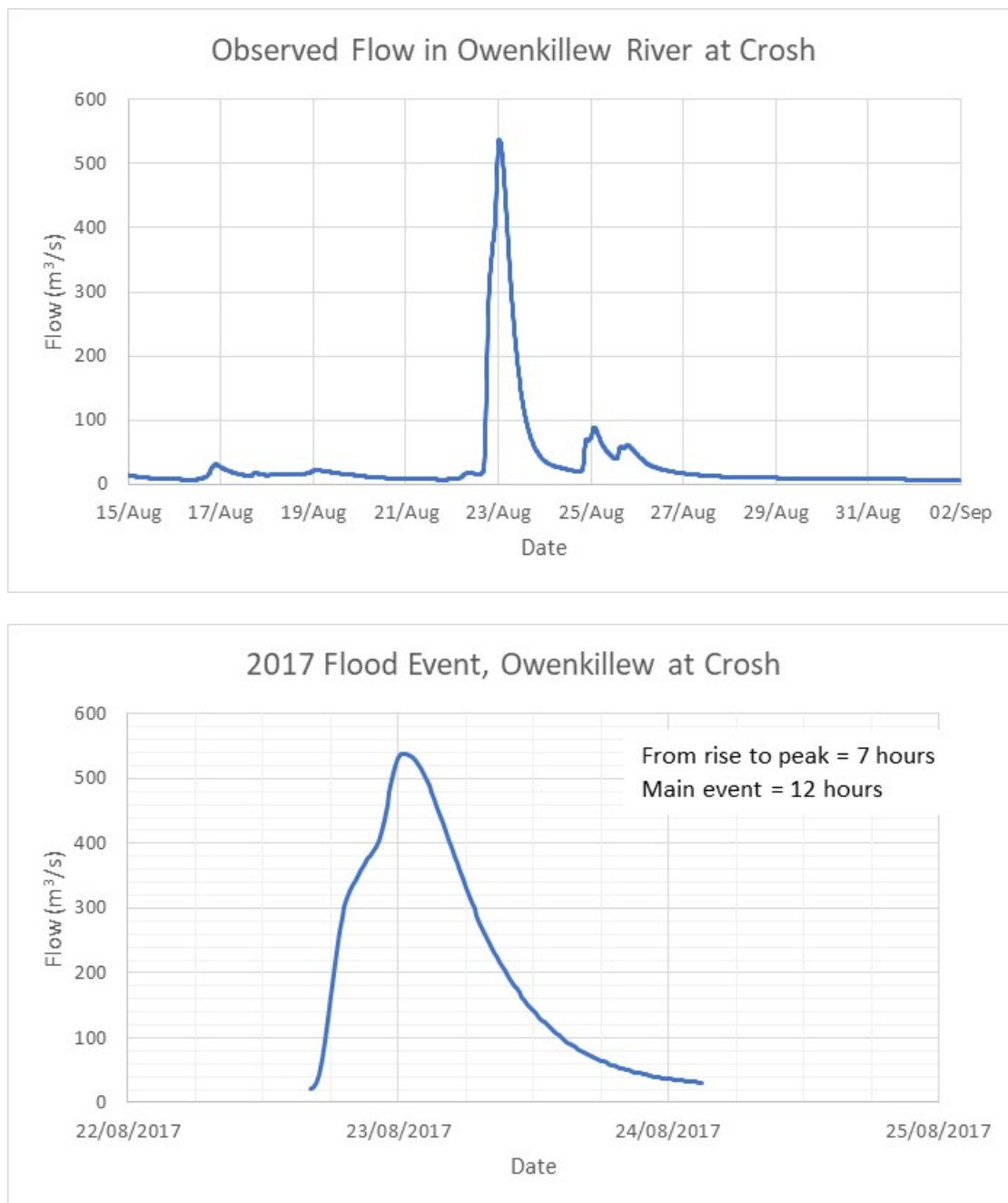


Figure A2: Observed flow in Owenkillew River at Croph; Event over 2-week period (top), Detail of main flood peak (bottom)

A.4 Met Office rainfall data

Daily rainfall data was obtained for the Met Office station at Lough Fea. Data from this site was used in the EIA to provide a long-term rainfall record for use at the site.

