

Mill Beck: a lesson in Reservoir Safety works aligned with public engagement and a participatory design process

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SYNOPSIS Following a review by the Environment Agency, a disused railway embankment structure has been designated a category A large raised reservoir. A spillway is now required capable of safely passing the Probable Maximum Flood. This will be a substantial structure 100 metres long and 60 metres wide. In initial consultations the local community challenged the need for the scheme. The project team therefore engaged with landscape planners and architects to develop an integrated design in close consultation with local people.

INTRODUCTION

Mill Beck Balancing Reservoir in Market Weighton is formed by a disused railway embankment to the north of the town centre. The reservoir is formed by a railway embankment which cuts across the valley, then splits: one line forming the dam crest and the other bifurcating the reservoir basin. At the downstream point of the reservoir valley the railway embankment, and therefore dam crest, is approximately 5m high.

A culvert runs through the embankment, conveying flows in Mill Beck. The penstock fitted to the culvert inlet is normally kept 100mm open, thus throttling flows in Mill Beck and temporarily storing this water upstream of the embankment. Should the reservoir impound water to the dam crest level this would be a volume in excess of 350,000m³. As such, the structure has been classified as a Large Raised Reservoir under the Reservoirs Act 1975.

An inspection of the reservoir was carried out in November 2008. The reservoir was assigned as 'Category A' and as such must be capable of safely passing the Probable Maximum Flood (PMF). Following the inspection, recommendations were made in the interests of safety under Section 10(6) of the Act, which have led to a requirement for a formal spillway structure to be provided over the dam structure, ensuring the

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reservoir can discharge in a controlled manner so as to ensure the dam's stability is maintained at all times.

The existing dam structure currently reduces flood risk to properties downstream in Market Weighton. Any works to modify the dam or the culvert are likely to change the level of flood protection currently afforded to the town.

Through a process of engagement, design development and consultation, the engineering design team and the All Reservoirs Panel Engineer remained flexible in their approach to the hydraulic design of the spillway, open to considering changes which would deliver optimum hydraulic performance whilst enhancing the aesthetics of the downstream space and local environment. This collaborative working, which acknowledged the importance of both technical and social compliance, led to the most appropriate solution for the site.

This paper aims to set out the process the project team went through with the local community in order to balance engineering requirements and local aspirations, and the changes made to the engineered design to accommodate stakeholders' requirements.

SITE SETTING

The railway embankment which forms the dam structure is nominally 100m wide at the proposed location of the spillway structure, with side slopes of typically 1 in 2.5. The site was once the location of the local railway station, as well as goods yards. There is a playground located immediately downstream of dam which will be affected by all the potential solutions considered. This playground will require temporary closure/relocation for the duration of the works and reconstruction upon completion of a scheme. In addition to this there are a number of footpaths, either running along the existing embankment or providing access to the playground from the railway embankment (Figure 1). In an event when the spillway operates water will discharge through this play area before continuing towards Market Weighton. It is therefore important that the play area includes some energy dissipation function during operation of the spillway.

Through our initial site visits we observed that the railway embankments are used extensively by the people of Market Weighton as a green space. The embankment and periphery of the playground is densely vegetated with a mixture of mature broadleaved trees, scrub and an area of low nutrient grassland on the crest of the bank. This vegetation is likely to be used by breeding birds for nesting. In addition to this, three trees were assessed as being at medium risk of being potential bat roosts. There are no other protected species issues on site.

