

Baystone Bank Impounding Reservoir Safety

the restoration of Whicham Beck provides ecological benefits, risk reduction and reduced OPEX costs

by Carl Sanders

Protecting and enhancing natural resources such as rivers, lakes and some of the most beautiful countryside in the country is all part of United Utilities normal business. Baystone Bank, which was constructed over 135 years ago, is north of the village of Millom within the Lake District National Park. The reservoir was taken out of supply over 10 years ago. This article examines the discontinuance of the Baystone Bank dam, which will result in flows returning to Whicham Beck for the first time in over a century.



The restored Whicham Beck September 2011
Aerial photography by Suave Aerial Photographers. Courtesy of United Utilities and Eric Wright Civil Engineering Ltd

Hydrology and hydraulic arrangement

Baystone Bank Reservoir impounded the Whicham Beck and the Whicham Beck tributary. The total catchment area at the dam was 2.47km², with approximately 93% accounted for from the Whicham Beck and 7% from the tributary. The standard average annual rainfall for the catchment is 1,780mm. A by-wash channel allowed reservoir inflows to be either diverted around the reservoir basin or to spill into the reservoir depending on the inlet sluice opening.

Baystone Bank Reservoir historically supplied Lanthwaite Water Treatment Works (WTW). By 1996 the reservoir yield was not required for supply purposes and was not part of the future plans. Lanthwaite WTW was also considered by United Utilities as a redundant asset and was disconnected from the potable network.

Overflow capacity

Dam break studies carried out by United Utilities (prior to 2002) upgraded Baystone Bank Reservoir from Hazard Category B to Hazard Category A, as defined by the Institution of Civil Engineers Guide to Floods and Reservoir Safety (1996). In response to this and as part of an on-going programme by United Utilities to evaluate the adequacy of the overflow facilities of their impounding reservoirs, in 2002-2003 an overflow capacity study was undertaken.

The Hazard Category A required the reservoir to be able to cope safely with a Probable Maximum Flood (PMF). The overflow capacity study found the most severe flood event was the Winter PMF event with a peak inflow of 37m³s⁻¹ and an outflow nearly 35m³s⁻¹. The main spillway chute was estimated to have a hydraulic capacity of

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approximately $15\text{m}^3\text{s}^{-1}$. The auxiliary overflow weir and downstream apron were estimated to have an adequate capacity to discharge $17.5\text{m}^3\text{s}^{-1}$. However, the masonry spillway channel that runs down the right mitre of the dam was only considered capable of passing 2 to $3\text{m}^3\text{s}^{-1}$. The total spillway capacity was therefore judged to be $17\text{--}18\text{m}^3\text{s}^{-1}$ – short of the $35\text{m}^3\text{s}^{-1}$ required to safely pass the Winter PMF and therefore remedial works were required to meet current recommended standards.

In 2003 the Section 10 Inspection under the Reservoirs Act (1975) was undertaken by I.C. Carter. Given the findings of the earlier overflow capacity study, the Inspecting Engineer made a recommendation “in the interest of safety” (ITIOS) that if the reservoir is retained then works are carried out to safely pass the design flood. The Reservoirs Act (1975) required these recommendations to be addressed by July 2011.

Ecological surveys

An extended phase 1 habitat survey was undertaken in 2010. This survey identified that the reservoir supported spring quillwort (*Isoetes echinospora*) which is rare in Cumbria (having only been identified at two locations in the county). The area supports high density populations of European eel (*Anguilla anguilla*) and brown trout (*Salmo trutta*); sea trout have been recorded up to, but not beyond the reservoir which presented a significant barrier to migratory fish. Bat foraging activity was recorded around the site.

Options appraisal

From 2007 onwards, United Utilities evaluated a range of possible options for Baystone Bank Reservoir. These options ranged from spillway upgrading to full discontinuance. An assessment undertaken in 2010 demonstrated that for the 1 in 100 year flood event, discontinuance of the reservoir would not increase downstream flood risk. Following this detailed options appraisal

and discontinuance assessment, United Utilities determined that discontinuance of the dam would bring the most benefits.

