GAVIA environmental

Gavia Environmental Ltd
Room 1.05 HQ
20-23 Woodside Place
Glasgow
G3 7QL

Tel: 0141 401 0699
E-mail: derwyn.lear@gavia-environmental.co.uk
14/05/2023
Our Reference: P23159

Attention: Adele Ellis

AE Associates
Kaimknowe Farm
Glendevon
FK14 7JZ

Re: Tealing Solar Development Flood Risk and Drainage Assessment

Dear Adele

Please find below our responses to queries raised by the local community group pertaining to the Flood Risk and Drainage Assessment (FRDA) completed by ourselves for the Tealing Solar Development in 2022.

Query Raised	Gavia Response (14/05/2023)
There is significant risk of flooding, particularly in relation to the North-East area of plot 4 where severe flooding took place in November 2022.	The photographs showing the flooding upstream of the minor road bridge (referred to as NE corner of Plot 4) would appear consistent with the modelling outcomes. The 1 in 200 year event is similar in terms of flows to the 1 in 100 year as the event is indicated to show (Table 2 of the FRDA – 5.68m^3/s vs 4.76m^3/s), therefore is discussed for comparative purposes. The outputs from the model during the 1 in 200 year event (Figure 3 of the FRDA) show a width of flooding in the region of 65m along the road. Flood levels in the photographs would appear to reach a larger rounded fence post to the east of the bridge where several pallets create a boundary to the watercourse. This feature can be detected from aerial imagery, and the modelled flood extents for the 1 in 200 event actually extend a further 10m east along this fence line (hence go to a greater depth). Furthermore, it is highlighted that in the 2D model, flows bypass the bridge structure i.e. it

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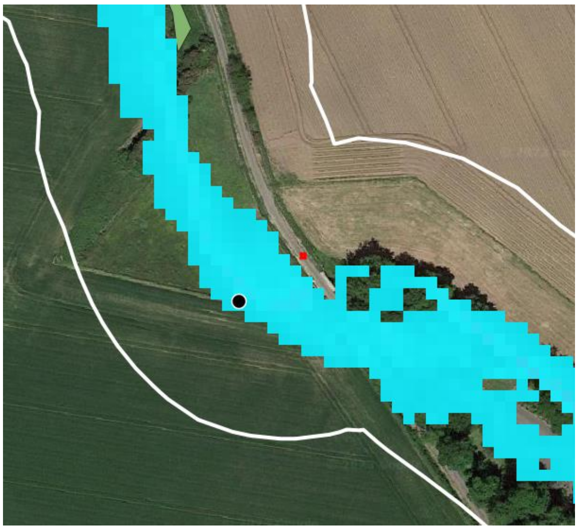
	shown as a full blockage in the LiDAR, therefore incorporating the bridge would likely only reduce the modelled flooding in this area.  Diagram 1: Modelled flood depths during the 1 in 200 at NE corner of plot 4, the black dot indicates the flood extent from photographs provided, whilst the white line represent the 50m exclusion zone around the watercourse (no solar infrastructure will be placed within this exclusion zone). The photographs around Kellas are outwith the model domain and therefore cannot be verified with the model. It is noted that the SEPA flood maps indicate that 'Plot 5' has localised pluvial flooding at topographic low points. As discussed in Section 4.9 of the FRDA, solar panels will be raised above ground levels and are not considered to be sensitive to the localised shallow surface water flooding indicated by the SEPA flood maps. Overland flow pathways will also be maintained as solar panels will be mounted. Measure to mitigate against impacts on runoff are outlined in Section 8 of the FRDA. It is also highlighted that a 50m exclusion zone around watercourses has been implemented as shown Figure 7, giving a 100m stirp of land around the watercourse where no development will occur (see Diagram 1 above).
Flooding is likely to worsen because of climate change.	Climate change is factored into the modelling as outlined in Section 5 of the FRDA (a 39% uplift is

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	added to the fluvial flows to account for climate change).
The main hydrological impact assessment by Gavia Environmental conducted in May 2022 appears to be inconsistent with actual recent flood events,	See initial response at the top of this table regarding comparison of recent flood events with the modelled flood extents.
It is also noted by Gavia Environments that "The design flow estimation and mathematical modelling process involves the assumption of various conditions which add an element of uncertainty into the subsequent results. Where assumptions are required, a conservative approach has been adopted". It appears that these modeling assumptions are not adequate, and for example a 3D model, including the bridge near the North-East of plot 4 should be included. Evidence of actual events is attached below in figures 1, 2 and 3.	See initial response at the top of this table comparison of recent flood events with the modelled flood extents.
Evidence from existing solar facilities robustly demonstrates that clearing and preparation for siting solar facilities results in compaction of soil and increases water run-off. It is noted from previous solar facility developers that "We have deliberately avoided flood-prone areas within our development proposals'.	Clearing and preparation is a temporary impact during construction and so the likelihood of contributing to flooding during a short time period is significantly reduced. As set out in Section 8.3, measures are set out to mitigate this impact during construction including silt traps, settlement ponds and silt fencing, which will act to reduce surface runoff rates during the construction period. The development has also avoided flood prone areas as shown in Figure 7 of the FRDA, including a 50m exclusion zone around watercourses and locating all infrastructure outwith the modelled 1 in 200 year plus climate change event extent.
It is also stated in the academic publication 'Hydrologic Response of Solar Farms' by Cook & McCuen, J. Hydrol. Eng., 2013 that "the kinetic energy of the water draining from the solar panel could be as much as 10 times greater than that of rainfall. Thus, because the energy of the water draining from the panels is much higher, it is very possible that soil below the base of the solar panel could erode owing to the concentrated flow of water off the panel.." and that if the land	Compaction would only be caused during construction, beyond this the level of vehicle movements would be insignificant and potential compaction and erosion would be much reduced compared to intensive farming activities. Maintenance activities are not expected to be frequent. Natural revegetation post construction of the disturbed ground would reverse any compaction, and ploughing would not be beneficial as a vegetative layer will be more

