NORTHUMBRIAN WATER (iving water

Rainwise

Working with communities to manage rainwater

Kielder Reservoir, Northumberland

Kielder Water is the largest man-made lake in northern Europe and is capable of holding 200 billion litres of water, it is located on the River North Tyne in North West Northumberland.





Figure 2: Kielder Area



Figure 3: Kielder Water

Figure 1: Location of Kielder

The Kielder Water Scheme was completed in 1982 and was one of the largest and most forward looking projects of its time. It was the first example in the UK of a regional water grid, it was designed to meet the demands of the north east well into the future. The scheme is a regional transfer system designed to allow water from Kielder Reservoir to be released into the Rivers Tyne, Derwent, Wear and Tees. This water is used to maintain minimum flow levels at times of low natural rainfall and allows additional flows to be released for both domestic and industrial abstraction.

As a result of this investment NW has a raw water surplus and therefore has a degree of flexibility with the storage of raw water, this is an uncommon scenario in the United Kingdom.

Following the flooding, from the River Tyne, that took place around Corbridge as a result of Storm Desmond in early December 2015, Northumbrian Water (NW) were asked to provide additional flood storage capacity at Kielder Reservoir. At the same time the Environment Agency (EA) were keen to pursue the idea of variable releases to the river and the hydropower operator at Kielder (Innogy) wished to review operations in order to maximum generation ahead of plans to refurbish the main turbine in 2017.

CHALLENGES

Kielder reservoir has many important roles including river regulation for water supply, hydropower generation and as a tourist attraction. As such any amendments to the operation of the reservoir could not impact on Kielder's ability to support these activities. Operating the reservoir at 85 percent of its capacity would make up to 30 billion litres of storage available.

The three stakeholders (NW, Innogy and the EA) worked together to build a new operating regime for the hydroelectric plant at Kielder with the following key aims

- to maintain the security of water supply to the North East;
- to better reflect natural changes in river flows which should protect the ecology of the river;
- to provide increased flood storage in Kielder reservoir;
- to take into account the requirements of river and reservoir users; and
- to increase the generation of clean, renewable energy



Figure 4: Hydro Power Outlets at Kielder

SUCCESS CRITERIA

The following section will look at each of the success criteria in turn and consider whether the trial has achieved the aims of the new regime.

The reservoir level is kept within an acceptable range.

When the trial began the reservoir was over 1.5 metres above the target. A combination of low rainfall and large releases meant that the target was reached in only four weeks. A period of dry weather then resulted in the reservoir level falling below the target which caused access problems for the sailing and water ski clubs. NW worked alongside the reservoirs users and have agreed to fund the extension of the slipway when water levels allow.



Figure 5: Leaplish Slipway, Kielder

At the start of 2017 the reservoir level was kept within a planned range of the target until the large inflow at the end of February caused by Storm Doris. Extra releases were made which resulted in the reservoir level falling fairly quickly back towards the target, before another period of wet weather on the 22nd March. No flood alleviation releases were required, despite these large inflows.

This objective has been achieved.

There is a variation in the amount of water released.

Releases from Kielder reservoir have varied since the beginning of November 2016. There was an extended period in December 2016 when only compensation releases were made as there was very little water flowing into the reservoir. The new regime is designed to release a higher flow at the start of each week's release, followed by slightly lower flows to mimic a natural hydrograph. This objective has been achieved.

Fish passage at Riding Mill is not impacted.

Fish passing through the weir at Riding Mill are recorded at a fish counter at the gauging station. Factors influencing the numbers counted include the depth (and therefore velocity) of the water, water temperature and the availability of fish willing to move upstream. Due to natural variation in flow and temperature it is difficult to identify if the changes to the release regime have had an impact on migration and further monitoring will be required before any firm conclusions can be drawn. During the second half of November 2016 natural river temperatures were quite low and are likely to have inhibited counts. A comparison of counts suggests that there hasn't been a serious negative impact on fish movement.

The revised release regime does not adversely impact fish populations.

There is little evidence to determine whether or not fish populations have been affected by the changes to the releases but anecdotally, the coarse fishing has been favourable, although this may be more due to the mild winter and low natural flows.

