

The Highland Council have commissioned consultants WSP to design a Flood Protection Scheme for Drumnadrochit. Sub-consultants cbec eco-engineering has also been appointed to look at the River Enrick.



Flooding during the 1997 event (above) and 2006 event (right).



The general consensus of scientific opinion is that climate change is making our weather wetter with more storms anticipated and the likelihood of flooding is therefore increasing. This together with the evidence from past flood events, notably 1997, 2006 and 2016, means that it is sensible to install flood protection measures.

The Highland Council has a duty towards flood risk and this commission is to provide detail design and oversee construction of the measures proposed. This present work follows on from an earlier study.

The earlier study suggested various embankments at Kilmichael (to address “nuisance” flooding of the A831) and at Drumnadrochit to protect houses. A wall was also proposed downstream of the A82 road bridge.

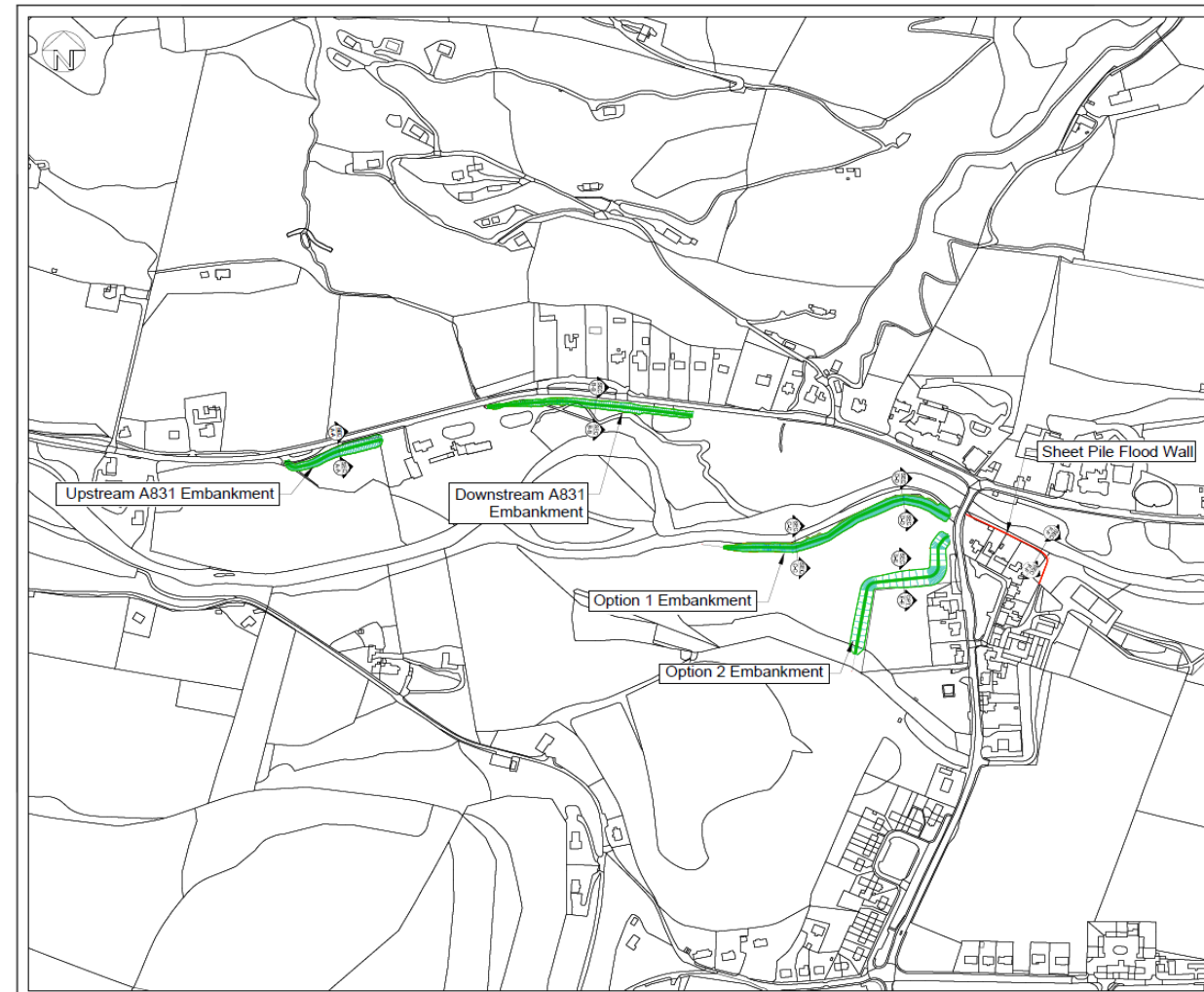
An option for either an embankment alongside the river, or a “set-back” embankment was also offered.

This was the starting point for this present study which, as you will see, has been further analysed and refined.

There have also been additional studies looking at ecological concerns, protected and invasive species, trees, and importantly ground investigations.

Computer modelling has also played an important part of the design which is explained later.

The proposed measures are described in the following boards.



