

BRITISH DAM SOCIETY 23rd BIENNIAL CONFERENCE – KEELE UNIVERSITY

Conference Tour – Friday 11th September 2026

**Dŵr Cymru Welsh Water – Llyn Celyn Reservoir
Natural Resources Wales – Llyn Tegid Reservoir****Logistics**

Delegates will visit Llyn Celyn and Llyn Tegid reservoirs which are situated near Bala in North Wales and form part of the Dee Regulation Scheme. At Llyn Celyn delegates will view the recently constructed auxiliary spillway and enhanced drawdown valves, we will then travel to Llyn Tegid (~20mins) to see the recent stability and embankment realignment works.

Both visits involve ~1km walk over uneven ground. Please wear sturdy footwear and appropriate clothing depending on the weather, noting it can be very exposed on the dams.

Overview of Dee Regulation Scheme

Flows in the River Dee have been managed to support abstraction downstream since 1805 when Thomas Telford built the sluice gates on Llyn Tegid (the largest natural lake in Wales). Llyn Celyn was then completed in 1965 and Llyn Brenig in 1973; they are the largest and third largest reservoir in Wales storing 80,931MI and 61,543MI respectively. Welsh Water is the registered undertaker for all the dams except Llyn Tegid but Natural Resources Wales (NRW) are responsible for managing the releases for water supply, flood risk mitigation and to provide environmental benefit to the riverine SAC. The water released is also used for recreational benefit and hydropower. A schematic of the reservoirs is shown in Figure 1. In total the Dee provides water to 2.5 million people across Northeast Wales and Northwest England. United Utilities are by far the largest abstractor (~660 MI/d) compared with a combined volume of ~100 MI/d from Welsh Water, Canals and Rivers Trust, Hafren Dyfrdwy and Severn Trent. Llyn Alwen was completed in 1920 but is used for direct supply only and so does not form part of the Dee Regulation.

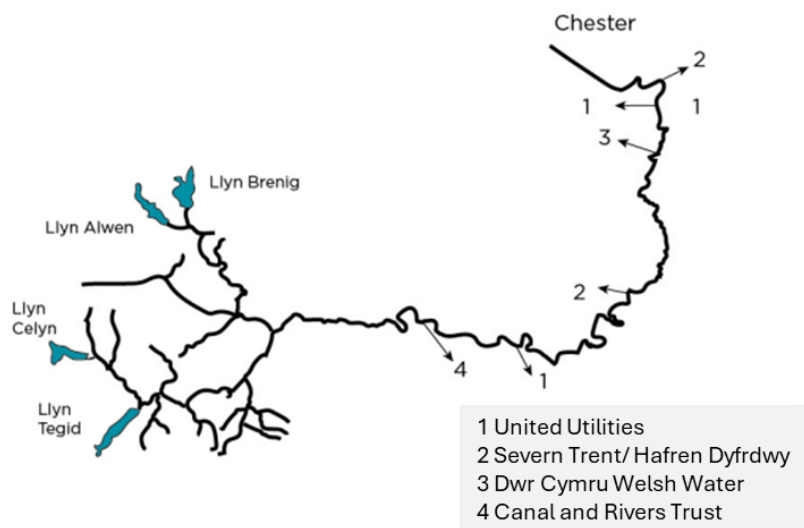


Figure 1 - Schematic of Dee Regulation Scheme

Llyn Celyn Reservoir

Llyn Celyn is formed by a 45m high, 680m long gravel-fill embankment dam and is the largest reservoir in Wales with a capacity of ~81,000MI. It is classed as a Category A reservoir as the flood risk area downstream reaches as far as Chester.

The outlet system comprises of a draw-off tower with siphon arrangements and a scour outlet system, with both pipelines routed through a parallel diversion tunnel. After passing through hydropower turbines releases are discharged into the river downstream as part of the Dee Regulation Scheme.

A Measure in the Interests of Safety (MIOS) following the Section 10 inspection undertaken in August 2020 required significant improvement works including increasing the flood conveyance and drawdown capabilities.

Auxiliary Spillway

A new auxiliary spillway has been constructed to ensure sufficient capacity to safely convey the Safety Check Flood. The spillway is located at the dam's north end, it is 270m long with a 150m downstream culvert and spans 33m in width, it features a 67m long weir, 4m high walls, and nine tipping gates each measuring about 9m by 3m. This was a complex scheme taking six years to deliver and required detailed planning and close collaboration with numerous stakeholders in order to keep the reservoir 'live' and operational throughout.