Based on the measured event at Lough Fea the rainfall on 22nd August 2017 was 61.6mm (see Figure 3). The NIDI Report 2018 notes that around 60 – 70mm of rain fell in the space of 8 to 9 hours. The peak of the flood event appears to have focussed on the north-west of Northern Ireland (and to the west of Lough Fea), so the higher rainfall totals in the NIDI Report 2018 probably reflect the more intense rainfall in the west of Northern Ireland.

Return period rainfall totals (9-hour and 24-hour event) for Lough Fea and for the project site are shown in Figure 4. These are based on the standard FEH 2013 rainfall totals extracted from the FEH Web Service.

Assuming a rainfall depth of 65mm in 9 hours, this is approximately equivalent to a 1 in 65 year event at Lough Fea and just less than a 1 in 100 year event at the site.

The storm water calculations for the mine site infrastructure were based on a 24 hour, 1 in 1,000 year rainfall event. From Figure 4 a 1 in 1,000 rainfall event approximates to twice the rainfall total that fell in the August 2017 event.

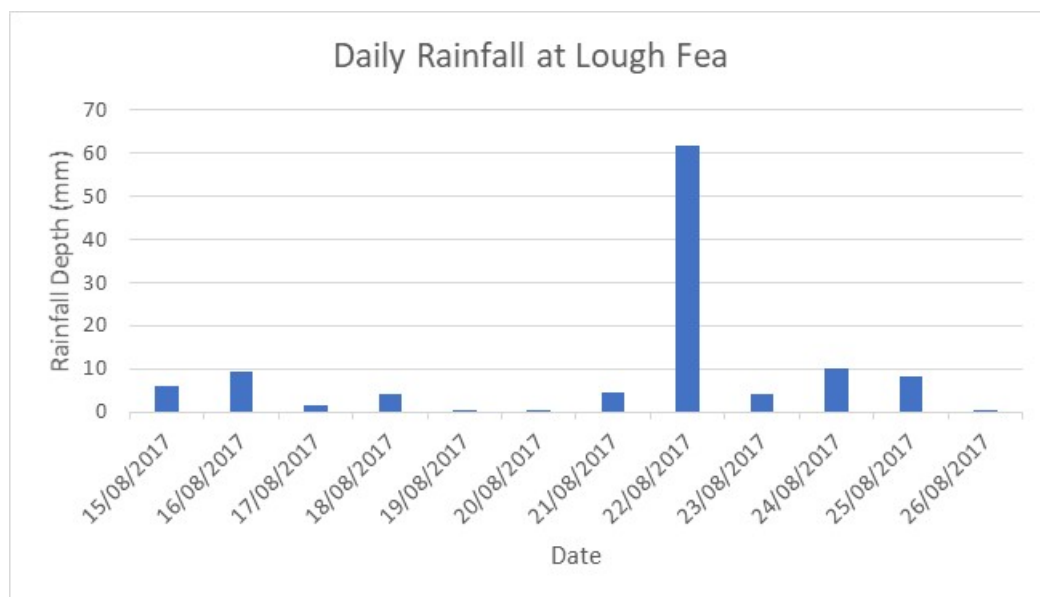


Figure A3: Observed daily rainfall at Lough Fea during 2017 event

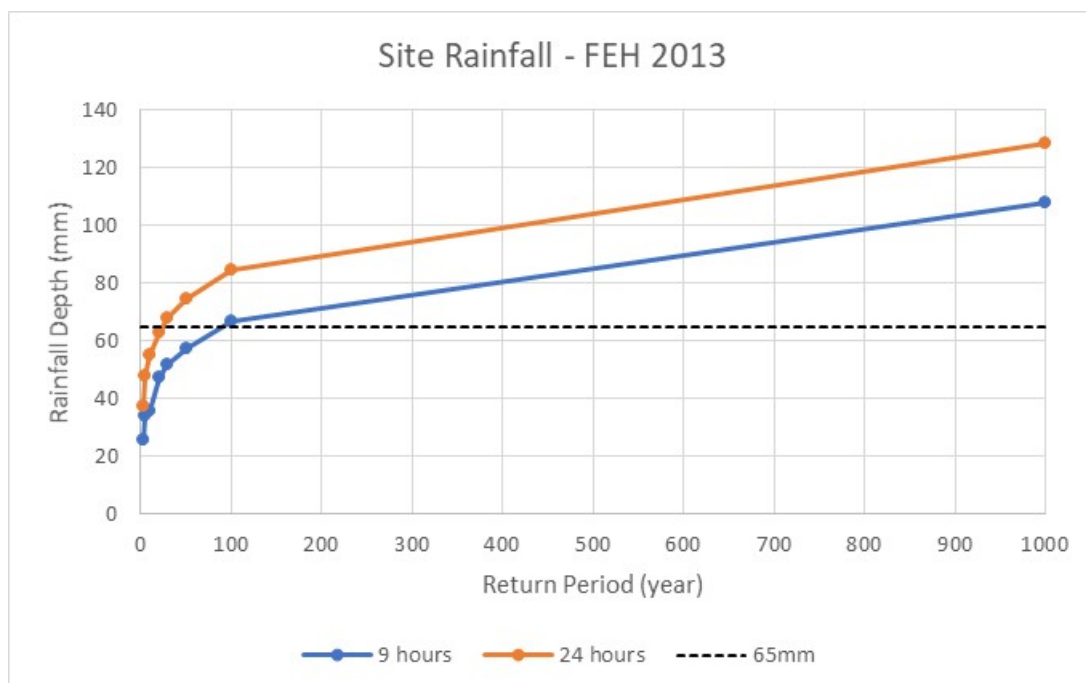
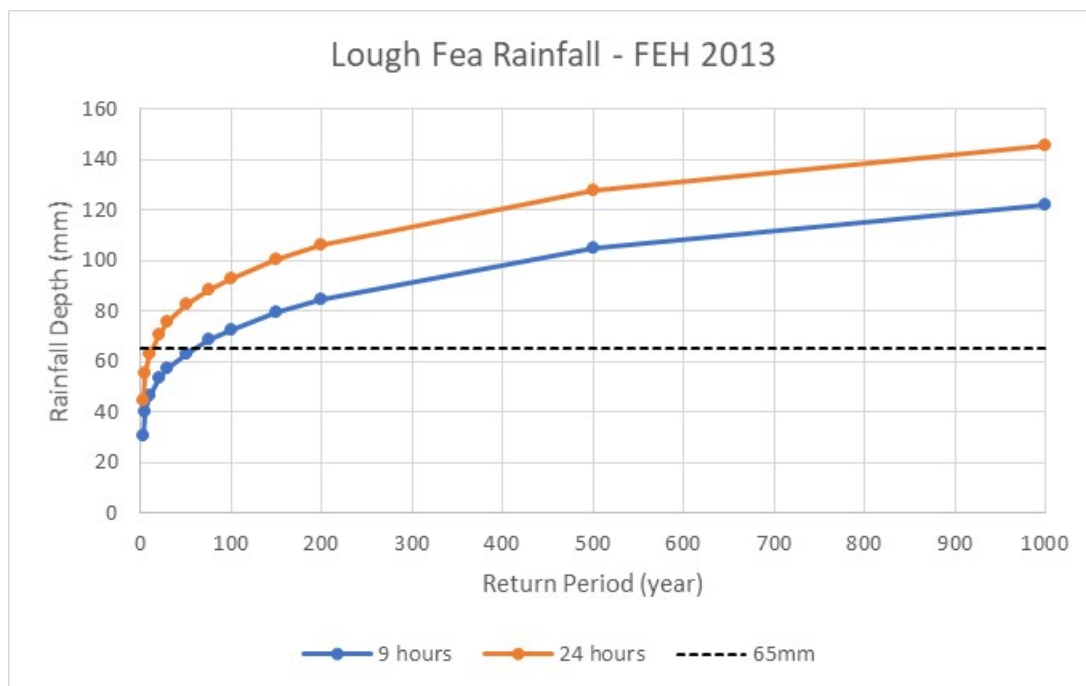