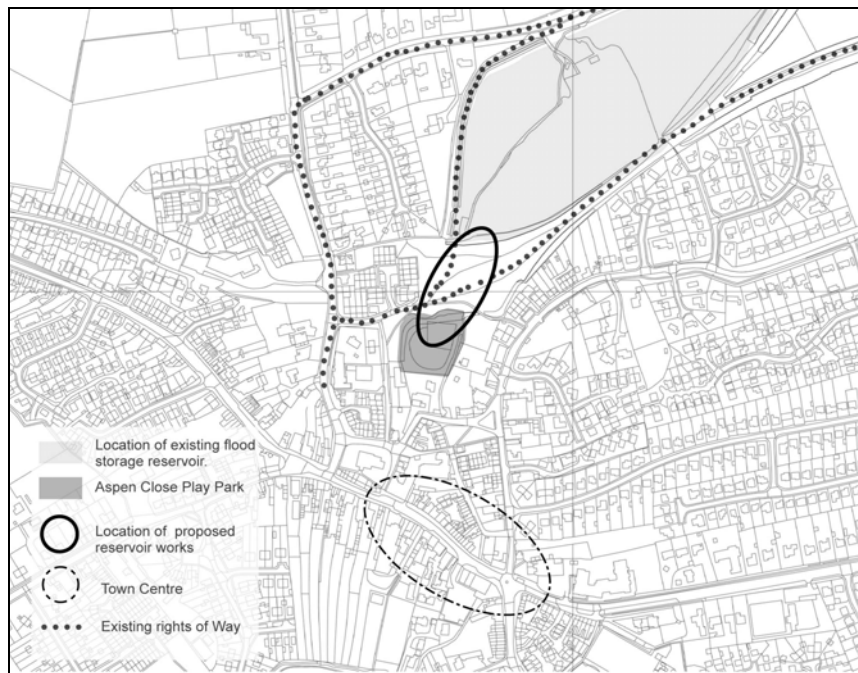


Figure 1. Location Plan

In terms of landscape, the site lies within the Wolds Area of Landscape Protection as defined in the East Yorkshire Borough Wide Local Plan. The site also lies within Landscape Character Area 10h (West facing scarp slope of the Yorkshire Wolds) of the East Riding of Yorkshire Landscape Character Assessment. Any works will have a visual impact on residents on surrounding streets backing onto the embankment and playground. People using the footpaths that run along the railway embankment will also be affected.

The area of the proposed works has a number of important amenity roles. The railway embankment provides a route for an important part of the local public rights of way network, including the Hudson Way and the Wilberforce Way. It also links into the Yorkshire Wolds Way. A number of footpaths also provide access to the playground to south of the embankment and access into the centre of Market Weighton. The playground also provides a valuable amenity facility for the neighbouring residential properties and Market Weighton as a whole.

Due to the environmental and local amenity importance of the proposed site, as well as the requirement to drive forward the reservoir safety works, the team considered that the opinions of local stakeholders should be included in the final layout and form of the space. To achieve the necessary stakeholder engagement their input was needed at the earliest opportunity and continuing consultation maintained throughout the design process. This would ensure the completed scheme provided suitable amenity space and

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public access, as well as ensuring that the local stakeholders understood the need for the scheme, which would hopefully ease the planning process.

THE TEAM

The Arup design team worked closely with the Environment Agency project delivery and environmental teams to develop options for delivery of a spillway. The team was guided by the Qualified Civil Engineer for the works and the Supervising Engineer for the newly designated reservoir. The Arup core team included landscape planners and architects from the point when a spillway solution was confirmed. By working closely with each other the design team could appreciate the possibilities for minimising the impact on the immediate surrounding area. The landscape architects appreciated the engineering constraints of providing a safe spillway structure and were able to develop options within these confines – also questioning the engineering requirements at times.

CONSULTATION PROCESS

Consultation with the local community is embedded in the Environment Agency's project management process. The method, called "Working With Others" (WWO), recognises the importance of public views and concerns when a project is proposed. It seeks to engage with interested and affected parties - "stakeholders" - and include them in discussions and, where possible, decisions as the scheme develops.

Under WWO, stakeholders are identified and assessed based on the degree that they could be affected by the scheme and the amount of influence they might have. This enables the consultation and engagement to be focused on those who are judged to be both "most affected by" and have "most influence on" project outcomes.

For the Mill Beck scheme, this led to meetings with councillors from the local unitary authority and the Town Council and some public drop-in sessions. Discussions and presentations centred on need for the scheme; the legal framework of the Reservoirs Act; the possible solutions being considered and the timing of the project. These were all held early in the process so that stakeholders could influence the options 'long list'.