The programme had to be carefully planned to coincide with the time when the dam was most vulnerable and the core exposed with the natural drawdown. Temporary control rules had to be agreed with NRW and the QCE to operate the reservoir at a lower level to maintain sufficient flood storage. This in turn introduced a marginal increase in drought risk and so had to be agreed with the Dee Consultative Committee which represents the major abstractors. Careful stakeholder management was therefore required to ensure all parties understood why the works were needed and would help ensure the reservoir remained operational in the future. The exceptionally dry conditions experienced in 2022 resulted in the lowest reservoir levels since 1996. As a result, part of the valves and pipework had to be postponed by 12 months to avoid any impact on the water supply releases.

The project was delivered by our alliance partners Mott MacDonald and Bentleys (MMB). A Dam Safety Construction Management Plan and a Water Level Management Plan were in place to safeguard workers and the dam during the works. After completing earthworks and stabilising the adjacent highway, the structural steelwork, concrete placement, and the tipping gates were installed. The structure is now fully operational and protecting communities downstream.

The spillway scheme was one of the largest dam safety schemes undertaken by Welsh Water and required close collaboration between the internal project team, MMB and NRW. Detailed planning minimised the environmental impact and prioritised Health, Safety and Wellbeing throughout. Public engagement with regular open days for local communities and social media updates were well received and increased awareness of reservoir safety in general.

Enhanced Drawdown Valves

Enhanced drawdown valves have been installed into the existing bell-mouth spillway to increase the reservoir's drawdown capacity to a level as close as practicable to National Guidance. The scheme was completed in February 2024 and timed to provide additional protection during the spillway works whilst the dam core was exposed.

Two pairs of 1100mm hydraulically operated gate valves provide a total discharge capacity of 13 m³/s. The valves are fully submerged at top water level and are protected by external trash screens. Operation is controlled remotely from the adjacent hydraulic power unit located in the car park, using either a hand pump or petrol engine.



Photos during construction



Tipping gates upstream



Tipping gates downstream



Culvert discharge point



Enhanced drawdown valves

Figure 2 – Photos of Llyn Celyn spillway works and enhanced drawdown valves

Llyn Tegid Reservoir

Llyn Tegid is Wales's largest natural lake, with the first regulation system constructed in the form of a sluice structure and embankments in 1808, this to ensure water supply to the Shropshire Union Canal. The project was overseen by William Jessop who left the detailed execution of the works to Thomas Telford. The Bala Lake Scheme completed in 1956 superseded the original control system to aid further river regulation and flood alleviation. This project included the construction of embankments, weirs, a sluice house and involved lowering of the lake by 7ft. The scheme gives an effective storage capacity above natural lake level of 21.8 million cubic meters of water.

Llyn Tegid is a Category A Dam with earthfill embankments and a gated control structure. The embankments are approximately 4 metres high and approximately 2,300 metres long across the 'outlet' to Llyn Tegid. Llyn Tegid has a capacity of 21,878,121m³, a surface area of 4,500,000m² and a catchment area of 262km².

The gated structure consists of four counter balanced gates, each 5.1m wide by 4.2 m deep which have a vertical lift of 5.2 metres. There are also 2 No 3 m wide fish lock gates.

The overflow to the system is known as Weir Z. There are two other weirs; Weir X on the Afon Tryweryn and Weir Y which controls the flow from the Afon Tryweryn to a point upstream of the gates shown in Figure 6.

In addition to the abstraction a residual flow of at least 364 Ml/d is maintained over Chester Weir in all but the most testing of droughts, safeguarding the passage of migratory fish and limiting the ingress of saline water over Chester Weir during high tides. Although correspondence in 1956 between the then River Authority and Westminster discussed registration under the Reservoir Safety Provisions Act 1930, the reservoir wasn't registered until 1986.



