West Cumbria Rivers Trust

Caring for our Lakes and Rivers

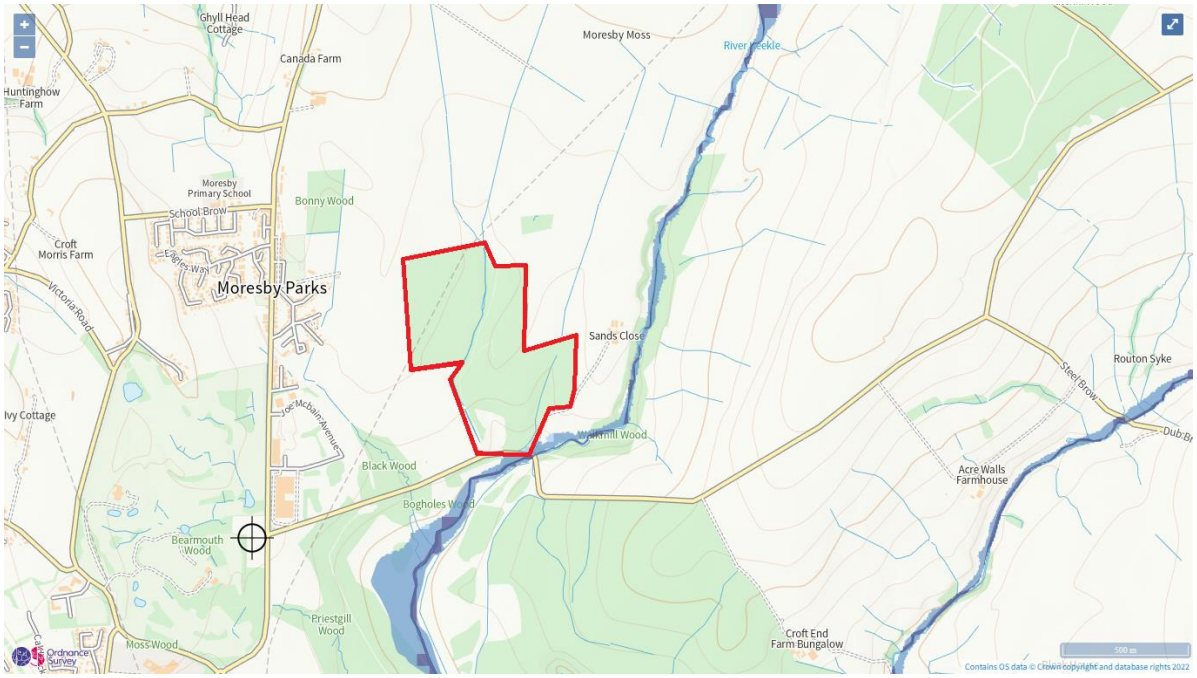
06th December 2022

Re: PP-11654353 – A Wilder Walkmill Planning Application

Flood Risk Assessment and Drainage Statement

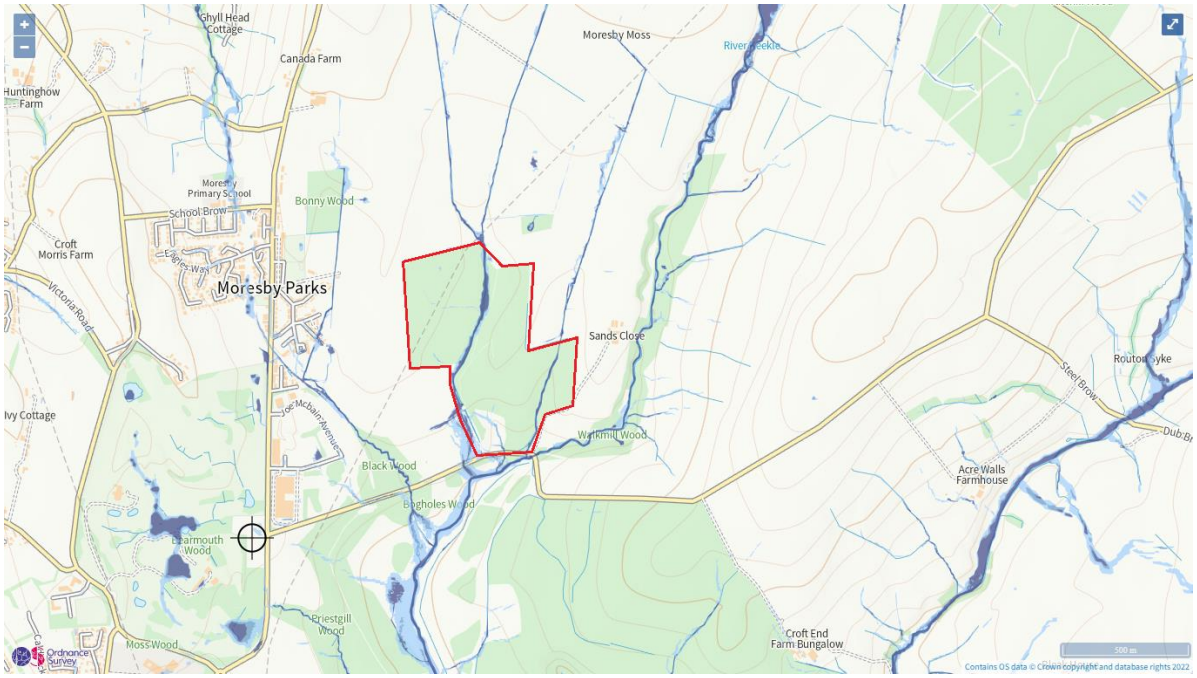
There are no properties or assets within the development site and therefore no receptors at risk of flooding. The Environment Agency flood map shows the entire site is located within Flood Zone 2 and has an overall 'Medium' risk of flooding. However, detailed flood risk maps suggests "Very Low Risk" overall for both types of flooding (from rivers/streams and from surface water). We understand the close proximity of the River Keekle to the Walkmill site is the reason for the 'Medium' risk but the local ground conditions and in particular the elevated nature of the Walkmill site (above the floodplain) allows us to draw the conclusion that there is no risk of flooding. We employed an external consultant to undertake flood risk modelling based on the proposed interventions, and they concluded the same (see Appendix for detailed information).

Below is a screenshot of the flood risk map:



There is no risk of flooding from rivers across the site – the nearest is the River Keekle which sits approximately 3m below the valley bottom therefore we consider this site to be safe from flood risk, and none of the proposed interventions will increase risk (see detailed design information in Annex).

However, there is some risk of localised flooding from surface water – between 'high' and 'low' – as shown on the surface water flooding map:



The existing watercourses do pose some minor risk of flooding, but this will be contained within the site and there are no properties affected. Furthermore, our designers conducted flood risk modelling and concluded: "*The modelling undertaken shows flood extent reduction to the fields towards the south of the site for all of the return periods modelled as a result of the new cascade channel directing the majority of flow to the east. This consequently results in some small areas of increased flooding in this area when compared to baseline for all