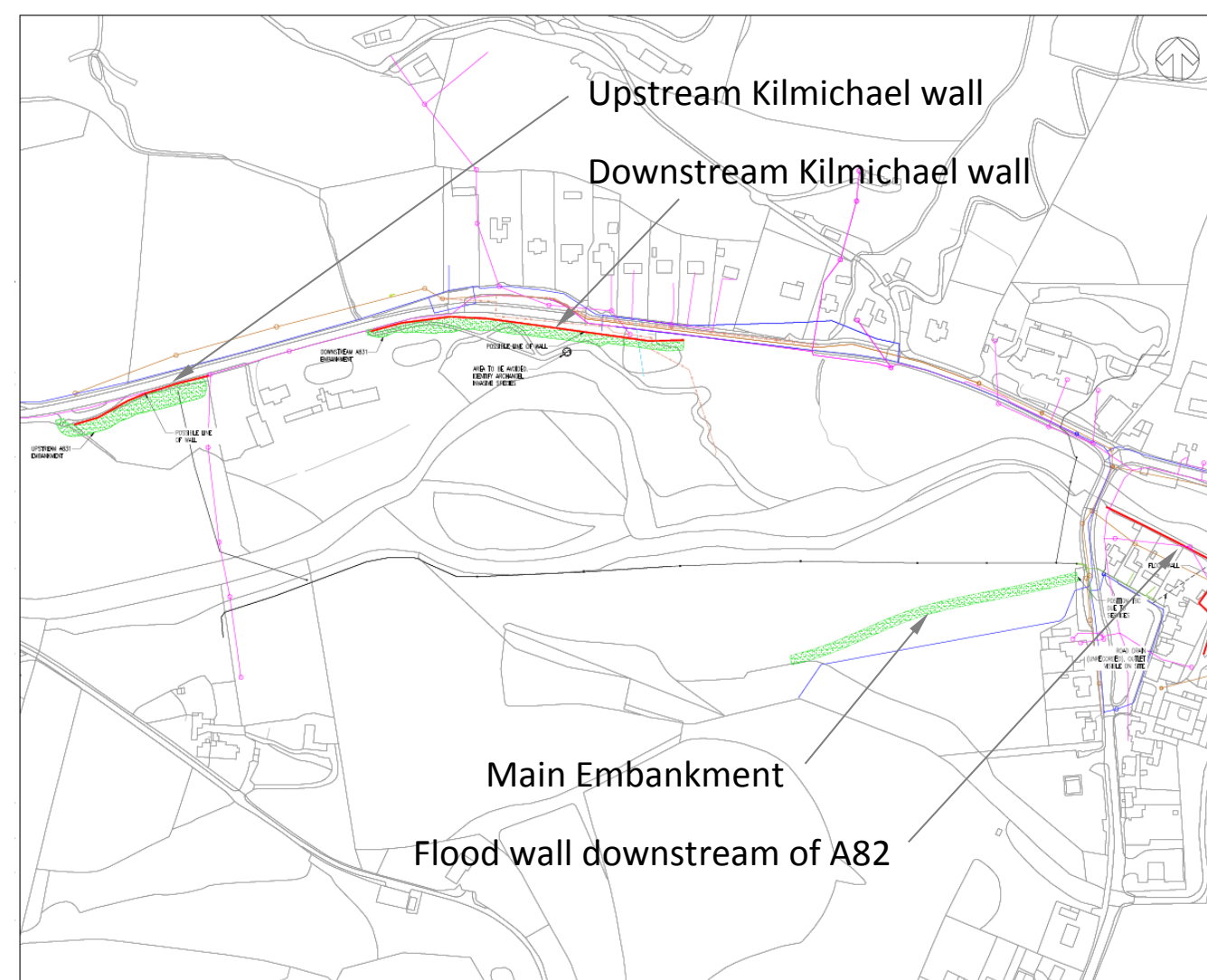
The Proposals from the original study produced during 2016.

There has been a significant amount of computer modelling of the River Enrick which is based on a topographical survey (land elevation). This can then provide information on where flood water may flow under certain storm conditions. The scheme aims to provide protection for Drumnadrochit up to the 200 year storm event which will also take account of climate change.

Several iterations of an increasingly refined model have informed us of where, and to what extent and height, each measure should be designed to.

Physical measures include walls and embankments as shown in the plan. Other measures have been considered such as including an overflow channel across the loop in the River Enrick at Kilmichael.

