Moor Monkton Raw Water Pumping Station

pumps and HV switchgear replacement

by
Timothy Crofton MEng (Hons), AMIMechE

Moor Monkton Raw Water Pump Station (RPS) is a river abstraction pump station located on the River Ouse, north of York, which transfers raw water to Eccup Water Treatment Works (WTW) and reservoir through a dedicated 28km cross-country pipeline. A booster pump station lies approximately half way along the pipe close to Wetherby. Yorkshire Water Services (YWS) commissioned CostainMouchel to replace life-expired and non-compliant High Voltage (HV) switchgear life-expired pump sets at Moor Monkton RPS. The maximisation of the river abstraction licence, up to 142Ml/d dependent on river levels (to facilitate Yorkshire Water Services' Water Resources Allocation Plan, WrAP), was also a requirement that necessitated new pumps at Wetherby booster pump station. CostainMouchel's solution provided the lowest whole life cost for the client.

Existing installation (left) and new installation (right)

Courtesy CostainMouchel

Feasibility Study / Option Selection

The first steps to ensuring the most efficient replacement were to gather all relevant information; characterise the rising main, the pump station and sump layout; and understand any restrictions on the existing assets. This included profiling the 1,000mm nominal bore steel pipe with two sections; the first 13km was 25bar rated and the second section was 16bar rated. The next step was to identify possible solutions including:

- Sectional pipeline replacement or installing a twin pipe.
- Additional booster pump station or relocating existing pumps after the weak point in the pipeline.
- Maximise the potential of the existing assets by reducing flow to 125Ml/d.

Due to the high capital cost of the solution, Arup was requested to provide a preferred solution given all the constraints. Hydraulic Analysis Ltd provided a theoretical solution to rising main characteristics and Hydrotec Consultants Ltd created a physical model of the sump for optimisation. The most cost-effective option was to reduce the flow to 125Ml/d.

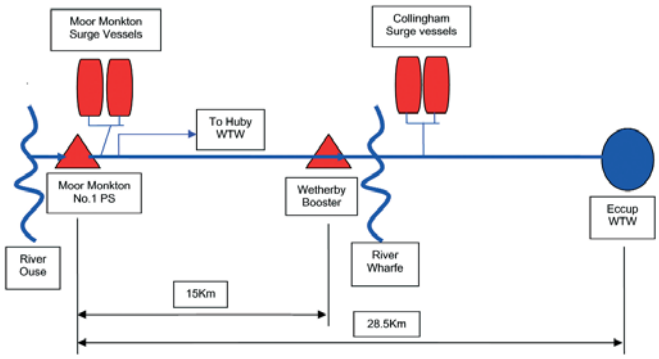
Design

CostainMouchel completed detailed design and delivered the preferred solution.

Hydraulic analysis - Further to the initial surveys undertaken, Hydraulic Analysis Limited confirmed the system curve with pressure and flow surveys in the pipeline to characterise the system curve as well as performing failure scenario simulations to ensure weak points in the rising main were not compromised. Analysis proved that the surge vessels were adequately sized for the proposed solution and, under simulated failure conditions, the pipeline remained within its maximum pressure ratings in the different sections and its minimum pressures remained positive ensuring no air was drawn into the system at the air valves.

Sump Modelling - Hydrotec Consultants Ltd constructed and tested a 1/5th full-size scale model with different inlet conditions and a range of combinations of pumps. Initial tests indicated that pump inlet conditions were compromised by strong submerged jetting and submerged vortices. A solution was developed and tested in the model, comprising baffle units downstream of the sump inlet to stop cross flow (jetting) and vortex suppression mats to minimise vortex creation. These modifications showed significant improvement in the pump inlet conditions and ensured that the pumps would operate efficiently. CostainMouchel implemented the recommended pump sump modifications to improve the inlet conditions to the pumps.

Pump selection - SPP Pumps Limited resized the main variable speed three-stage pumps and booster sets for fixed speed operation. A portion of the generated head was moved from the booster pumps to the main Moor Monkton pumps. At Moor Monkton, four-stage vertical turbine pumps with 785kW motors were used to give the



Moor Monkton to Eccup System Schematic *Courtesy CostainMouchel*

optimum two-pump flow with fixed speed drives. At Wetherby, the booster pumps' impeller diameter was reduced on the split case pumps, which allowed the re-use of the 850kW motors and minimised the pressure at the weak point under the River Wharfe. The multistage pumps were selected from the lowest life-cycle cost series offering improved efficiency and lower maintenance costs.

Baffles and vortex suppression mats - The baffles and vortex suppression mats were installed as per sump model recommendations. The design of the baffles had to take into account the possible jetting force through the inlet penstock of up to 8m head into an empty sump so extra top bracing was included.

HV equipment - The life-expired oil-filled incoming 11kV transformer was a health and safety risk and so removed and replaced with vacuum-operated switchgear. The obsolete and problematic 3.3kV MCC starters were replaced with autotransformer starters. A dedicated HV specialist on the CostainMouchel project team was involved throughout all feasibility, design (in conjunction with Schneider Electrical Ltd and Integrated Utility Services), installation and commissioning stages.