of the return periods modelled. There are other minor reductions and increases elsewhere through the modelled reach as a result of the new features proposed e.g. new sinuous channels, for all of the return periods modelled. There are no at risk properties within the modelled extent therefore there are no negative flood risk impacts that impact people or property*".

Yours Sincerely,

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Director
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Appendix – Flood Risk Modelling and Assessment

3. Model Build and Results

3.1 2D Model Build

To undertake the fluvial flood modelling for the proposed river and floodplain restoration design on land at Walkmill Woodland, a 2D HEC-RAS model (version 6.1) of the study reach of the two watercourses flowing through the site has been developed, using available Environment Agency 1 m cell size LIDAR. The model was developed using a 1m cell size grid to enable suitable representation of the channel, and floodplain and associated floodplain flow routes.

The purpose of the modelling was to understand the fluvial flood impact of the proposed restoration design for the study site at Walkmill Woodland.

The proposed river and floodplain restoration design is to improve the hydromorphological functioning of the watercourse and to create improved wetland within the site area. The proposed design is shown in Figure 2.21 above and includes:

- creation of offline, online and seepage ponds
- creation of wetlands
- creation of channel widening
- creation of new sinuous channels / bifurcating channels
- creation of ditch cuts
- removal of concrete lined channel
- creation of wood features
- creation of a cascade channel
- creation of ditch blocks
- creation of channel infill

The modelling has used the EA LIDAR data to represent the channel and floodplain. model section data to inform this based on the nearest cross-section data available within the current main channel. Geometry modification polygons have been added to the model to reflect the proposed river and floodplain restoration design. The resulting model surface is shown below in Figure 3.1.