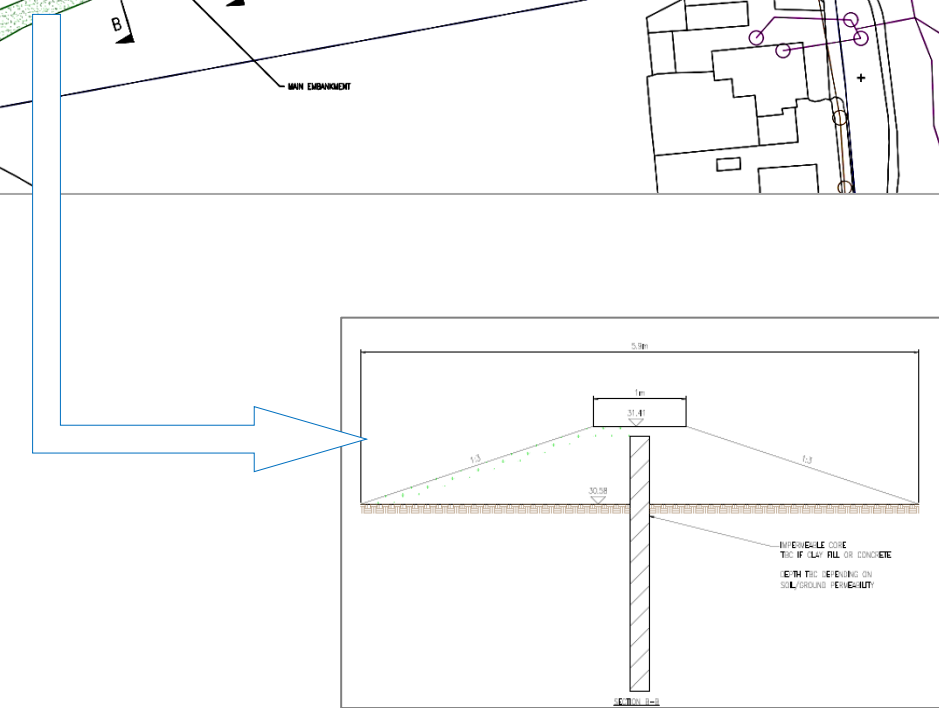
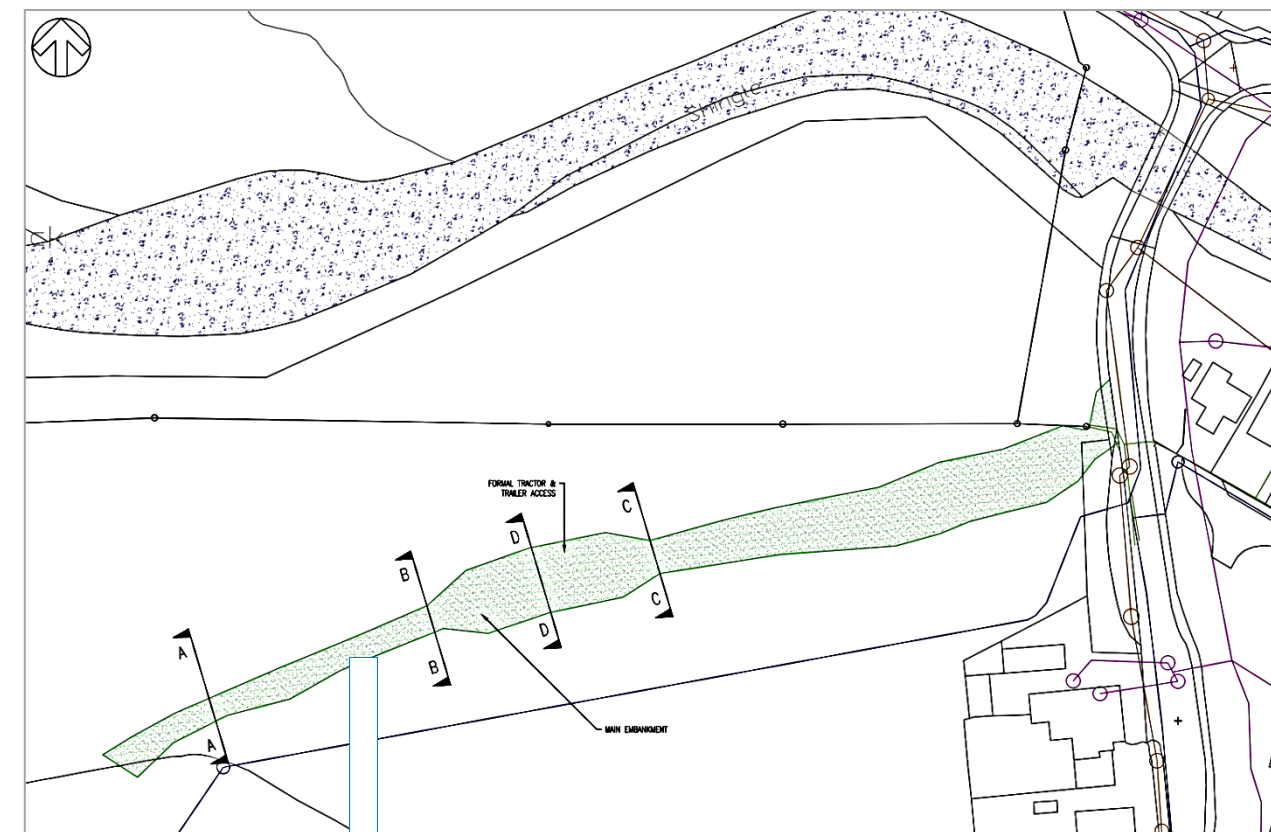
Flooding on the A831 occurs more frequently but for these lower “return period” events no properties are flooded and this balance between protection and cost of construction needs to be carefully considered.



After careful consideration and taking into account environmental concerns, it has been decided that the set-back embankment is the best option. This means that protected species including otters and badgers will not be disturbed, or minimally so, compared to an embankment along the Enrick. It also means that there is additional flood storage in the field which will further help to reduce flood risk overall.

One concern about this location is the pressure of water pressing through the soft ground which is made up of sands and gravels and means that water may seep underneath the embankment. To address this, another computer model is used to analyse flow and the depth of the waterproof core that will be necessary as part of the construction. This is explained later in Board 8.

The plan shows the footprint of the embankment. Note that it will be wider towards the post office where the land is slightly lower and the base of the embankment spreads out due to the increased height.



