

Amendments to the Operation of Kielder Reservoir

1. Background

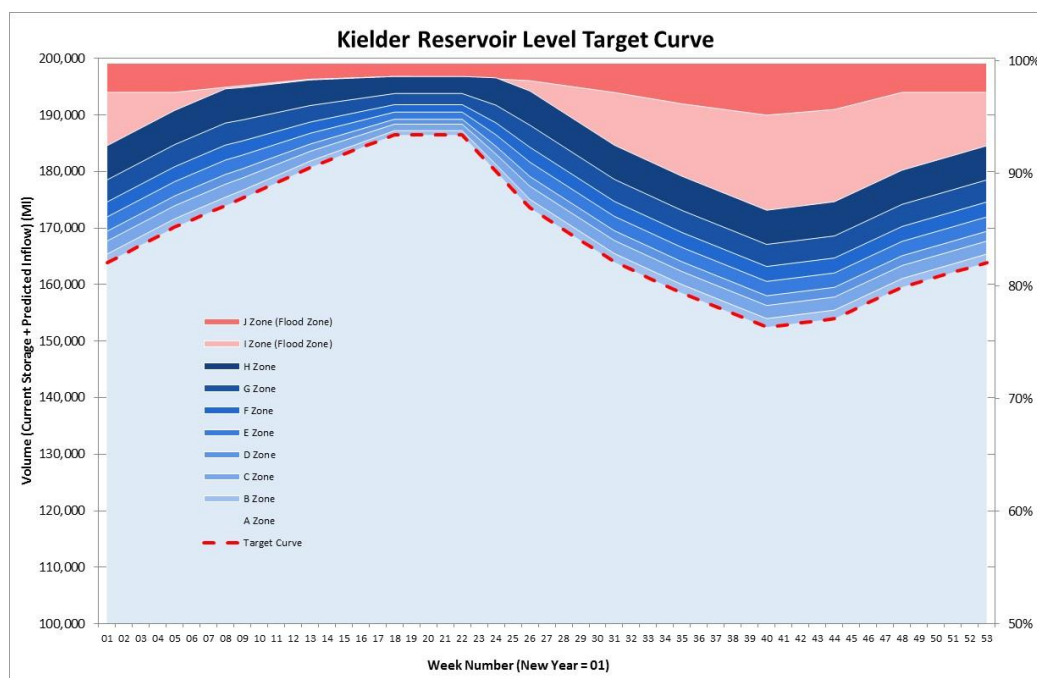
Following flooding in the Tyne Valley as a result of Storm Desmond (early December 2015), Northumbrian Water Limited (NWL) was asked by a Tyne flood risk management stakeholder group to look at the potential for providing additional flood storage capacity at Kielder Reservoir. Kielder Reservoir has many important roles including river regulation to enable strategic support for water abstractions to ensure a secure supply of treated water to meet the demands throughout the North east.

Work has been ongoing with external stakeholders, particularly the Environment Agency (EA), to create a new operating regime for releases from Kielder, with a view to naturalising flows in the North Tyne whilst also providing increased flood storage. This would be achieved by operating Kielder Reservoir at lower levels than currently, without compromising the ability to maintain supplies to water treatment works during all prevailing conditions including drought. It should be noted however that the Kielder catchment area is only 10% of the overall catchment area for the River Tyne.

2. Proposal

In consultation with the stakeholders new control curves, which determine when alterations to releases are made (shown on the graph below) have been developed. In addition, in order to achieve the objectives the number of release regimes has been increased from the current 5 to 10 variations