As the scheme was being driven by the requirements of the legislation it was important to make clear, from the outset of consultations, the limitations on the influence that stakeholders could have on the selection and detail of the preferred option.

The 'long list' of options developed through the consultation process was explored and finally a preferred solution was developed. This solution required a formal spillway structure to be constructed across the railway embankment, to safely pass flood flows in an extreme event. The existing railway embankment provided a standard of protection to Market Weighton

of 1 in 800 years, albeit utilising an ageing railway embankment which was not designed for this purpose. By cutting a spillway into the embankment, the standard of protection would be reduced to approximately 1 in 175 years. This was found to be the maximum possible standard of protection, whilst considering the space available for a spillway structure and ensuring a cost effective solution. The standard of protection was maximised by detailing the spillway with no wave surcharge allowance. The design team considered that the width of the dam crest would dissipate any wave energy and that some minor erosion from wave action could be accepted, compared to the alternative of further reducing the standard of protection provided by the dam structure (Figure 2). There were concerns that the local stakeholders would not accept the reduction in standard of protection and would not appreciate the high standard of protection still provided post-scheme.

COMMUNITY DROP-IN SESSIONS

During the design development process the Environment Agency, along with Arup as their designers, set up two public drop-in sessions. The sessions were manned by a range of Agency and Arup staff, including a senior All Reservoir Panel Engineer, environmental and landscape specialists, the Agency's flood incident management team, as well as the design engineer and project manager.

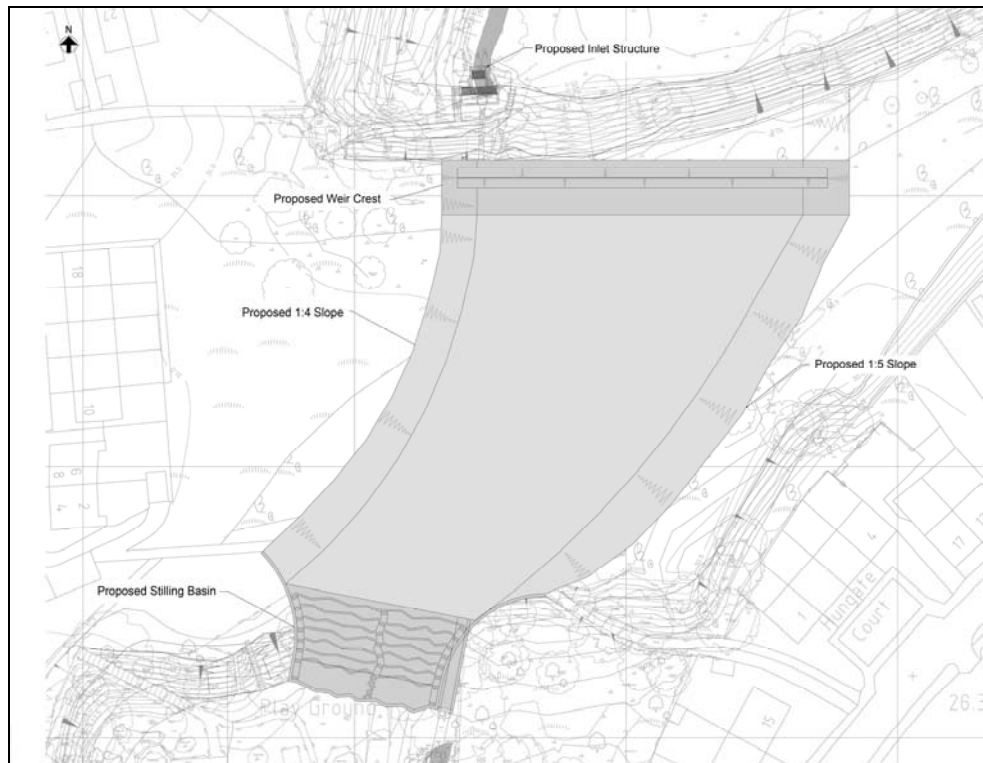


Figure 2. Basic engineered solution

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The first session presented the background of the Reservoirs Act, the need for the scheme, and an example of a typical conventional spillway solution (Figure 2). The main aim was to inform stakeholders, gauging their reactions to the proposals, and gather general comments, suggestions for potential options, and ideas for mitigation.