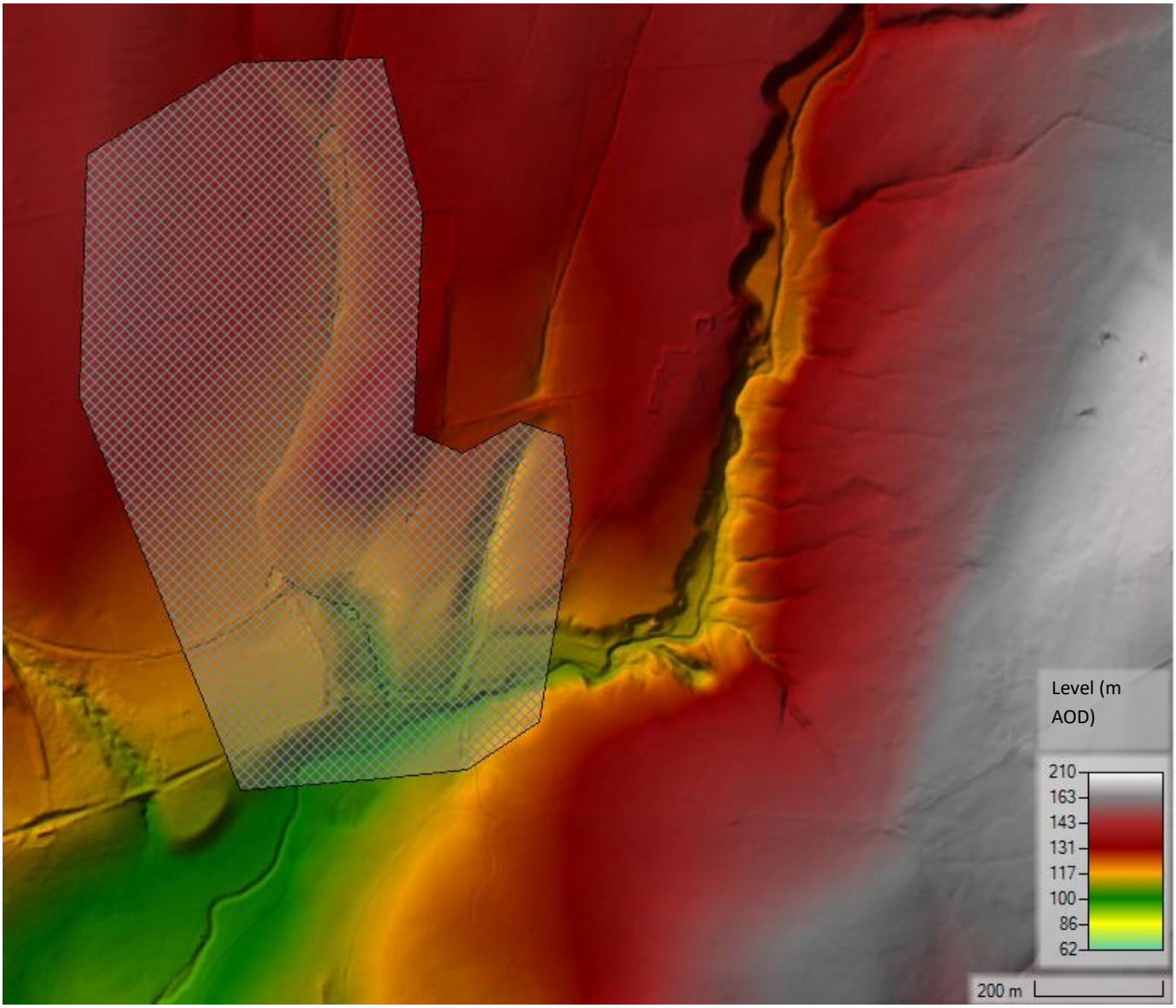

Figure 3.1. Model surface / DEM

The model has also assessed the impact on flood risk both locally, upstream and downstream through use of a flow monitoring line at the downstream extent of the model.

The model has been built using a Digital Elevation Model (DEM) across the model domain that provides a ground elevation value for each model grid cell. The model extent is shown in Figure 3.2 below, this also shows the grid orientation.

Figure 3.2. Model extent for the Walkmill Woodland reach

3.2 Model Run Parameters

Default parameters were used in the 2D HEC-RAS model setup. Simulated depths, velocities, water level, bed shear stress, and flow were output to assess flood extents across the model domain. Monitoring lines were used at the downstream end of the model to determine likely downstream flood risk impacts. Model outputs were sensibility checked. The downstream boundary of the model is a normal depth boundary, with the rating calculated using the underlying model surface information.