It is not possible to conclude if this objective has been achieved or not.

Spill is limited.

There were no periods of spill during the trial and the highest reservoir content was 97% on 31st March 2017.

This objective has been achieved.

Flood releases are required infrequently.

Flood releases were not required at all during the trial due to the low rainfall from November 2016 to January 2017. This is one of the main shortcomings of the trial as it has not been possible to monitor any impact on temperature or rate of rise that these large releases may have.

This objective has been achieved due mainly to low rainfall and reservoir inflows.

The estimates made for the proposed week turn out to be correct more often than they are wrong.

Due to differences in the way the releases for the coming week are calculated there was some uncertainty at the start of the trial about how accurate the releases in the 'proposed' week would be. At the drop-in event in October 2016 several river users expressed a preference for keeping the 'proposed' week and so, although these releases have not been communicated via the innogy webpage, they have been calculated. Results have shown that the proposed week has only been correct 4 times during the 21 week trial (1 week in 5) due to the wide variation in inflows. If the proposed week is going to be published then users will have to understand that it is unlikely to be correct.

This objective has not been achieved and views will be sought from external stakeholders about whether or not to publish the proposed releases.

Summary of the Success Criteria

| The reservoir level is kept within an acceptable range of the target | This has been largely achieved |
|---|---|
| Variation in the amount of water released | Some improvement in flow variation but still does not reflect natural inflows |
| Fish passage at Riding Mill is not impacted | No evidence to suggest fish passage has been impacted |
| Not adversely impact fish populations | Little evidence either way, but some suggestion of good coarse fishing |
| Spill is limited | No spill |
| Flood releases are required infrequently | No flood releases |
| Estimates are made for the proposed week turn out to be correct more often than they are wrong | The proposed week was only correct one week in five |

SHORTCOMINGS OF THE TRIAL AND FURTHER WORK

It is difficult to draw too many conclusions about the impact of the winter trial of the new regime on river flows, given the very short dataset (5 months) and the unusually dry, then wet, weather conditions. The main shortcoming of the trial is that no releases in excess of the maximum hydropower generation were required. Furthermore, it was not possible to arrange monitoring of the TRIAD releases (these are short duration increases in hydropower generation to capture periods of peak energy demand during week day evenings).

Given that no adverse impact of the new regime has been detected the trial has continued into summer 2017. Further monitoring is planned, some of which is aimed at trying to increase the understanding of freshwater pearl mussels and how they may react to the releases.

The additional monitoring includes:

- rate of rise, velocity, wetted area and turbidity measurements during 25 and 50 cumec releases;
- time lapse, rate of rise, velocity and turbidity readings during TRIAD releases when natural flows are low, ramping from 8 cumecs to 16.4 cumecs;
- a trial of a 3.5cumec release to assess if it would be safe for broodstock collection. This will be the new minimum flow rate through the refurbished turbine;
- continued monitoring of temperatures and flows during the summer months when there is the potential for the effects of the releases to be more noticeable.

RECOGNITION

The scheme has been praised by Hexham's Conservative MP, Guy Opperman. He said it was "the single biggest flood prevention measure in the country" "The idea is simple. Run the reservoir at a lower level in the winter months so that when the biblical style rains come the reservoir can absorb the extra water and prevent it going down the Tyne.

"This takes around 10% of all water going past the likes of Corbridge, Ovingham and Hexham out of the game.

"Of all the possible flood prevention ideas this is by far the biggest and dwarfs all the local plans already in place.

"It is of particular help to the communities of the North Tyne at Bellingham, Wark and all places in between until the river meets the south Tyne at Warden."

And he praised Northumbrian Water for agreeing to the idea.

"Keeping the reservoir under capacity increases the risk of a water shortage in the unlikely event of a drought in the winter months but this would be dealt with by monitoring water levels", he said.



Project Team

Northumbrian Water Environment Agency Innogy

Status

The initial trial began on 1st November 2016 and ended on 31st March 2017.

For further information please email Rainwise@nwl.co.uk