The second session presented the preferred option for the works. It was important to show how input from the first session had been considered and used. Members of the design team were available to discuss the engineering constraints and how the decision for the selected option had been reached. This session also gave stakeholders further opportunity for input to the final landscaping treatments in certain areas of the site.

A series of hand drawn 'sketch' layouts were available for the community to sketch ideas and write their ideas on (Figure 3) – enabling the design team to consider and incorporate any ideas from the drop-in session into the final layout.

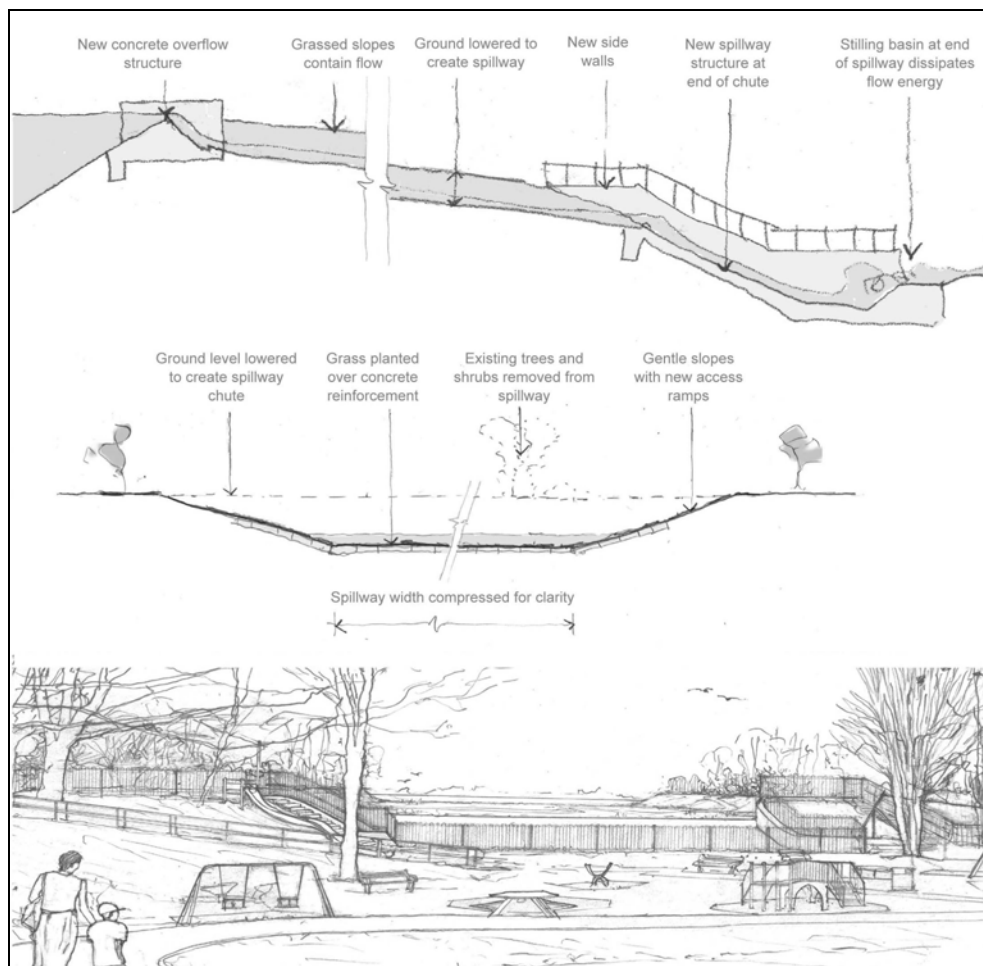


Figure 3. Example sketches used during drop in sessions

In these initial consultations the local community challenged the need for the scheme on a number of levels. One of the major issues was the extent of intrusion into the local environment. Some in the community felt that the potential damage to the landscape outweighed the scheme's benefits. To address this specific issue an environmental working group of local representatives was set up. All who had attended the drop-in sessions were invited to express an interest in taking part in the group. The group was supported by staff from the local authority's playspace team and the Yorkshire Wildlife Trust.