Manning's 'n' roughness values

Manning's 'n' roughness coefficients have been applied to the 2D model surface and have been informed through published information with regards to appropriate roughness values[1]. These values are:

Model domain feature	**Manning's 'n' value**
Open channel – low energy river system with some in-channel vegetation growth	0.045
Floodplain – some high grass and light brush/vegetation cover, generally similar across whole model domain	0.05

[1] Chow, V.T. (1959) Open Channel Hydraulics. McGraw-Hill, New York

3.3 Hydrology

Flow inputs to the upstream end of the 2D model domain for the two main channels flowing through the study site were derived from an AutoRefH (RefH2) approach. For the purposes of this modelling assessment, a 1 in 100yr plus allowances for climate change[2], 1 in 20yr and 1 in 2yr return period flood event have been run through the model. The corresponding flows were:

Eastern channel:

- 1 in 100yrCC (+20%) – 4.2 m^3/s
- 1 in 20yr – 2.0 m^3/s
- 1 in 2yr – 1.0 m^3/s

Western channel:

- 1 in 100yrCC (+20%) – 2.9 m^3/s
- 1 in 20yr – 1.5 m^3/s
- 1 in 2yr – 0.7 m^3/s

3.4 Flood Extent Change

Flood modelling for the current and restored site scenario has been undertaken to determine the fluvial flood risk impacts as a result of the proposed scheme. This has been undertaken for the 1 in 100yr plus allowances for climate change, 1 in 20yr and 1 in 2yr event. *Note – the scheme does not address or model overland flow routes impacting the site that originate outside of the scheme boundary and wider area. Therefore, the extent of wetting under baseline conditions from these sources is not explicitly shown and is not being addressed by the proposed restoration measures.*

Figures 3.3 to 3.5 demonstrate the flood extent changes for each of the flood return periods listed above, with baseline shown in blue and the restored scenario shown in red (no change areas are shown in purple). The figures show flood extent reduction to the fields towards the south of the site for all of the return periods modelled as a result of the new cascade channel directing the majority of flow to the east. This consequently results in some small areas of increased flooding in this area when compared to baseline for all of the return periods modelled. There are other minor reductions and increases elsewhere through the modelled reach as a result of the new features proposed e.g. new sinuous channels, for all of the return periods modelled. There are no at risk properties within the modelled extent therefore there are no negative flood risk impacts that impact people or property.

[2] https://environment.data.gov.uk/hydrology/climate-change-allowances/river-flow

Figure 3.3. 1 in 100yrCC flood extent change, blue = baseline, red = restored (where red is visible indicates flood extent increase, purple indicates no change and blue indicates reduction in flood extent).

Figure 3.4. 1 in 20yr flood extent change, blue = baseline, red = restored (where red is visible indicates flood extent increase, purple indicates no change and blue indicates reduction in flood extent).

Figure 3.5. 1 in 2yr flood extent change, blue = baseline, red = restored (where red is visible indicates flood extent increase, purple indicates no change and blue indicates reduction in flood extent).

The impact of the proposed restoration works on the 1 in 2yr flood event downstream is confirmed by Figure 3.7 below that suggests a small delay in the risk to the peak of the modelled event as a result of the proposed restoration scheme (likely a result of the storage potential offered by the ponds and wetlands etc). This is similarly true for the 1 in 100yr plus allowances for climate change flows (Figure 3.6), but to a lesser extent.