Figure A4: Rainfall Depths for 9 hour and 24 hour event from FEH 2013; Lough Fea and at site, compared with rainfall in August 2017 event

A.5 Impact of 2017 event on EIA and Site Design

A.5.1 Impact on Surface Water Effects Assessment

Due to flood storage capacity in the East (Upper and Lower) and West Ponds at the Proposed Infrastructure Site, the EIA predicts that post-development flood flows from the site will be lower than under baseline conditions. Therefore, there will be no change to the conclusions of the EIA in terms of the impact of the project on flood flows downstream.

In terms of impacts on monthly average flow conditions, the analysis presented above indicates that although the monthly runoff volume for August 2017 was larger than average, it was not the largest monthly volume seen in the flow records at Crosh. In addition, August is not one of the wetter months at the project site. The water balance calculations presented in the EIA are based on running models using observed rainfall data for a 50-year period. The capacity of the water treatment plant has been calculated based on the requirements of the wettest months, so the impact of a wetter August will not affect the conclusions of the EIA in terms of monthly flows.

A.5.2 Impact on Site Water Balance and Storm Water Management

The East (Upper and Lower) and West Water Ponds are designed to contain the 24-hour, 1 in 1,000 year rainfall event falling on the site. As is shown in Section 3, the total rainfall used in this calculation is twice the rainfall that fell in the August 2017 event. This provides a significant freeboard over the 2017 event.

In addition, the requirement for storm water storage in the ponds is much less than the operational volume of these ponds. In ES V3 Appendix B10 – Flood Risk and Drainage Assessment, the runoff volumes for the 1 in 1,000 year, 24-hour event are calculated to be 26,800m³ for the East Ponds and 18,200 m³ for the West Pond.

The volumes of the ponds are;

West Pond; 38,855m³

Upper East Pond; 52,870m³

Lower East Pond: 9,973m³

During operations the ponds will be operated so that there is a freeboard between the operating water level and the full pond volume that is at least equivalent to the required storage volume within the ponds for the 1 in 1000 year, 24 hour storm, i.e., water will be pumped from the water management ponds to the WTP to maintain an operational water level that is below that required to provide the flood storage.

ESV3 Appendix C4 – Annex A – Mine Site Water Balance provides model results showing the predicted water volumes within the ponds during operations relative to the required storage volume for flood storage (Figures 14 and 15 in that report). The model predicts the water levels in the ponds can be kept below the level required to provide the required flood storage.

A.6 Summary and Conclusions

The flood event that occurred in north-west Northern Ireland in August 2017 was in many places the largest flood event on record. The rainfall event is likely to have had a return period of around 1 in 100 years and this resulted in flow events that had a similar or higher return period.

The return period at any river gauging station depends on the nature of the catchment and the previous flood records at the site. With the 2017 event added to the AMAX record at key sites, the return period of the flood event is also predicted to be around 1 in 100 years.

Comparison of the rainfall depths during the August 2017 event and used in the design of the site water management ponds show that the design condition for the ponds used rainfall depths double that which occurred in August 2017.

Due to flood storage within the East (Upper and Lower) and West ponds, the EIA predicts that post-development the flood flows from the site will be lower than under baseline conditions. This result does not change, even if the flood statistics for rivers downstream of the site are updated.

If this event results in any future update to the rainfall statistics for Northern Ireland (incorporated into updates of the FEH methods) they will be taken into account in the adaptive management at the site. The site water management will continually be reviewed as the project moves towards construction and then into operation. If there is a need for additional flood storage at the site there are options to manage water levels in the East and West Ponds at lower levels (providing a larger storage volume above the operational water level) and to control site runoff.