Control upgrade - Low Voltage elements included a new Mitsubishi PLC - which has to communicate with an Alan Bradley PLC for control of existing actuated valves - and Profibus installation, utilising fibre optics from CEMA Ltd. This also had to link the two pump stations located 15km away using a dedicated private wire.

Condition Monitoring - Condition monitoring was installed on all the pumps. Temperature and vibration sensors mounted on the bearings can be used to analyse potential problems. These signals can be viewed remotely to see trends change over time.

Installation - The installation had to take place with minimum disruption to the water supply to Eccup WTW and reservoir. This was managed by sectional replacement of the 3.3kV MCC and pumps, enabling at least two pumps to be operational at all times. Complete shutdowns were required for the replacement of the 11kV transformer and switchgear and also for the modifications to the pump wet well that required man entry.

Conclusion

The new system maximises the abstraction potential from the river within the constraints of the existing assets that were re-used. The HV switchgear was successfully replaced with only a minimum shutdown of the pump station.

Pumps, baffles, vortex mats and the new switchgear have been installed and commissioned. The overall performance testing and took place at the end of May 2009 and results indicate that the pumps perform to the required duty.

The Team

The project was delivered for Yorkshire Water Services by the AMP4 Clean Water (East) Joint Delivery Team, comprising YWS, Costain and Mouchel, led by Mike Ward (Special Projects Manager, YWS). All staff involved, working together as CostainMouchel, are co-located at offices in Castleford, West Yorkshire.

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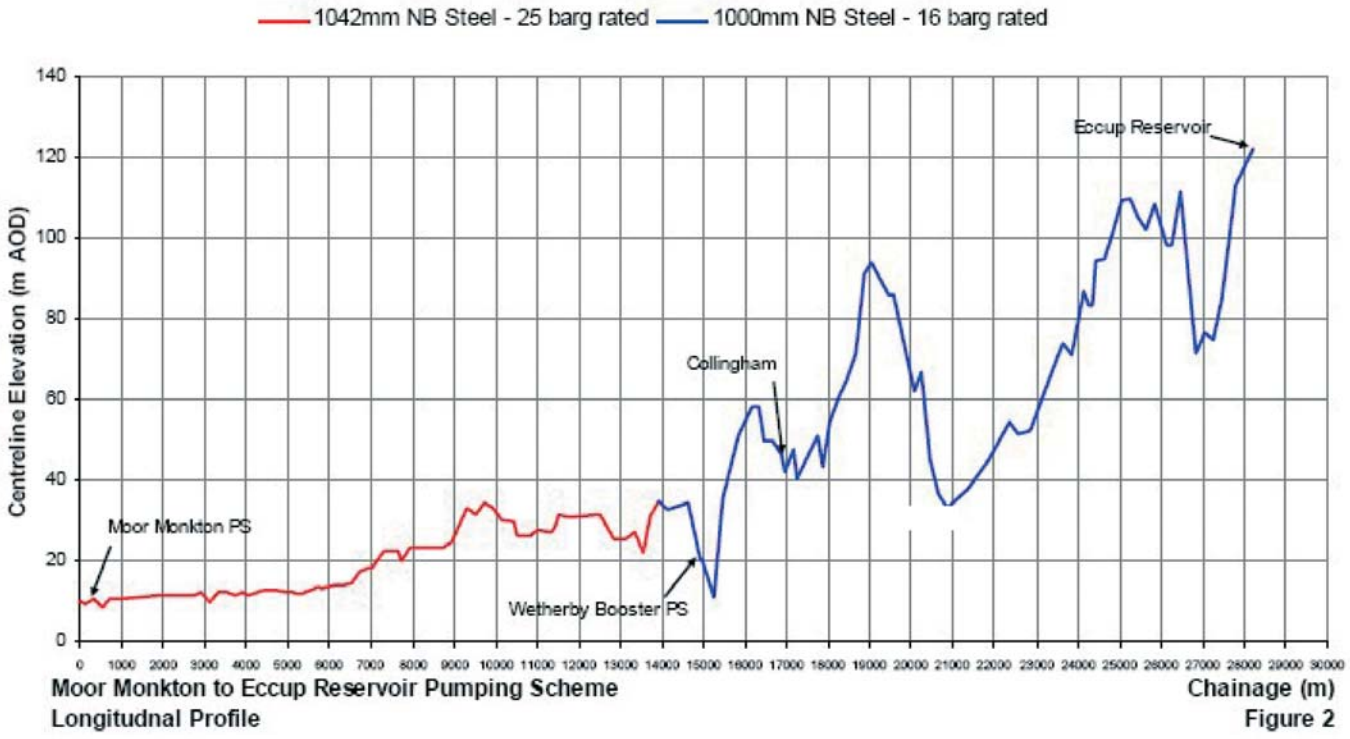

Moor Monkton to Eccup Reservoir Pumping Scheme
Longitudnal Profile

Figure 2

Courtesy Hydraulic Analysis