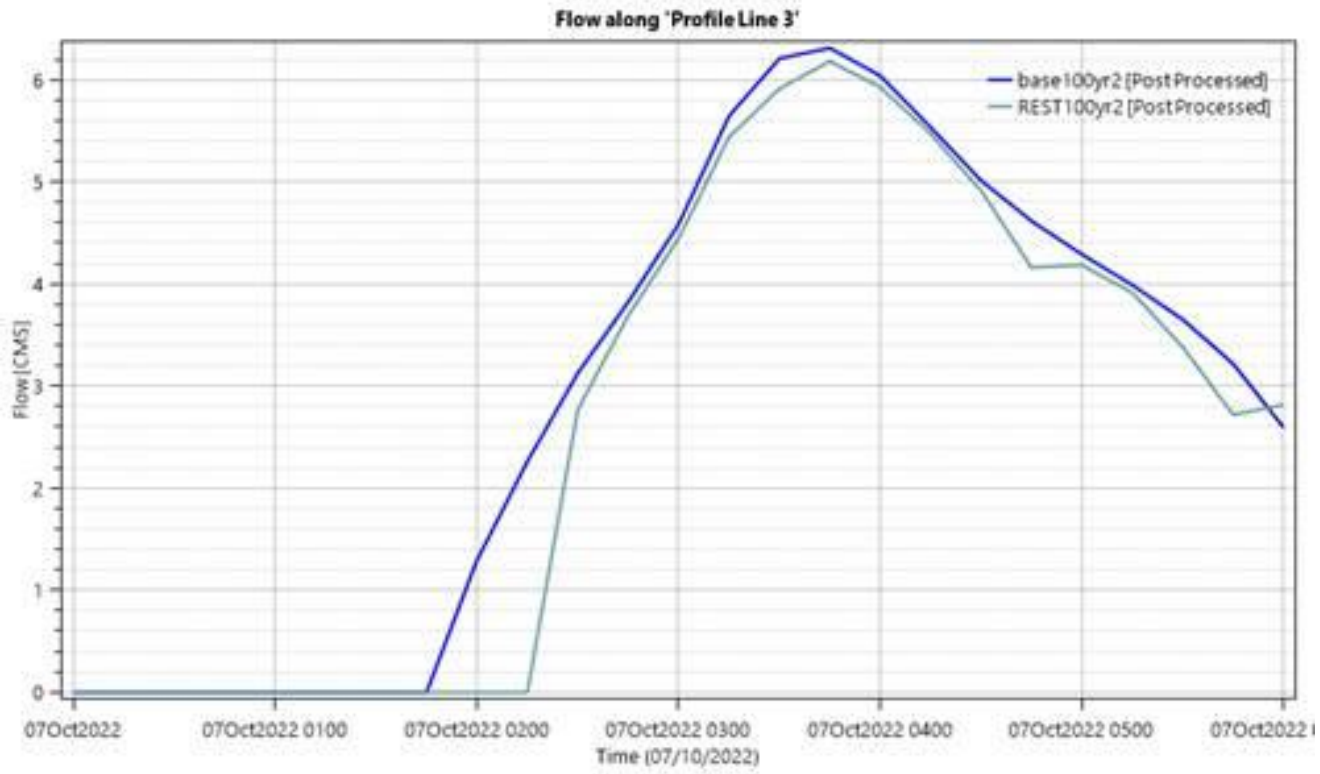

Figure 3.6. Downstream hydrograph comparing baseline (blue) and restored (green/grey) flows for the 1 in 100yr plus allowances for climate change event.