Figure 3 - Thomas Telford's Original Sluice

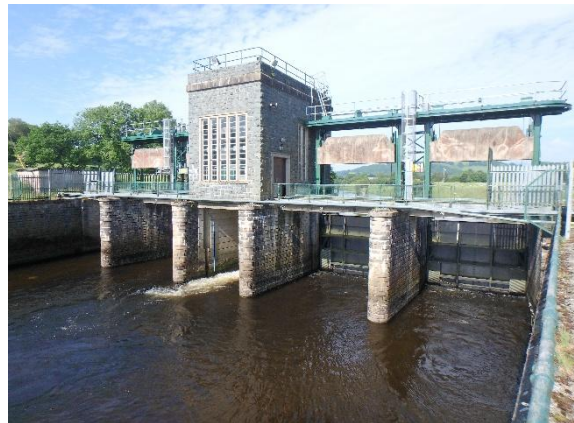


Figure 4 - 1956 Bala Lake Scheme Sluice



Bala Lake – scheme construction 1953



Lowering the lake level by 7ft



Sluice foundations



Approach channel to Weir X

Figure 5 – Bala Lake construction photographs from 1953

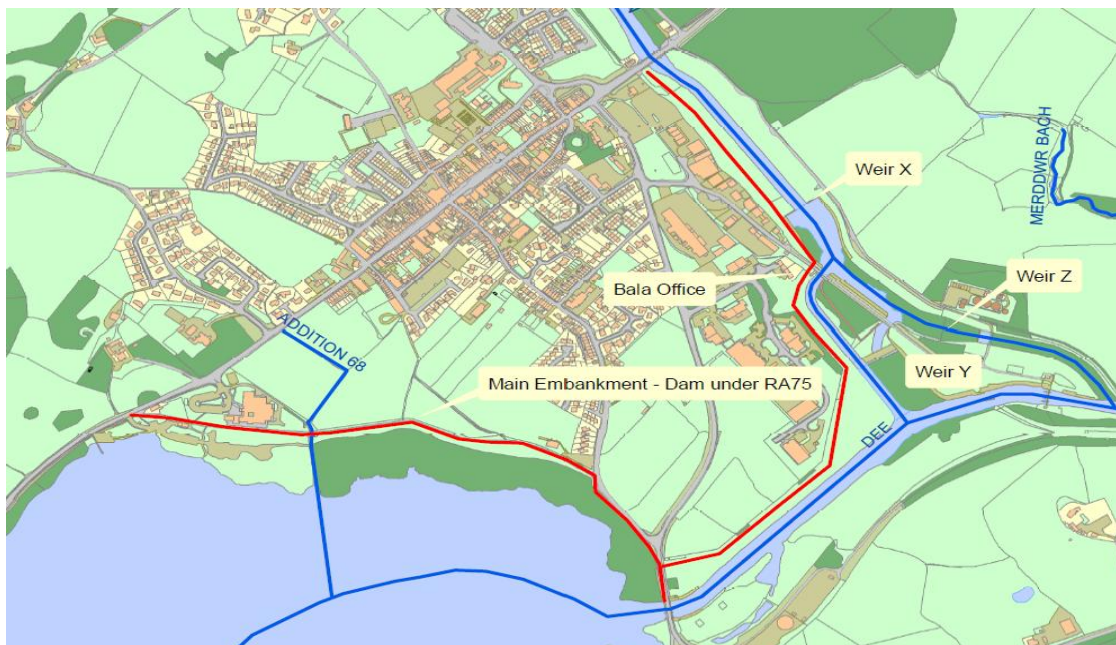


Figure 6 - Bala Lake Scheme

The lake, with its vast 4.83 million square metre surface area, maximum depth of 46 metres and underlying acidic rocks lining a glacially cut basin on a geological fault line, has long been a focus of scientific study. Its designation as a SSSI and RAMSAR site is due to its rare mesotrophic lake ecosystem and acts as the only habitat for the endangered Glutinous Snail and the Gwyniad, a unique freshwater whitefish.

Reservoir Safety Works 2021/2022

In a 2019 Section 10 Report a Measure in the Interest of Safety required that ***works are carried out to safely accommodate the design storm and the associated still water flood surcharge and wave surcharge and to ensure a stable embankment under seepage loads etc.***

A £7M scheme was undertaken, starting in November 2021 which took 15 months and was constructed by William Hughes Civil Engineering Contractors.