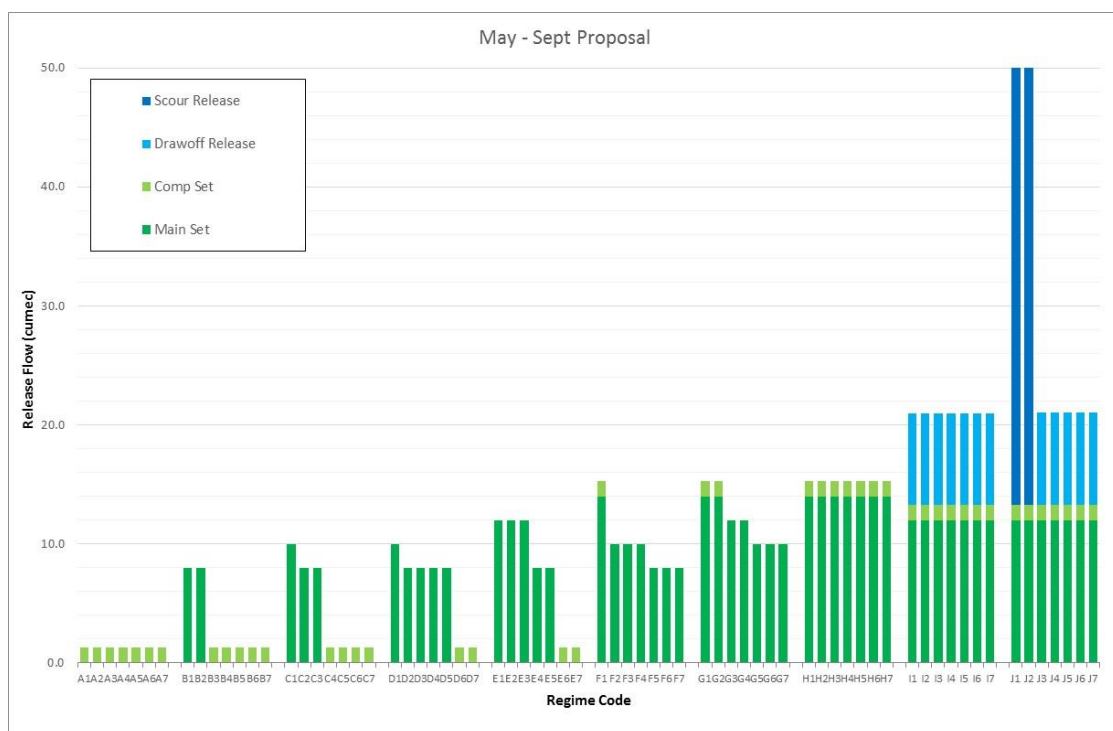
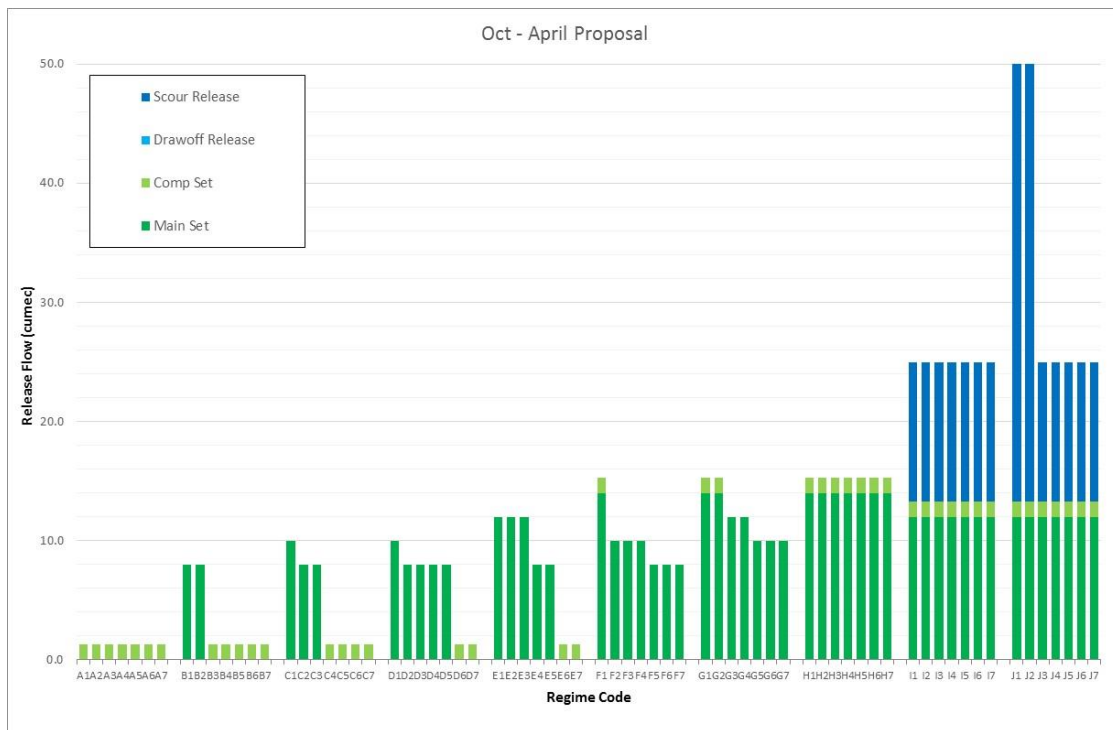
When the reservoir is in the A zone, pale blue area, only compensation water of 114 Million litres a day (ML/d) will be made. If the reservoir is above the dashed red line, or expected to go above the line in the next week then the larger turbine will start to release water up to its maximum of 1,330ML/d in the dark blue area. If the reservoir level rises into the pink area then additional flood releases of 864ML/d (bringing the total release to 2,160ML/d) will be made and if the level continues to rise and enters the pale red area then releases up to a further 2,160ML/d can be made bringing the total release to 4,320ML/d.



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Note that large flood releases from Kielder will only be made if the conditions in the North Tyne allow as these large releases could potentially cause flooding around Bellingham if there is additional flood water coming in from the catchment downstream of Kielder.

The graph below shows two proposed release schedules, a winter one and a summer one. For example, release E will take place when we expect the reservoir to go into area E on the above graph.