WORKING GROUP

Prior to the first meeting of the working group it was decided that some preparatory design work should be undertaken to help inform the design and decision making process. The landscape architect team therefore worked to develop a 'design sketch book' (Figures 4 and 5). This outlined the setting of the scheme and some history of the site. It then continued to define the different forms the structure could take and the forms the final space could take. The sketch book concentrated on the crest of the dam and the downstream face where the play area is situated, as these were seen as key areas where the scheme would impact significantly.

Primarily prepared as a source document in the working group meetings, the design sketch book was also used in ongoing discussions with local councillors.

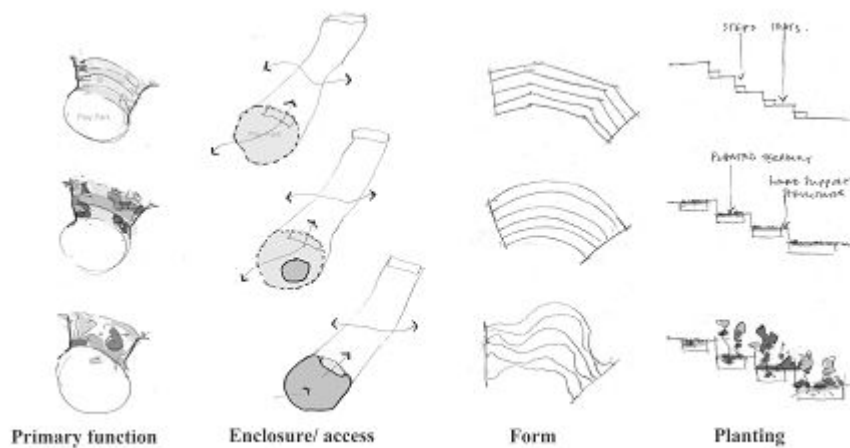


Figure 4. Excerpt from design sketch book – considering different design principles for the space, based on feedback from comments.

In total three working group meetings were held, spread across the outline design period. These enabled the ideas and concerns of the group to be minuted and taken back to the designers. Where possible the ideas were incorporated into the developing design of the structure and the space. The meetings also enabled a dialogue between the designers and community,

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which increased the understanding and appreciation for the requirement of the scheme and the technical constraints that the design had to sit within.