Figure 7 - Lake Embankment original slate Rip Rap



Figure 8 - Lake Embankment Rip Rap works 2022

The works included:

- **Upgrading rock armour** – The upstream face of the embankment was replaced with granite rock RipRap as the original flat slate was ineffective at dissipating wave energy.
- **Tree and vegetation removal** - mature trees and vegetation had established within the existing reservoir embankments, most showing significant decline. Approximately 300 trees were removed during construction with 900 new trees planted elsewhere on the scheme.
- **Strengthening downstream embankment slopes** – Installing a composite turf reinforcement mattress (TRM) to the downstream slope to protect embankments from overtopping. The TRM was designed to increase the embankment's permissible shear stress to mitigate risk of breach during overtopping.
- **Addressing stability** - seepage and stability modelling at design stage highlighted a stability risk associated with the existing embankment. To mitigate this, a stability berm was constructed at the downstream toe of the Dee and Tegid embankment.
- **Embankment realignment** – A 65m-length section of embankment was realigned, preventing the concentration of wave forces which posed an overtopping risk.
- **Extension of Bala Lake Railway** - Through consultation and agreement with the charity Bala Lake Railway Trust (BLRT), the new foreshore embankment design incorporated new ballast, ramps and crest widening to facilitate the future extension of the steam railway into Bala Town Centre.



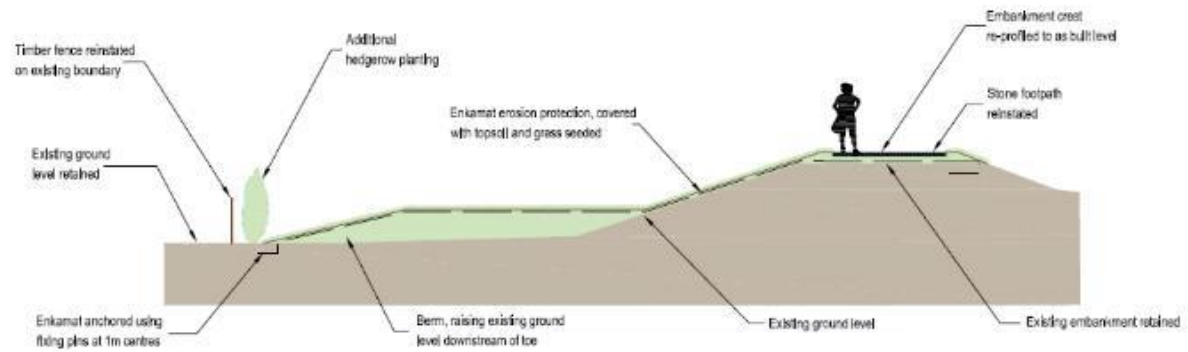
Figure 9 – Llyn Tegid – tree removal works



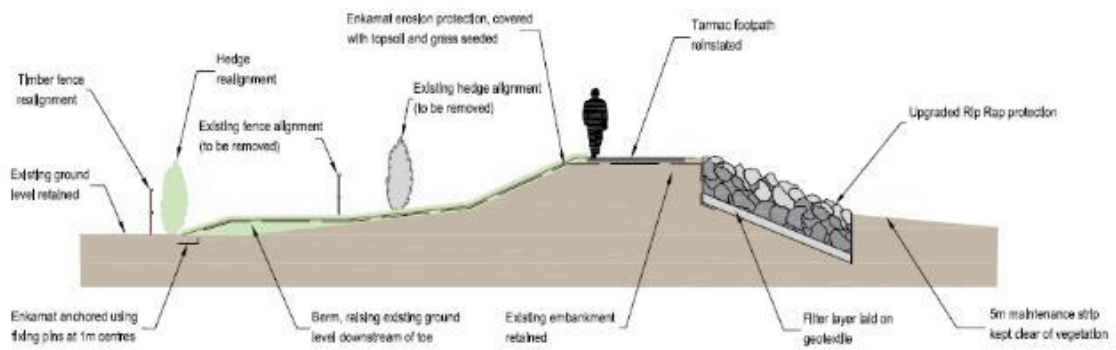
Figure 10 - River Embankment showing TRM installation



Figure 11 - TRM grass uptake and footpath installation



TYPICAL SECTION, DEE EMBANKMENT (1:100)



TYPICAL SECTION, LLYN TEGID EMBANKMENT (1:100)

Figure 12 - Showing stability berm cross section