Hydro and Wind Consultancy, Design & Installation

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Beeston Weir
Weir Modifications

Flood Risk Assessment

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Site-specific flood risk assessment

1.1 This assessment is associated with Environment Agency consent applications for weir modifications at Beeston Weir.

1.2 Please see the relevant supporting statement for general background information on the site and proposed development. This site-specific assessment follows guidance on flood risk and costal change as published by the government. It also follows the National Planning Policy Framework, Feb 2019 and makes reference to EA Flood Data.

1.3 Figure 1 below shows that the development is located in Flood Zone 3, which is appropriate for its function. An exception is appropriate under the Exception Test because the development is water-compatible and it is infrastructure.

1.4 The latest relevant flood data for the site were obtained from the Environment Agency.

Figure 1. Environment Agency flood map

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Development description

1.5 Beeston Weir is located on the river Trent in Beeston, Nottinghamshire. The river at this point is the boundary between the district of Broxtowe and the city of Nottingham.

1.6 The application site relates to both existing weir crests at Beeston Weir. The main weir consists of an existing masonry crest perpendicular to the overall river flow, the side weir is a concrete structure parallel to the overall river flow.

1.7 The main weir features a defunct Denil fish pass on the north shoulder; there is also a 5 m wide concrete platform immediately downstream of the weir, adjacent to the left bank. The crest of the main weir is capped with a 300 mm high beam.

1.8 The side weir faces an operational hydropower station, with a vertical slot fish pass situated between the two.

1.9 The diversion of flow through the hydropower system (installed in 1999) lowered upstream water levels which resulted in complaints from boaters navigating the river. The main weir was raised from 24.1 mAOD to 24.4 mAOD in 2001 by installation of a beam along the crest, however complaints from boaters have continued.

1.10 Two local stakeholders, Beeston Marina and Beeston Sailing Club, are unhappy that water levels typically reduce by at least 300 mm when the hydropower scheme is operating, which is particularly problematic when the river flow condition is below Qmean. This affects access to the water and both stakeholders have lobbied the Canal & River Trust (CRT) and the HEP operator to raise water levels.

1.11 A further complaint relates to when the plant stops abstraction during an emergency shutdown, as this creates a 15-30 cm high wave at the HEP inlet that propagates upstream and over the weir.

1.12 Weir modifications are proposed to address these navigational issues, whilst also increasing HEP energy production and reducing flood risk. Flow splits are designed to remain as-existing during normal flow conditions, ensuring that there are no significant changes to the weir pool environment or passability of the site for migratory fish.

1.13 The current proposal includes the following works:

- Main weir
    - Removal of existing 300 mm beam
    - Installation of adjustable weir crest system
    - Creation of fish easement at left bank
- Side weir
    - Increase crest level by 200 mm

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Table 1. Summary of proposed weir modifications

Weir parameter	Side weir	Main weir
Hands-off depth (mm)	-	75
Crest length (m)	82.26	72.32
Existing crest level (mAOD)	24.700	24.400
Proposed crest level (mAOD)	24.900	24.100 to 24.825
Proposed crest type	Fixed	Adjustable

Flood data

Table 2. Summary of flood levels from EA data

Summary of Flood Levels from EA data at Beeston Weir	
Typical bank level	25.600 mAOD
Flood Levels at location SK 53552 35273	
100-year flood 1% AEP	27.290 mAOD
100-year flood + Climate Change 20%	27.750 mAOD
100-year flood + Climate Change 30%	27.890 mAOD
1000-year flood 0.1% AEP	27.880 mAOD

Historic Flood Events

1.14 The River Trent has a long history of significant flooding, dating back as far as 1683. The initial flood defence was built in 1947 after flooding affected 28 miles of road, 3000 properties and 86 factories in the city centre. Following the flood event from 2000, the Environment Agency worked with partner organisations to study the flood risk over the entire length of the River Trent and its main tributaries. The Nottingham Left Bank Flood Alleviation Scheme (FAS) was subsequently developed by the Environment Agency which covered the River Trent from Sawley to Colwick.

1.15 The Nottingham Trent Left Bank FAS was designed to reduce the risk of flooding to 16,000 homes and businesses along a 27 km stretch of the River Trent. The scheme, which was completed and fully operational in 2012 at a cost of £45 million, raised existing flood defences from Sawley to Colwick in order to reduce the risk of flooding to one percent (i.e. 1 in 100 chance).1

1.16 In Beeston and Rylands, work raised 700 m of existing flood wall, built approximately 200 m of new flood wall, rebuilt about 900 m of flood embankment and raised the flood gate on the

1 Greater Nottingham Level 1 SFRA Addendum 2017

Beeston canal. Further upstream, Attenborough received 2.5 km of new flood wall between the Attenborough Nature Reserve and the railway line, and the road at Barton Lane was raised.

Definition of the Flood Hazard

1.17 Appraising the sources of possible flood water, the SFRA signals surface water, sewers, groundwater and reservoirs/canal sources. The river Trent has a residual flood risk in a 1 in 100-year flood event.

Probability

1.18 From the Environment Agency's flood data, the flood level behind the weir during the 1 % Annual Exceedance Probability (AEP) is modelled as 27.290 mAOD, with 0.1% Annual Exceedance Probability (AEP) modelled as 27.880 mAOD. These are above the typical bank level.

Climate Change

1.19 The EA Product 7 data has the 1 in 100-year levels with a 20% 'Climate Change' allowance. This increases the levels from 27.290 mAOD to 27.750 mAOD.