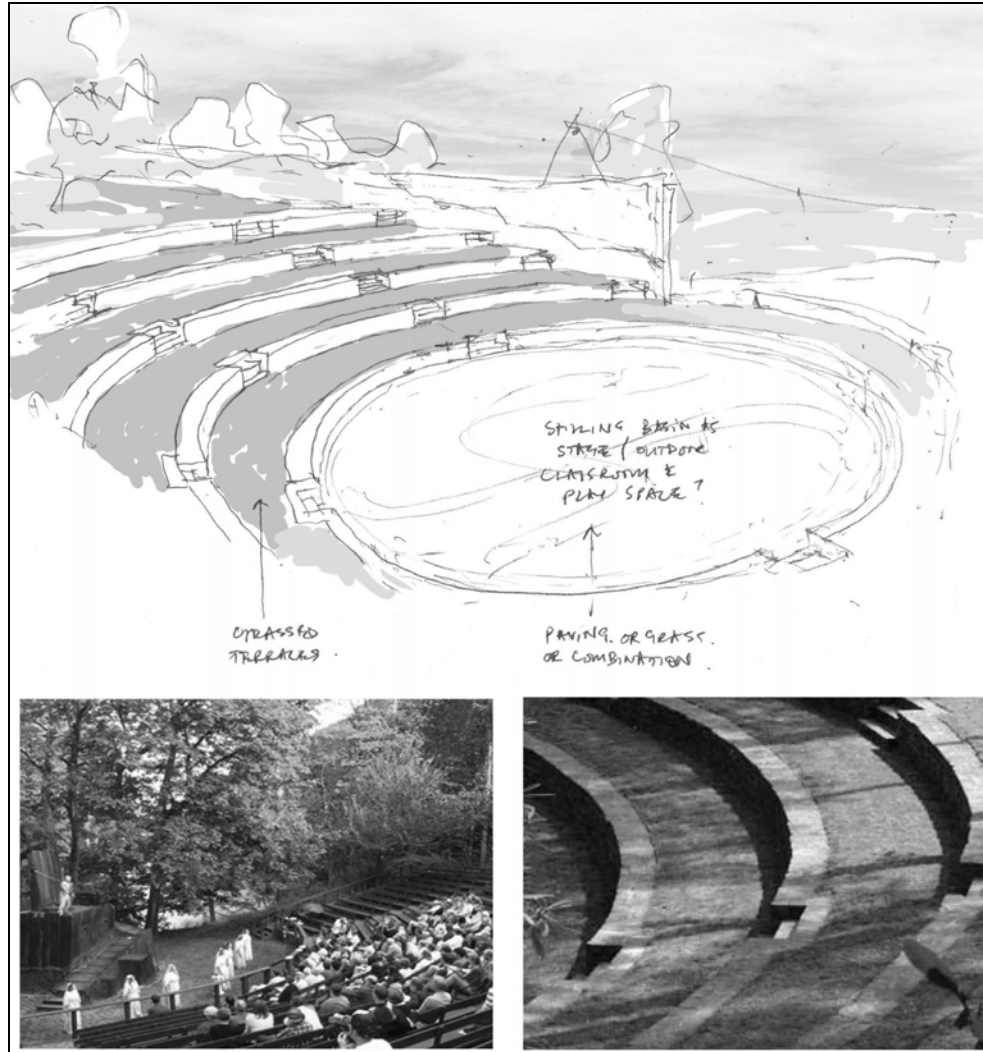


Figure 5. One of the options for the spillway which were included in the design sketch book

The first meeting aimed to establish what the community would like to see. The dam crest is used locally as open green space and links separate housing areas and public rights of way. The working group clarified that the crest would be reinforced with an open cellular concrete block system and discussed their preference for the area to retain well established grass land. There were also key trees which ideally would be retained and discussion about the possibilities of introducing additional 'chalk meadow' areas which occurred in the locality.

The downstream slope and play area were also considered by the working group. The enclosure options for the play area were discussed in some

detail and it was agreed that the play area should remain fully enclosed. The location of the fencing and the style of fencing was discussed. The working group were made aware of the restrictions in the location of the fencing across the spillway channel and understood the requirements of ensuring the spillway was clear and operable when needed. A balance was therefore agreed where the enclosure would be across the bottom of the spillway channel. The stilling basin structure was also considered, as the original engineering drawings showed a standard concrete construction. It was discussed how the presence of the stilling structure could be softened by filling the base with soil and grass seeding. During an event, the sacrificial soil would then be washed out enabling the structure to operate, whilst the majority of the time, it was partially obscured and the impact softened by the landscaping and infilling.

The maintenance of the final scheme was also a concern for the working group. Any existing vegetation is only trimmed once a year, therefore it was important to ensure any play options and landscaping was of minimal maintenance. Discussions also took place on who would be ultimately responsible for the maintenance of the site, post-scheme, and where funding would come from for any increased maintenance requirements.

Following the initial working group meeting the design team took on board the comments noted and further developed the design proposals. Much of this work was concerned with ‘masking’ the engineering structure. The working group had considered the different forms the downstream structure could take and their preferences were incorporated into design proposals. The second working group meeting was then held to present a developed option and to clarify details.

A third meeting was then held a couple of weeks later to enable confirmation of the final design and agree minor detail changes.

Following the success of the working group meetings and the development of the design in line with these discussions, the team committed to take the developed design back to the group during detailed design, and to arrange further consultation with the playspace team and a children’s user group.

Details of design changes made following the working group meetings are summarised below:

- The dam crest would be left largely as long-length grassland, as it is currently, but access on mown footways through the site would be provided.
- There was concern that the play area would not be as secluded upon completion of the scheme and the group wanted the downstream slope to remain as high as possible – the design team therefore aimed to

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minimise the fall across the dam crest – maximising the height of the downstream slope.