Development of the proposed solution

A multi-disciplinary project team was assembled and tasked with producing a solution that would:

- Achieve full discontinuance.
- Reinstatement of Whicham Beck and restore the natural river and floodplain processes (as far as reasonably practicable). By reconnecting the upstream and downstream reaches of Whicham Beck the hope was that this would help restore instream habitat for migratory and resident fish.
- Create a suitable habitat for spring quillwort and foraging space for Daubenton's bat. This required the retention (or creation) of a pond with a minimum surface area of $4,000\text{m}^2$, a minimum water depth of 2.0m and a maximum capacity of $<10,000\text{m}^3$.

Throughout the project the Environment Agency fully supported the concept of renaturalising the flow regime and sediment transport functionality of this upland river. Given the sensitive location of the reservoir (within the Lake District National Park boundary) the restoration of the watercourse was always an integral part of the reservoir discontinuance process, not a separate activity and this was key to getting the relevant approvals.

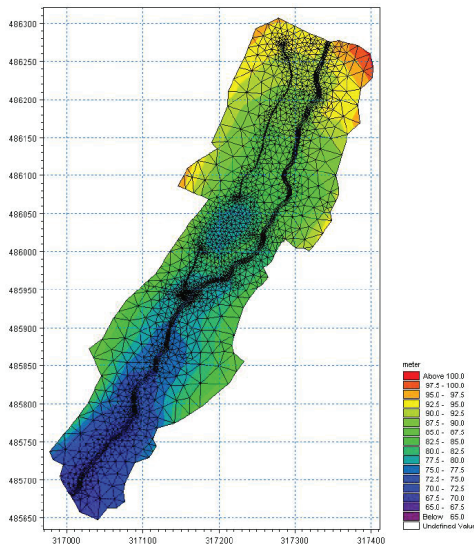
The design was based on an Ordnance Survey map from 1867, which gave the pre-impoundment alignment.

Having established the proposed concept and got agreement from all the stakeholders that this design better met the original intentions, the design process continued. A hydraulic model of the proposed concept was then created by MWH to check how the



Baystone Bank Impounding Reservoir - February 2007 - Courtesy of United Utilities

watercourse and pond would operate during a flood event. The hydraulic modelling was undertaken using Mike21 FM.



MIKE 21 Mesh showing the river and pool arrangement. Courtesy of MWH

Construction of the proposed solution

Planning approval (and approval from all the stakeholders) was granted in January 2011. Eric Wright Civil Engineering Ltd mobilised to site in late February 2011, and PBA Applied Ecology Ltd was deployed to the task of ecological and environmental management.

The presence of the by-wash channel around the reservoir basin allowed the majority of the construction work to take place off line. The by-wash continued to operate throughout the construction phase. By July 2011 (the target date set by the ITIOS requirements) the embankment had been “discontinued” and the Impounding Licence revoked (under Section 13(2) of the 1975 Reservoirs Act).

During the excavation of the sediment in the reservoir basin and subsequent construction of the new channel, a number of the sections of the original (pre 1877) stream bed were identified. The alignment of the watercourse was modified to incorporate these into the proposed design. During the earthworks phase, any suitable materials for channel bed and banks which arose, was stockpiled for future use. This resulted in no need to import material to site. All materials used in the construction were sourced from within the site area.

Environmental management

During the construction phase, ecological mitigation measures were implemented to allow the construction to take place, whilst minimising the ecological impact. Mitigation measures were focused around three areas; environmental management of the construction works, maintenance of water quality in the watercourses, and management of indigenous fish.

Post-construction

As the vegetation has become established the location of the former dam and reservoir basin has become very difficult to identify, with the new watercourse/ground profile blending seamlessly into the landscape. The new river channel has continued to evolve over time, as sediment is moved within the channel. Gravel has accumulated, moved and eroded, adding further natural variability. Evidence of Otters using the pond has also been identified. The project has been very well received by all parties, including the Environment Agency and the adjacent landowner.

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Fish rescue and survey at the inlet to the Reservoir
Courtesy of United Utilities and PBA Applied Ecology Ltd



The restored Whicham Beck - Courtesy of United Utilities



PBA Applied Ecology Ltd. are proud to have worked with United Utilities and MWH on the Utilities Award nominated Baystone Bank Reservoir De-commissioning and River Restoration Project

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