Glenfield Invicta

Delivering Project Solutions

INCREASING THE RESILIENCE OF BURNHOPE RESERVOIR

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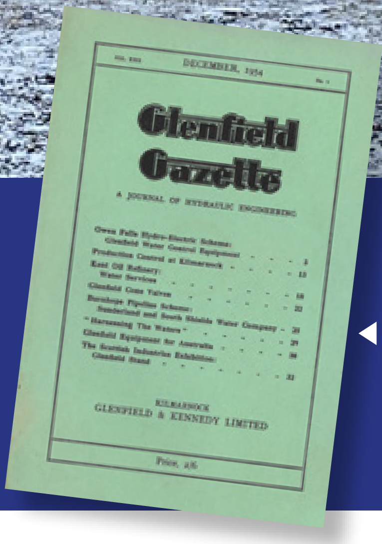
Burnhope Reservoir is operated by Northumbrian Water. It is located in the North Pennines AONB (Area of Outstanding Natural Beauty), a UNESCO Global Geopark.

At its deepest, Burnhope Reservoir is 40m from surface to bed. It has a capacity of around 6.4 million cubic metres.

Glenfield Invicta supplied a number of valves to the original project and continues to ensure the safety and efficient operation of reservoirs and dams across the UK.



Glenfield Gazette from 1954 showing Glenfield Invicta's historical connection to Burnhope Reservoir.

In 2022, Esh Stantec contacted Glenfield Invicta to advise on the optimal valve configuration to increase draw down at Northumbrian Water's Burnhope Reservoir. Glenfield Invicta's expertise and experience was particularly valuable in designing and specifying valves that met the project requirements of the reservoir within the context of challenging construction envelopes.

Specification and Design

ESH Stantec engaged with Glenfield Invicta from the earliest days of the project and this ensured strong collaboration and communication throughout.

Design challenges and constraints

Engineers from ESH Stantec and Glenfield Invicta visited the site several times to gain a full understanding of the project's challenges and constraints.

When water is discharged from a reservoir at high speed it possesses high kinetic energy. If unchecked, it can cause damage to surrounding structures and natural features. This kinetic energy can be dissipated safely and effectively using a specially designed discharge valve, ensuring the risk of damage to the downstream section is greatly reduced.

For Burnhope Reservoir, flow rates of up to 4.5m3/s must be controlled by the discharge valve; this equates to **4.5 tonnes of water passing through the valve every second.**

The construction space envelopes on the site were restricted. The tailbay into which the drawdown water was to be discharged was narrow and there was no space for a stilling pond.

Proposed solution

After reviewing the available options, the Glenfield Invicta engineering team specified the installation of a **DN600 Series 857 free discharge valve** fitted in conjunction with a bespoke hood. With the Series 857, draw down rates can be finely controlled. The bespoke hood was incorporated to limit the width of the discharge plume thereby safeguarding the structural integrity of the tailbay. Although this does reduce the overall Coefficient of Discharge value, calculations were made to verify that the solution would achieve the required discharge rates specified. Remote electric actuation was specified for ease of operation.

A DN800 Series 54 reservoir-specification gate valve was also proposed to provide upstream isolation.

Series 54 reservoir-specification gate valves

Glenfield Invicta has developed a specialist reservoir-specification for gate valves to accommodate the operating parameters required on reservoirs which can be onerous. For example, the seat and body rings in the gate valve have to be screwed and pinned to be able to accommodate considerable flow velocities that are well in excess of standard water systems.

Features include:

Aluminium bronze shoes and channels result in a very tight and continuous tolerance between the body and wedge throughout the valve stroke. This reduces potential vibration and fatigue damage.

The addition of a **jacking screw** at the base of the valve allows a direct axial thrust to be applied to the base of the wedge; if the valve has been closed for long periods of time, it can become increasingly difficult to operate.

Stainless steel fasteners and stem, and an increase in coating thickness, combine to prevent corrosion and increase the valve's operating life.

Design factors

The general operating principle of a free discharge valve is relatively straightforward, However the design element is critical, and that's were Glenfield Invicta's knowledge allows it to make sure the valve can achieve maximum discharge rates whilst ensuring hydraulic forces do not cause excessive vibration regardless of the valve position; Series 857 free discharge valves should not be operated anywhere below 5% open for any period of time except when the valve is opening or closing. Vibration is minimised through the use of multiple aerodynamic 'ribs' which are specially designed and connect the main body of the valve to the downstream cone section (as per the picture below).

It is also imperative that the valve is correctly sized. Sizing calculations are based on the required discharge through the valve at the corresponding available pressure head. If not done correctly, this could lead to major issues with the valve itself, the overall discharge system, and the surrounding boundary surfaces. If undersized, the valve would not be able to achieve the specified emergency drawdown.

At Burnhope Reservoir, further design calculations were required due to the requirement to incorporate a fabricated hood at the point of discharge. In particular, it was important that the relative position of the valve and hood was accurately calculated to ensure the optimal discharge flow was achieved. The hood was secured separately to the concrete floor using chemical anchor bolts. The following pictures were all taken during the successful commissioning of the valve and hood to ensure everything worked suitably and as expected.

Fixed cone valves are used to pass a controlled amount of water downstream with no damage to the immediate surroundings due to its considerable energy dissipating characteristics. These valves also offer an effective method of aeration due to atmospheric dispersion.

The outlet cone ensures that discharge is in the form of a hollow expanding jet, which is ideal for energy dissipation as the water is spread over a rapidly increasing surface area, thus permitting effective atmospheric cushioning. If partial /controlled containment of the jet is desired (such as for Burnhope Reservoir), a hood can be installed downstream of the valve.

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Installation and commissioning

Throughout the project, from design through to commissioning, weekly Teams meetings were held with the key stakeholders in the delivery of the project.

Glenfield Invicta worked closely with Franklyn Yates for the installation of the valve, fittings, upstream pipeline and hood.

As mentioned above, the restricted construction space envelopes on site were a challenge. Furthermore, a degree of flexibility and accommodation in terms of installing and commissioning the valves was factored into the project due to the remote, rural location of the reservoir and to allow for potentially inclement weather.

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A challenging and rewarding project

Greg Morris, Business Development Manager – Dams, Reservoirs and Hydropower, was the Glenfield Invicta lead on the Burnhope project:

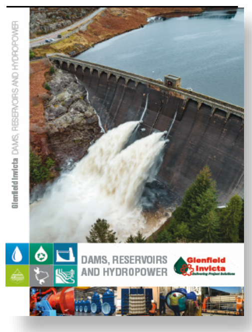
'This was both a challenging and rewarding project to be a part of. The close collaboration across all stakeholders played a key role in the successful outcome. I would also like to highlight the professionalism of our engineering team and the excellent support received from Franklyn Yates.

Glenfield Invicta has been heavily involved in this reservoir project for several decades. From a personal perspective, it is extremely satisfying to know that I have helped in some part in ensuring this historic asset can continue to be used safely and effectively for years to come.

We have worked on multiple reservoir drawdown projects across the UK, but there are still many other reservoirs that would benefit from additional drawdown capacity.'

Steve Boyd was the Esh Stantec Project Manager for the Burnhope project:

'Burnhope Reservoir was an interesting project to work on with Greg and the Glenfield Invicta engineering team. Not only do they have immense expertise and attention to detail, but they are also 'hands on' and embraced the challenges and constraints of the Burnhope site. The collaborative relationship we built with Glenfield Invicta and Franklyn Yates contributed significantly to the successful delivery of the project.'



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