- The group appreciated that the heavily wooded downstream slope would need to be cleared for the works to be constructed, but requested that the felling of the mature trees was minimised. Through discussions with the working group alternative spillway alignments were explored to minimise vegetation clearance on the downstream face.
- The design team had been considering the enclosure of the play area and the downstream space and how public access would be managed through the final space. Through the working group discussions it became apparent that the community wanted the downstream space and the play area to be reinstated as closely as possible to the current layout.
- The design team had considered alternative options for the downstream face, including a formal stepped amphitheatre layout in either a stone or grassed surfacing. It was considered that this would provide a community space and an enhancement which could be provided through the scheme. Through the working groups it was agreed that the community would prefer the downstream slope to be as natural as possible and did not feel the community required the additional meeting space. The design team therefore aimed to detail the downstream face to represent, as closely as possible, the existing heavily vegetated profile.

SUMMARY

Through the thorough and continuous process of engagement described in this paper the original stilling basin design was heavily modified to deliver a more aesthetically pleasing spillway formed using planted steps of irregular shapes and minimising the amount of visible concrete surfacing. The revised design now leaves scope for the local community to influence the planting of the stepped spillway. Throughout this design development and consultation process the engineering design team and All Reservoirs Panel Engineer remained flexible in their approach to the hydraulic design of the spillway, open to considering changes which would deliver optimum hydraulic performance whilst enhancing the aesthetics of the playground and local environment. This collaborative working environment where all parties acknowledged the importance of both technical and social compliance lead to solutions which all parties could be happy with.

The scheme is now progressing through planning and detailed design. This includes the construction of a physical model of the proposed spillway

(Figure 6). The model was specified to be easily adaptable and versatile to allow the following objectives to be optimised:-

- Slope across the dam crest (minimising the fall across the crest will maximise the height of the downstream face, as requested in the working group meetings);
- Profile of the downstream face – detailing of the stepped profile;
- Downstream stilling requirements – confirmation of the extent of the stilling basin required and minimisation of its impact on the play area, also considering incorporation into the play area;
- Tapering of the spillway channel – the channel currently tapers from 60m at the weir to 30m at the downstream end of the crest. This will be explored in the modelling to determine if any further tapering is possible, which would further minimise the visual impact.

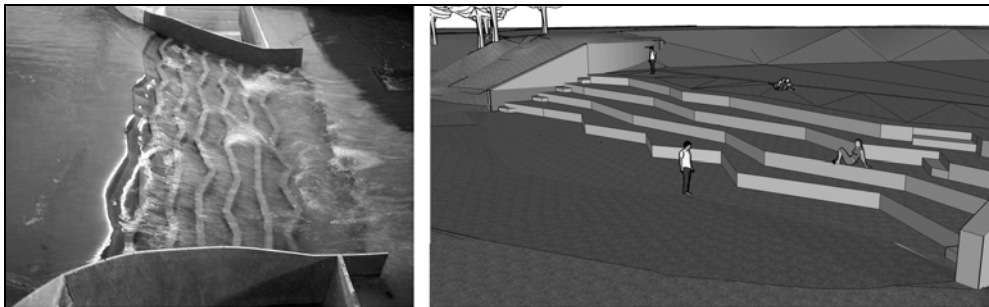


Figure 6: final design for spillway and downstream space following consultation (right hand image) and physical model of the layout (left hand image)

The physical model has provided the following outputs, which are currently being developed further through the detailed design stage:

- Confirmation of the performance of the weir and the tapered channel.
- Reduction of the slope across the top of the embankment from a nominal 1 in 100 gradient to level, with hydraulic advantages and avoiding the need for an expensive sewer diversion.
- Derivation of limits of the design of the stilling basin for the landscape architect to work within.

REFERENCES

- ICE (The Institution of Civil Engineers) (1996) *Floods and Reservoir Safety*, 3rd edn. Thomas Telford, London, UK.
- HMSO (1975) *Reservoirs Act, 1975*. Her Majesty's Stationery Office, London, UK.