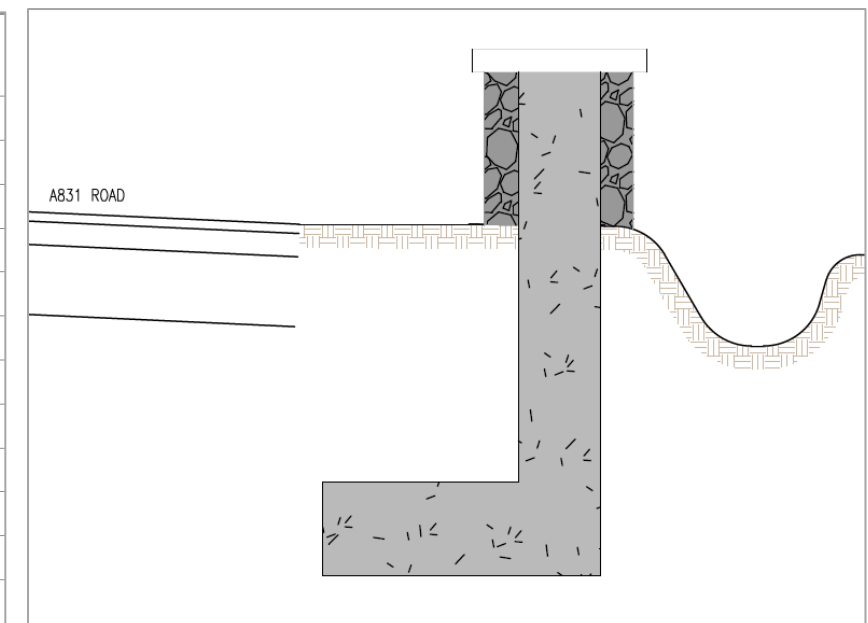
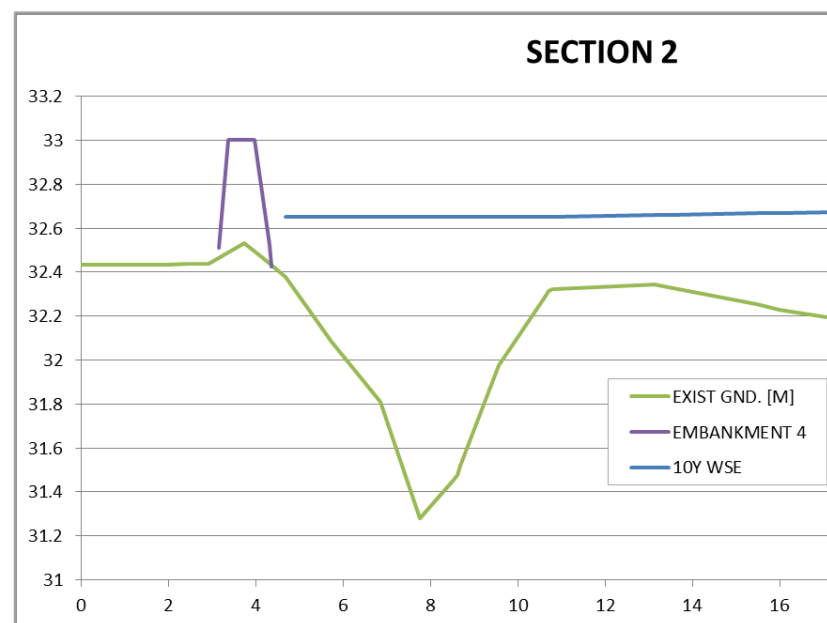
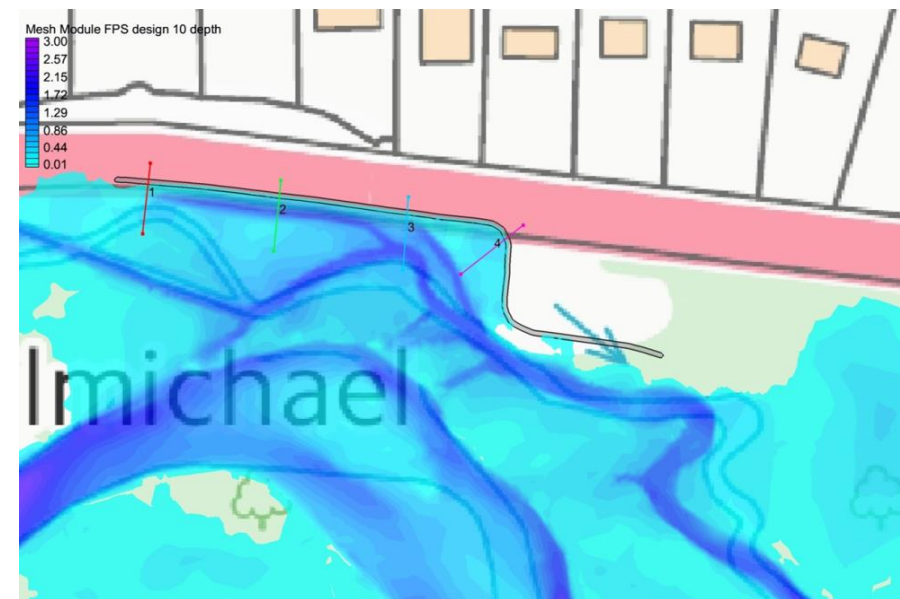
The A831 has suffered from occasional flood events causing road closures and road safety concerns. These events occur more frequently than the larger events that affect the A82 and Drumnadrochit and although they are less likely to affect properties they are still of concern.

With careful analysis and suitable design this can be remedied without excessive expense but much more extreme storm events still need to be analysed. This is to ensure that by installing something to address smaller flood events we don't make the more extreme event even worse, for example by retaining flood water that might otherwise return to the river.

There is limited space to construct flood protection along the roadside and this measure is likely to be a wall.

We also need to consider road safety which may force us to set back the wall a short distance from the road to ensure drivers have a clear line of sight.

A second wall further west (past Aldergrove House) is still being considered, but flooding on this part of the road is less of a problem and may not be necessary.