Flood Risk Management Measures

1.20 To minimise off-site flood risk during construction, the existing beam along the main crest will be removed first, and the remaining weir modifications and temporary works will be carried out in short sections sequentially.

1.21 To minimise on-site flood risk during construction, temporary works will extend to a suitable height to prevent inundation except during extreme conditions. Storage of materials will take place outside the main river channel. Weather alerts will be closely monitored.

1.22 To minimise off-site flood risk during operation, the adjustable weir crest includes robust fail-safe mechanisms to ensure that it automatically lowers, in a controlled manner, during extreme flows or loss of power or communications. These mechanisms are mechanical and are designed to work correctly at all flood levels.

1.23 During flows greater than Q3 the weir crest would be lowered to 300 mm below the existing crest level and as such the flood conveyance area would be increased slightly.

1.24 All electrical and control equipment associated with the adjustable weir crest will be protected against flood damage to at least the 1 in 100-year flood level.

1.25 Operatives will be able to monitor operating conditions, including upstream water levels, remotely.

1.26 No maintenance of the adjustable weir would be carried out during high flow conditions.

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Adjustable weir construction and operation

1.27 Please see the hydrology assessment, Appendix **Error! Reference source not found.**, for full details of the operating philosophy. In summary:

(a) The weir remains fully raised to 24.825 mAOD up to Q40

(b) Flow splits are maintained up to Q10

(c) The weir is fully lowered to 24.1 mAOD in high flow and flood conditions

1.28 During high flows the weir crest level would be lowered to 300 mm below its present level.

1.29 The adjustable weir is constructed from modules consisting of a fixed length of steel gate with a length of rubber balloon fitted underneath the gate. The rubber balloon is inflated or deflated to raise or lower the steel gate. The modules are put together to create the desired length of adjustable weir. Air pipes are fed the rubber balloons. A compressor is used to inflate or deflate the balloons. The system is exceptionally strong and resilient to debris.

1.30 Little maintenance is required. The air pipes would require bleeding every 2 to 3 months and the compressor would require an annual service. Regular inspections would be carried out by boat.

1.31 In the event of a puncture the pressure would decrease but the compressor would compensate for this loss of pressure. An alarm would be raised so the module could be repaired. It would have minimal impact to the weir operation.

1.32 Inflation and deflation rates can be specified as required during the detailed design stage. To ensure the rates are sufficient to respond promptly to changes in river flow, we expect to specify maximum rates of approximately 2 metres per hour at these sites. This equates to full inflation/deflation in 22 minutes.

1.33 The power requirement to maintain pressure in the adjustable weir, when fully inflated, is very low. As a result, during loss of power when the adjustable weir is fully inflated, any weir deflation will be negligible (unless the water level reaches the failsafe trigger level, when controlled deflation would occur).

1.34 Failure of the weir in the fully inflated position is prevented by a number of design and management measures. Failure of the weir in this position would be detected at Q40, when the weir should begin to lower. Failure of the weir to deflate requires:

- Failure of comms/power AND;
- Failure of backup comms/power AND;
- Failure of mechanical failsafe #1 AND;
- Failure of mechanical failsafe #2 AND;
- Failure for support team to manually deflate the weirs

1.35 Communications and power systems will be continuously monitored remotely, with alarms sent out to the service team in the event of any unusual behaviour or loss of power. A strict and regular maintenance schedule will be complied with.

1.36 The first failsafe is a simple mechanical device that causes the weir to deflate when the upstream water level rises to the auto-deflation level. A special butterfly valve and drop-

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bucket unit is supplied. Once a pre-set level in the river is reached, the water fills the bucket and causes it to drop and trigger the butterfly valve (additional deflation valve). A proximity sensor is located close to the arm, so the maintenance operatives are notified (an alarm is triggered) in case this system is activated.

1.37 The second failsafe is a simple pressure relief valve system that responds to excessive pressure within the inflated rubber bladder. When a pre-set pressure level is reached, the mechanical valve ensures that the bladder automatically deflates until the pressure returns to a safe level.

1.38 In the event of any failure for the system to operate correctly, or during any loss of power or communications, the 24/7 support team will be alerted. Due to the operational protocol of the scheme as described above, any failure will be identified well in advance of any potential flood event. If this extremely unlikely event occurs, the service team will therefore be able to deflate the weir crest manually.

1.39 Full details of operational and maintenance procedures will be subject to agreement at a later date with Environment Agency and the Canal & River Trust.

Off-site Impacts

1.40 The main weir has breadth 72 m and will be reduced in level by 300 mm, resulting in an increase in flood conveyance area of 22 m^2. The side weir has breadth 82 m and will be increased in level by 200 mm, resulting in a reduction in flood conveyance area of 16 m^2. The net change is a small increase in flood conveyance area of 6 m^2. In addition, during flood events the effective crest length of the side weir will be reduced due to its orientation. As such the flood level will be reduced slightly as a result of the proposed development.

1.41 The changes in water level patterns upstream of the weir will not adversely impact any tributaries, as discussed within the Hydrology Assessment document.

1.42 The run-off from the proposed development will not greatly change due to the small footprint of impermeable surfaces and additional capacity of the hydropower channels.

Residual Risks and Mitigation Measures

1.43 The Principal Contractor will be required to provide appropriate construction method statements, risk assessments and mitigation measures under the EA environmental permitting process. Appropriate cofferdam structures will be used.

1.44 During operation, operatives will be able to monitor operating conditions, including upstream water levels remotely. The associated risks and compliance enforcement will be managed by the Operator.

1.45 Any weir crest maintenance operations will be carried out following consultation with the Environment Agency and Canal & River Trust.

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