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underneath and surrounding the panels is not correctly managed (such as due to compaction via use of machinery) then the runoff is likely to be increased significantly and the peak discharge increased by approximately 100%." Farmers traditionally subsoil annually after harvest to remove compacted soil. Solar facility contractors are unlikely to be able to undertake this (as solar panels will be in situ), therefore any soil damage and compaction which can lead to flooding is likely to remain for the duration of the development e.g. 40 years. This is supported by the opinion of a Flood Risk Management Engineer: "In my opinion solar farms on agricultural land will increase surface water runoff for the following reasons 1. The 2013 Cook and McCuan paper has this PRIMARY ASSUMPTION -WATER FLOWS UNIFORMLY OFF THE BOTTOM EDGE OF EACH SOLAR PANEL. It then assumes the water flows uniformly over the downhill land where it infiltrates uniformly into the soil and/or runs off it in the same way it would have done prior to solar panel being installed and therefore there will be no increase in runoff. All of their modelling is based on the primary assumption. The laws of physics tell us: a) The primary assumption that water falls uniformly off the bottom edge of each solar panel is only correct if the bottom edge of each solar panel is horizontal. b) If it is not horizontal then, the water will flow towards the low corner of the panel where it will fall to the ground in a concentrated stream. Hence the primary assumption is wrong, from which it follows the rest of the assumptions at 1 above are not correct and therefore it cannot be concluded there will be no increase in runoff. Indeed it can easily be argued the runoff will increase simply because the panels concentrate the flow of rain water on to the land, and therefore all	beneficial to reducing runoff rates than bare ground. The following mitigation is outlined in Section 8.3 of the FRDA which would address the concerns regarding runoff falling unevenly from the solar panels: "It is recommended that gravel strips are installed along the edge of the panels, where water would drip from, to prevent any increase in soil erosion. The gravel strips will dissipate any runoff along the drip line and allow runoff or infiltration. This mimics the predevelopment scenario."

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the land is not mobilised for infiltration as it would have been prior to the installation of the panels. 2. After construction maintenance vehicles passing between the rows of panels will compact the ground more than would have been the case when it was used for agriculture. This will increase runoff 3. During construction all the ground will be compacted by construction vehicles. If this compacted ground is not broken up after construction, say by ploughing, runoff will increase."	
Query: will an updated hydrological impact assessment take place to include the below images (figures 1-3), as it is believed that the recent flooding in November 2022 is unlikely to have been considered in previous hydrological impact assessments. Additional flood images and video footage of drainage can be supplied upon request. This flooding was estimated to be a '1 in 100-year event', which to date has occurred twice in the circa last 5 years	This information may be useful to incorporate into the FRDA, however at present it would not affect the conclusions of the FRDA and would only seem to verify the modelled flood extents (see initial response at the top of this table regarding comparison of recent flood events with the modelled flood extents). It is noted that a 1 in 100 year event occurring twice in 5 years would not alter what the estimated 1 in 100 year river flow is; 1 in 100 year more accurately reflects that there is 1% annual exceedance probability (AEP) or probability of that event happening in any given year, rather than that the event will only happen once every 100 years.
Query: The hydrological impact assessment and update appears to be inconsistent with actual events, please request a further FRA to take into account the supposed '1 in 100' year events which have taken place twice in the past 5 years ,plus 3D modelling which has not been taken into account. Please also include the details of the planned flood management measures which appear to be currently lacking, and how the developers will eliminate the risk of increased flooding due to the development?	The design event assessed within the FRDA is the 1 in 200 year plus climate change and therefore it is not essential to assess a lower magnitude event such as a 1 in 100 year event (which would only result in reduced flood extents and depths). In addition see the above response regarding the 1 in 100 year occurring twice in 5 years. A 1D/2D linked model (which would incorporate bridges as is assumed to be what is suggested by 3D) is not deemed necessary at this stage, as the 2D model would essentially seem to treat bridges as complete barriers to flows therefore provides a conservative assessment. In addition, a 50m exclusion zone for development around watercourses (Figure 7 of the FRDA) has been

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	adopted which provides a greater buffer against any uncertainties from the modelling approaches. Measure to mitigate against impacts on runoff are outlined in Section 8 of the FRDA. See initial response at the top of this table regarding comparison of recent flood events with the modelled flood extents.

I hope that you will find these responses satisfactory. Please do not hesitate to contact me if you wish to discuss the site further.

Kind Regards,

Derwyn Lear CEnv C.WEM MCIWEM
Technical Director
Mobile: 07887765245