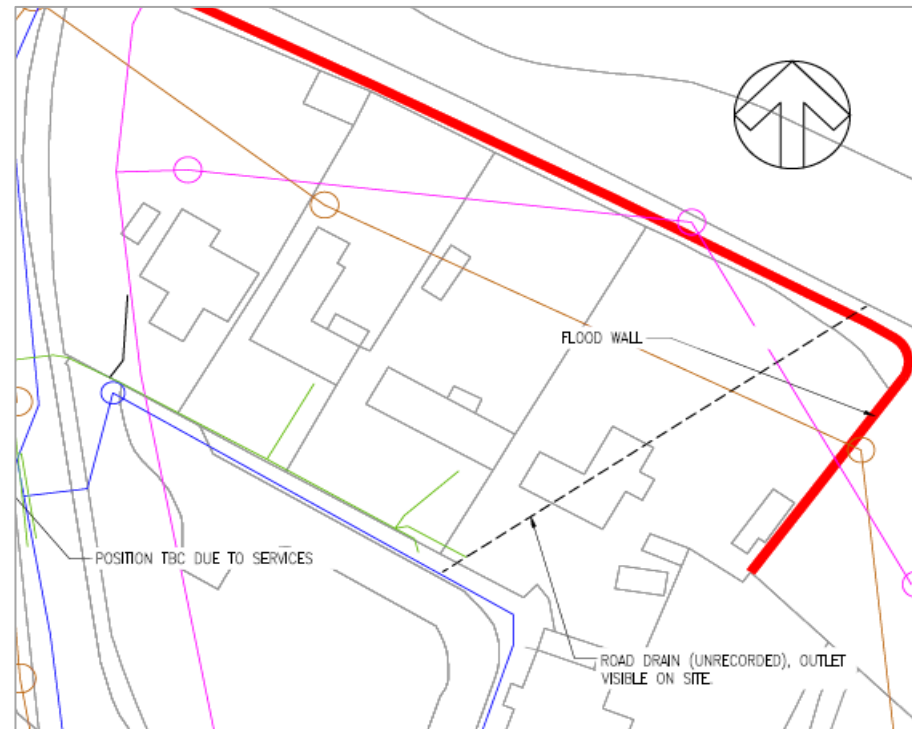
DRUMNADROCHIT FLOOD PROTECTION SCHEME

WALL DOWNSTREAM of A82 – BOARD 6

The houses downstream of the A82 road bridge have gardens that run down to the river bank. Computer modelling predicts that flooding could occur for very large storm events and a flood wall in proposed along the backs of the gardens.

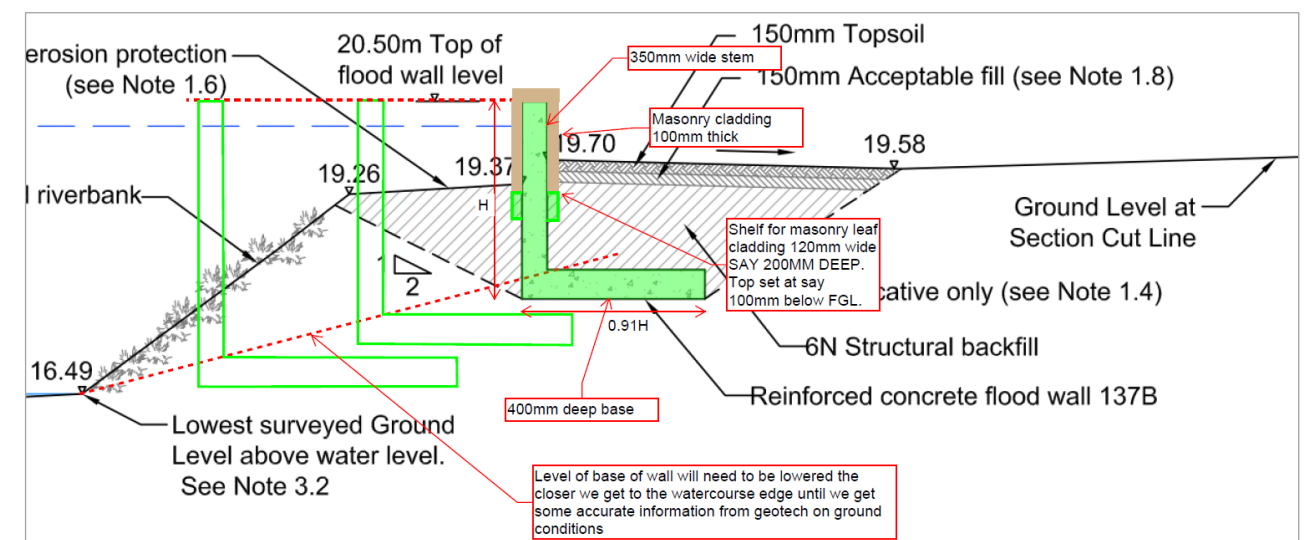
There is very little space for construction at this location again and it is important to consider any existing assets in the gardens, including out-houses. This compromises the initial design along this area and whilst an engineering solution will be found, we also need to consider minimising disruption and keeping any risk to the water environment to a minimum.

It is likely that a wall along the gardens of Bridgened House, Greenlea, Mackes and Eastlea will only be around 1m high and will be tailed-in towards higher ground at the farm.