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A model with daily time steps has been constructed. It uses the reservoir level on a Wednesday to determine the suitable release schedule (based on the Target Curve Graph above) after which it then starts the appropriate release on a Monday. In reality the releases during May to October will have a different start day each week to vary the weekly flow profile. For the purpose of the model, it was decided that this change in release days will have little impact on the modelling results and so for simplicity the start day was kept as a Monday.

3. Results

Reservoir Overflow

The table below details the number of day the model suggests the reservoir would have overflowed under the new operation (59) against how many days the reservoir actually spilled (273) since 1990. This equate to a reduction of 78% in the number of days overflowing.

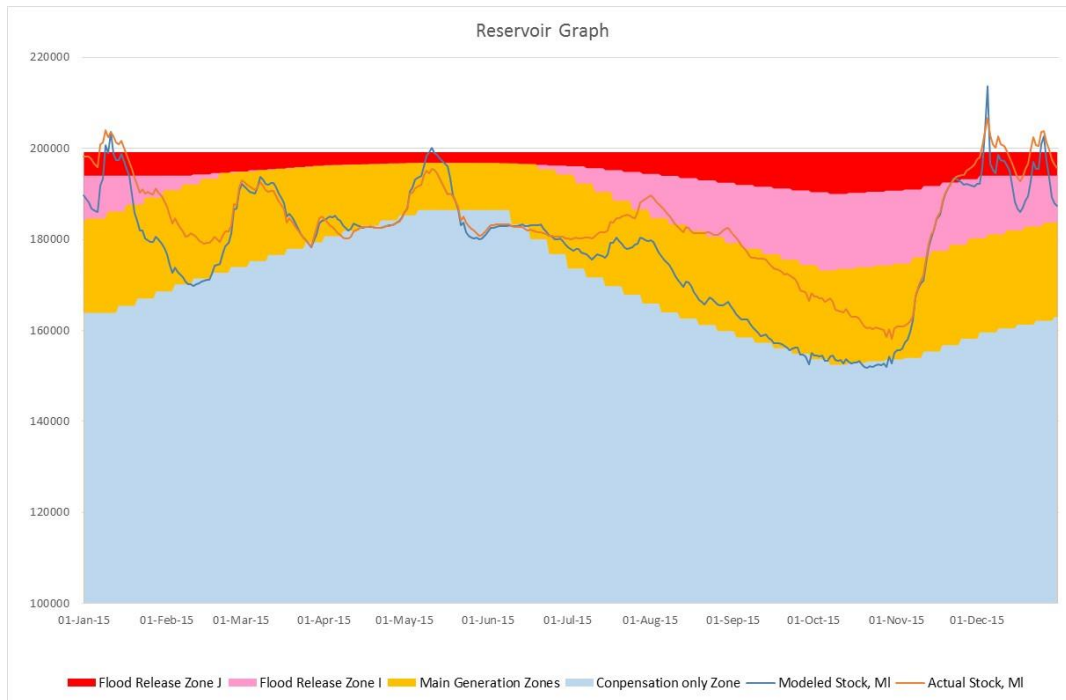
Year	No days Modelled Overflow	No days Actual Overflow	Year	No days Modelled Overflow	No days Actual Overflow
1990	6	20	2004	4	2
1991	10	6	2005	2	5
1992		2	2006	3	
1993	8	6	2007		
1994	1	14	2008		1
1995		17	2009	2	8
1996			2010		
1997	3	16	2011	5	4
1998		2	2012	2	17
1999		20	2013		37
2000		10	2014	2	11
2001			2015	8	28
2002	3	23	2016		10
2003		14			

It should be noted that a reservoir spill does have benefits for the environment and with regards to Dam safety confirms the efficacy of the spillway.

The graph below shows the reservoir level for 2015. This shows that due to the storms experience in late 2015, the reservoir would still have overflowed, although the duration of the overflow would have been reduced. The magnitude of the overflow should be ignored as the model does not account for any attenuation of water in the reservoir. Additionally, the model is only in daily time steps and so the peak could not be modelled accurately. The attenuation of water in the reservoir would potentially increase the length of the spill events in the model, but this not expected to be significant in terms of the number of days spilling.

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It should be noted that the ability to drawdown the reservoir level is restricted by the capacity of the discharge pipework. Whilst this is more than adequate to meet safety standards as required by the Reservoir Act, the pipework could not match the huge inflows to the reservoir during the storm event.



4. Next Steps

For completeness, over the next few weeks and months the changes to the operation of Kielder will continue to be modelled in Aquator, a water resource modelling package, to ensure adequate Security of Supply for our customers. This will be required as NWL's Water Resources Management Plan is currently being updated as part of the Periodic Review (PR19) process.

A consultation event, hosted by the Environment Agency, took place on 5th October 2016 in Hexham to present the proposed changes to the flow regime to the local stakeholders, representatives from NWL were present. There was no opposition to the proposed changes and it was agreed that we would begin the new operational regime from 1st November 2016. The control curves and release schedule will be continually reviewed and amended as necessary.