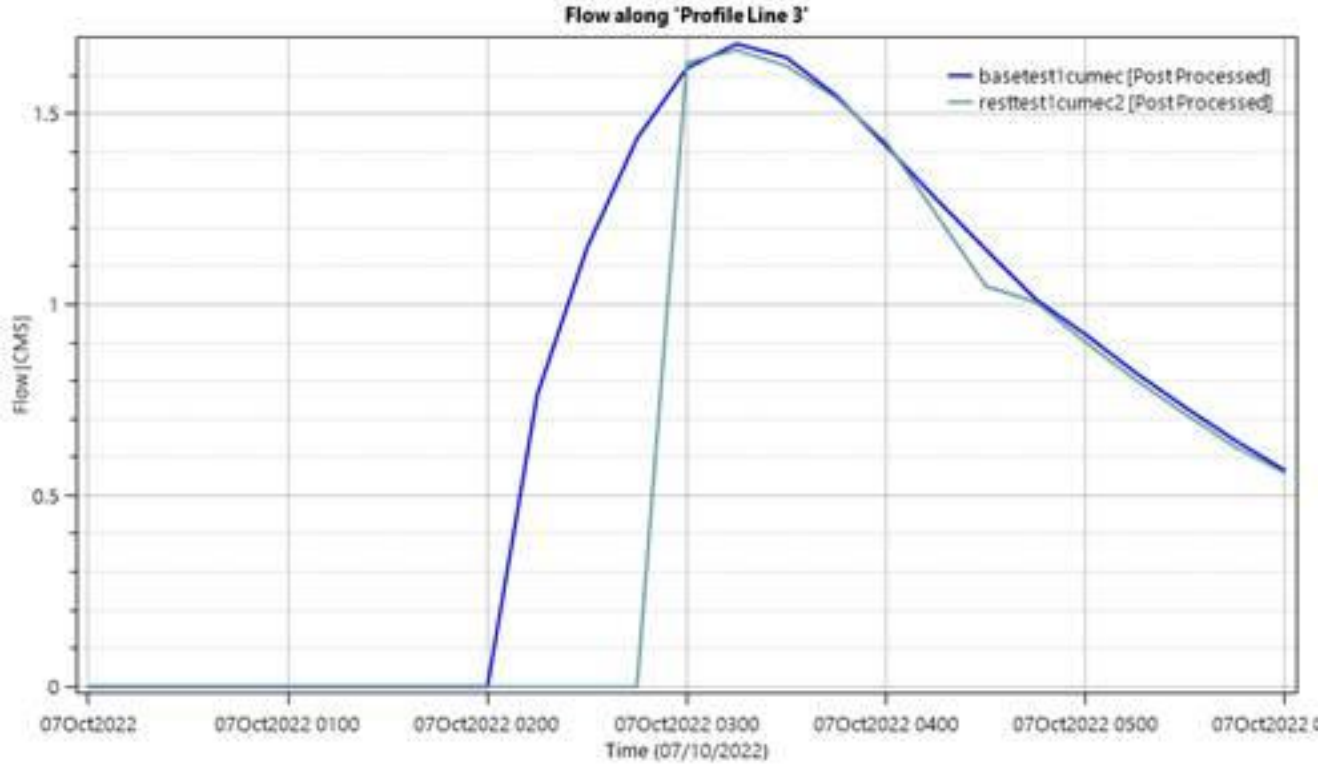

Figure 3.7. Downstream hydrograph comparing baseline (blue) and restored (green/grey) flows for the 1 in 2yr event.

4. Conclusions

- West Cumbria Rivers Trust (WCRT) commissioned Dynamic Rivers to undertake modelling to understand the flooding implications of a proposed river and floodplain restoration design to be undertaken by West Cumbria Rivers Trust on land at Walkmill Woodland, Cumbria.
- Following a desk and field study, it was identified that the majority of channels within the study area are artificial and very straight, with remnant features linked to historic mining of the site and all watercourses generally acting to drain the surrounding landscape. All watercourses confluence with the River Keekle to the south of the site.
- The general land use at Walkmill Woodland is a mix of woodland and scrub, with watercourses generally flowing through a relatively confined valley with little floodplain. The artificial channels that flow through the site are generally straight and often concrete lined in the lower reaches of the site. These lined channels offer opportunity for removal of the concrete lining to provide a more natural channel and bank profile. Straight channels could also be improved by creating more sinuous channel planforms. Elsewhere, ditch networks significantly alter the hydrology across the site by efficiently draining the land and conveying the water quickly downstream. These networks offer opportunity for restoration works.
- 15 contamination samples were taken across the site where works are proposed. Overall, there were no elements present at levels that present an environmental risk although elevated levels of Copper, Calcium and Zinc were occasionally found. One sample from the infill on the central pond presented a risk of Copper toxicity, however two other samples from this infill had lower levels suggesting that on average the material is safe to handle provided the contractor is made aware of the sample results prior to any works.
- To undertake the fluvial flood modelling for the proposed river and floodplain restoration design on land at Walkmill Woodland, a 2D HEC-RAS model (version 6.1) of the study reach of the two watercourses flowing through the site has been developed, using available Environment Agency 1 m cell size LIDAR. The model was developed using a 1m cell size grid to enable suitable representation of the channel, and floodplain and associated floodplain flow routes.
- The modelling undertaken shows flood extent reduction to the fields towards the south of the site for all of the return periods modelled as a result of the new cascade channel directing the majority of flow to the east. This consequently results in some small areas of increased flooding in this area when compared to baseline for all of the return periods modelled. There are other minor reductions and increases elsewhere through the modelled reach as a result of the new features proposed e.g. new sinuous channels, for all of the return periods modelled. There are no at risk properties within the modelled extent therefore there are no negative flood risk impacts that impact people or property.
- The modelled impact of the proposed restoration works on the 1 in 2yr flood event downstream suggests a small delay in the risk to the peak of the modelled event as a result of the proposed restoration scheme (likely a result of the storage potential offered by the ponds and wetlands etc). This is similarly true for the 1 in 100yr plus allowances for climate change flows, but to a lesser extent.

Recommendations

- It is critical that the hydraulic regime across the site is in line with the newly created features to ensure the site will function, it is recommended that Dynamic Rivers supervises the site works during construction, as detailed in the accompanying Method Statement.