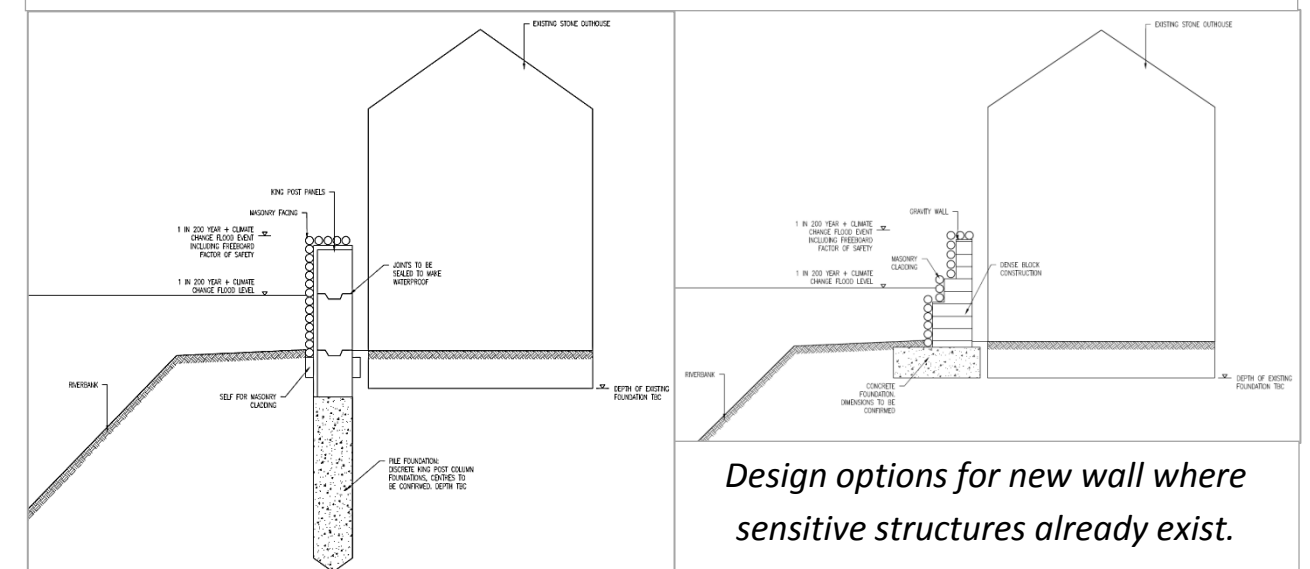


Access to the river may still be possible via steps or perhaps flood gates although no decision has been made on this yet.

Other considerations in this area include a BT cable and pole and drainage infrastructure.



Design for new wall where no garden buildings presently exist



DRUMNADROCHIT FLOOD PROTECTION SCHEME

SOILS and INFILTRATION – BOARD 7

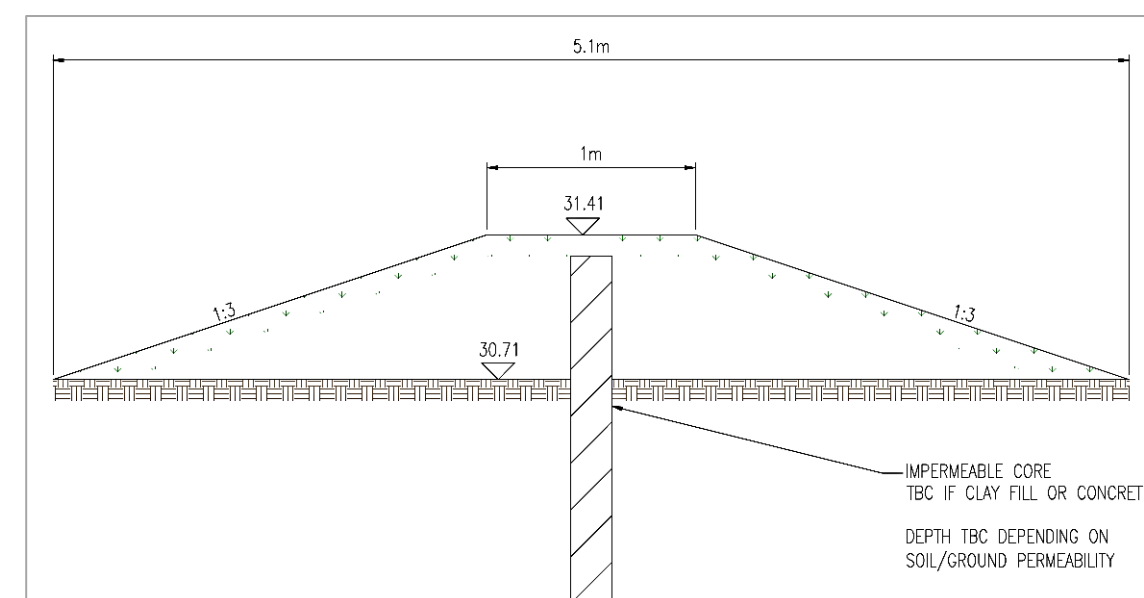
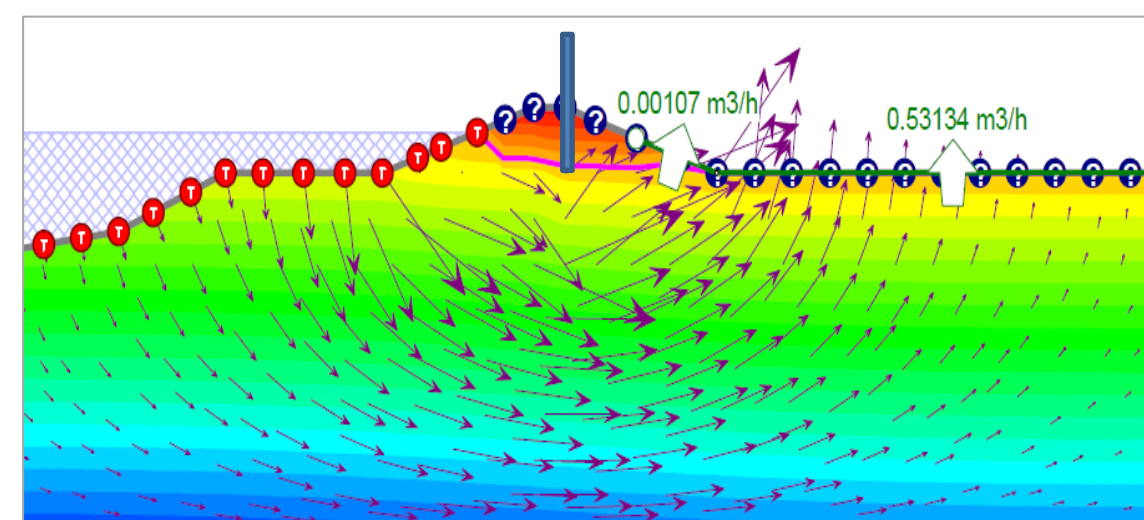
The soils in the area of Drumnadrochit are generally quite permeable, which means that any water below ground level (groundwater) can flow with relative ease, although not fast. Seepage under flood protection measures is a concern and constructing flood protection measures cannot ignore this. We are in the process of finalising calculations that will inform final design of the necessary protection detail below ground.

Following the same principles, we must also ensure that flow cannot pass through the embankment and a central waterproof core will be integrated within the construction to ensure no leakage through the flood defence. Flood walls will, by their construction, form an impermeable barrier against this flow although we must still consider flow under each wall.

Computer modelling is being performed to calculate the flow that may pass under or through each embankment or wall. This is done by taking the initial ground conditions and calculating flow through the ground.

Then a core is installed to a certain depth or extent and the model is run again. If this initial depth or extent is not enough, or too much, another model run is made with other values and this iterative process is performed until an optimum result is reached.

The image below is an output from this model and shows one of the iterations and the direction of groundwater flow through the soil.



Example cross-section through an embankment showing how the core may be installed.

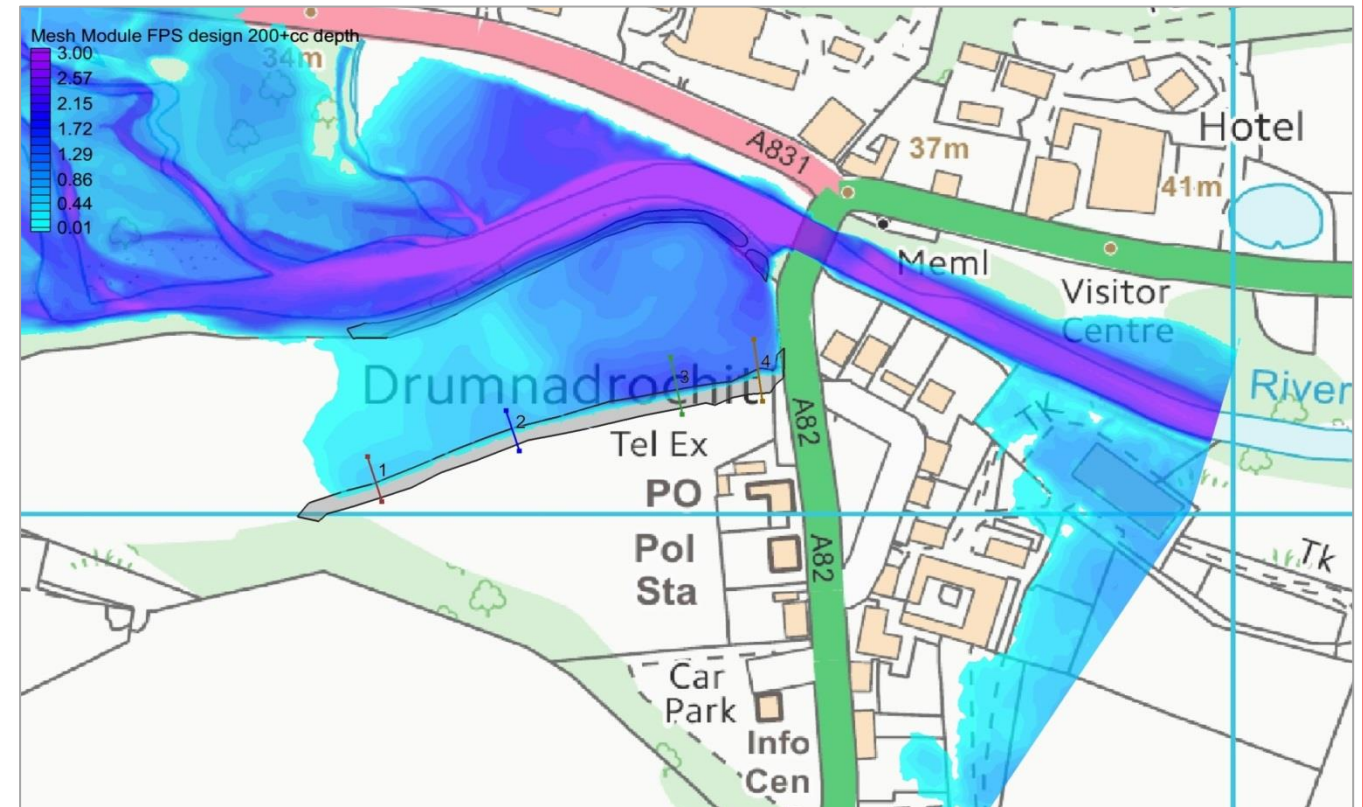
DRUMNADROCHIT FLOOD PROTECTION SCHEME

COMPUTER MODELLING – BOARD 8

Water behaves in a predictable way and it is possible to be modelled on a computer. Care is needed to predict accurately, especially during extreme conditions, but with comprehensive details of the river channels and surrounding land together with other obstacles (for example bridges, buildings) we can analyse with reasonable confidence what can result during a storm event. Our focus has been to create a good understanding of this for the River Enrick by looking at the whole catchment and location then centre with particular detail on the Drumnadrochit area – see the video on the screen for the computer model outputs and how flooding occurs when the Enrick bursts its banks.

These results are for various storm events with increasing extremes of flood. The target for Drumnadrochit is to protect to the 200 year event - quite extreme - and then also take account of climate change as an additional 20% of flow.

Outputs can be shown as still pictures (see figure), video, see screen, or presented numerically in a spreadsheet.



Computer image of predicted results for extreme event - protection measures in place

Many iterations have been modelled; the consequences of installing one defence can have a knock-on effect on other locations but a design is nearly finalised.

These measures are constructed, engineering solutions and as a next part of the study more natural methods are also being considered – see next board.

DRUMNADROCHIT FLOOD PROTECTION SCHEME

NATURAL FLOOD MANAGEMENT and OTHER CONSIDERATIONS – BOARD 9

Natural flood management (NFM) involves techniques that aim to work with natural river processes, features and characteristics to manage the sources and pathways of flood waters. This includes restoring, enhancing and altering natural features to reduce flood risk and is separate from more traditional “hard” engineering solutions.

The restoration of flood plains upstream of Drumnadrochit may assist in reducing flood risk, but we cannot ignore other effects that this may bring. In this case the loss of good agricultural land may result and this may not prove beneficial in the long term.

Another obvious measure is installing a hydraulic restriction at the outlet of Loch Meiklie which could hold back high flows for longer within the loch. This may offer a significant amount of flood storage but again could have some drawbacks.

These and other measures have already been looked at and are now being taken forward for further consideration.

Environmental aspects have also been examined with ecological surveys performed for protected and invasive species. The location of the proposed defences has very limited impact on any protected species.

We have also consulted with SEPA (and will continue to do so), SNH, ND Salmon Fisheries Board, N&B Fisheries Trust, RSPB and Scottish Water and in addition we need to take account of any infrastructure, for example phone cable or electricity supplies.

Overall the design will fit the purpose of reducing flood risk to Drumnadrochit with minimal adverse impact.

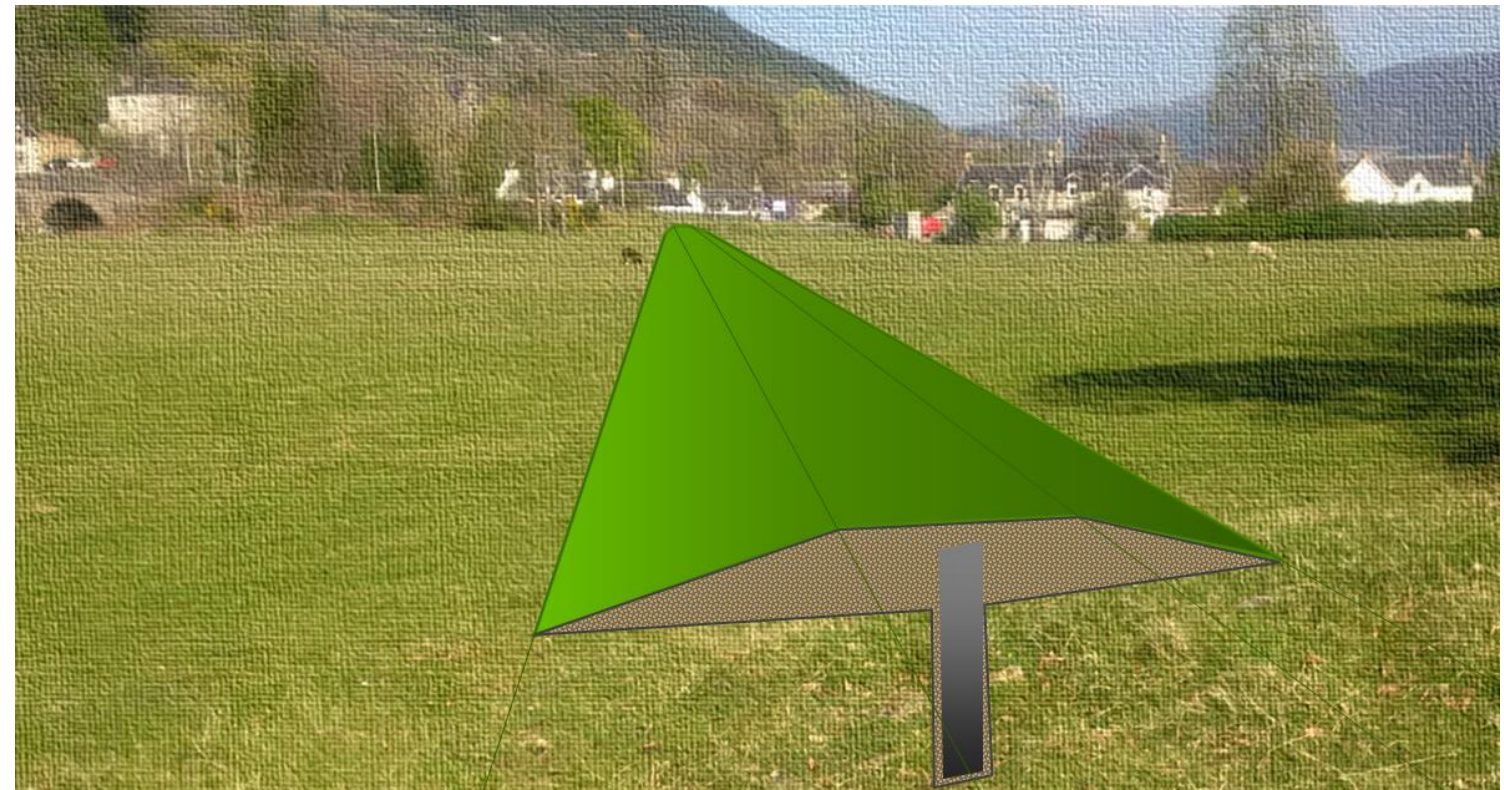


*An otter caught on camera on the
banks of the River Enrick*

We have nearly completed our design study and the final defences will not vary much from what you have seen.

Once all the above matters have been addressed and when we are satisfied that the optimum flood defence suitable for the wider environment of Drumnadrochit has been reached we will initiate proceedings with the Scottish Government and other regulators before then commissioning a contractor to take construction forward. This is likely to be next year. Prior to this other enabling steps will be needed to ensure that phone lines or water supplies are not interrupted. Another ecology survey will also be necessary as a final check that we are not disturbing protected species.

We are confident that even with climate change the measures that are proposed will serve Drumnadrochit for many years to come and ensure that flood risk is kept to a minimum.



An artist's impression (with cut-away and impermeable core) to show what the main embankment might look like