Alum Waters Sewer Flooding Alleviation Scheme

flood alleviation scheme to mitigate sewer flooding leading to pollution of the river Deerness and contamination of farmland

by Tina Robinson

As part of the AMP6 Capital Programme, Northumbrian Water Group (NWG) are investing over £1bn in water and wastewater services to provide unrivalled customer service. As part of this programme Esh-Stantec were commissioned by NWG to investigate the sewer network and to develop a notional solution to prevent sewer flooding on farmland at Alum Waters, New Brancepeth, County Durham. This follows repeat flooding reports from manholes NZ23419501 and NZ23413701. The population of the catchment is 20,922 with the population upstream of the tank estimated at 4,800. In this location, the sewer network is in a steep sided river valley, crossing the river in a number of places by elevated pipe bridges. Much of the network inaccessible even on foot due to woodland and dense vegetation.

Alum Waters: Construction of the Carlow precast concrete tank - Courtesy of Northumbrian Water Group & Esh-Stantec Limited

Hydraulic model

Esh-Stantec started their commission by enhancing the existing hydraulic model with manhole, CCTV, topographical and flow survey data to quantify the frequency and volume of flooding in the area and to identify the flooding mechanism. The flooding mechanism was confirmed as sewer incapacity between manholes 501 and 701 which was exacerbated by serviceability issues in the downstream network caused by siltation and root ingress.

Several meetings took place during the flow survey and model verification process to discuss the results with all stakeholders including NWG's operations team, landowners and their representatives. Optioneering work was then completed to identify viable options for development into a notional solution, which was then presented to NWG's sponsor for the scheme and was assessed to ensure compliance with all measures of success.

Solution

The notional solution was developed into a robust and buildable hydraulic solution which provided a level of protection in line with NWG's standard specifications. The solution was:

- Online upsizing of approximately 300m of the existing DN300 combined sewer to DN450, from existing manhole NZ23413701 to existing manhole NZ23416601.
- A new storage tank to provide usable storage volume of 3200m^3 with integrated flow control chamber and weir wall.

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Excavation of tank area with self supporting batter
Courtesy of NWG & Wood PLC

Erection of external wall panels and preparation of base
Courtesy of NWG & Wood PLC

Concrete pump on site to pour second section of the base
Courtesy of NWG & Wood PLC

Alum Waters: Slope reinstatement to minimise the duration of open excavation - Courtesy of Northumbrian Water Group & Esh-Stantec

- 6 (No.) new manholes in arable fields.
- Improvement and extension of the existing access arrangements for maintenance and cleansing of the storage tank.

Storage tank

The 3200m^3 storage tank was constructed using precast concrete units supplied by Carlow Concrete. The tank incorporates a low flow channel with a jet flow regulator fitted to limit pass forward flow rates to 30 l/s. This was the maximum flow rate that the downstream network could convey without surcharging. A weir wall was located between lanes two and three of the storage tank to create 'wet' and 'dry' sides to the tank. In dry weather operation and a proportion of typical year rainfall events, flows are confined to the 'wet' side, and only in larger rainfall events do flows spill into the 'dry' side. This arrangement aims to reduce overall tank annual maintenance requirements by reducing the utilised storage in a typical year and subsequent siltation within the tank.

Planning permission

The scheme required planning permission due to change in profile of ground above the tank and the construction of the access track as the permanent works could be viewed from the river Deerness Walkway and a locally designated nature park.

This resulted in a requirement to:

- Demonstrate no change in surface water flood risk.
- Reduce the visual impact of the track.

A pluvial assessment was undertaken using a 2D surface water model to assess how the ground profile alterations would affect overland flow routes and further to recommendations from this assessment, a small bund was installed to intercept and guide surface water back to original routes supporting the principle of holding flows back in the catchment during periods of heavy rainfall.

To mitigate visual impact, NWG's conservation advisor advised that hedgerows and small copses of oak and birch trees be planted, and specified EM08 meadow mix for clay to be used for seeding of the working area to introduce a wider range of meadow grasses and for gapping up of other nearby hedgerows to be carried out to enhance mitigation in agreement with the local authority.

Tank construction

Following confirmation of slope stability, the tank was constructed by open cut method, with over 337 (No.) precast panels being manufactured by Carlow Concrete and delivered to site. A blinding screed and 400mm of reinforced concrete was laid over an area 66m x 30m. The reinforced concrete base slab was laid in six sections and power floated to provide the required finish.

Over an 11 week programme, the external wall panels, internal supporting panels for the roof and roof panels were installed. A concrete screed was then installed over the roof. All the wall and floor panels are fitted with a hydro-tight seal which is activated by water ingress and comes into full operation within 3 months. The infill sections to the wall panels were completed together with the in situ installation of the benching to the required fall. The roof of the tank has ten access points to facilitate inspection/cleansing of the tank in the future.

During detailed design, the storage tank design was optimised to achieve the most efficient storage volume considering both loading and flotation in both the temporary state and permanent state.

Temporary works were significantly reduced after consultation with NWG asset protection whilst still providing appropriate protection to a 30" strategic potable water main. Slope stability checks and

validation reduced the overall level dig for the tank construction, an overall difference in level of 23m.

Controls were installed allowing close monitoring of the slope in the temporary state and in particular during and following adverse weather. This was supported by detailed geotechnical assessment of slope stability. Slope reinstatement was coordinated with the tank sub-contractor and temporary works designer, and undertaken in stages as storage tank installation progressed in order to control slope stability and minimise the duration of open excavation.

During construction, surface water run-off and groundwater from natural springs was controlled by a lagoon; water collected in wetter conditions and then evaporated or percolated into the ground during drier conditions. During periods of heavy rainfall an overflow route was created with a means of filtering any excess flows through a geotextile membrane to remove fine silts and sands.

As well as the management of flows above ground, consideration was also given to the likely volume of water that would be displaced underground as a result of tank installation using the Dupuit equation for unconfined steady-state flow. Whilst making some broad assumptions regarding specific aquifer properties and rates of effective recharge for the site, volumes were estimated at between 0.5m^3 and 2.0m^3/day. These volumes were extremely small and did not require any special measures to divert nor would they make a significant contribution to surface water flows when compared with the observed rates of surface water flow.

Managing ecology

The Environment Agency was consulted throughout the project in order to manage ecology and to ensure that there was no pollution of the River Deerness from surface water run-off from the site. The Environment Agency's representative made a number of site visits during the project. The existing sewer was diverted to maintain the network during the construction of the attenuation tank and associated drainage, as opposed to establishing over pumping, significantly reducing the risk to the surrounding environment.

Supply Chain	Company
Principal designer & contractor	Esh-Stantec
Precast concrete tank	Carlow Concrete
Temporary works design	James Christopher Consulting
Site supervision, client CDM advice & safety inspections	Wood PLC

Following the full implementation of this sewer upgrade and turn of flows through the storage tank, NWG's Operations team, undertook extensive root clearance and de-silting to improve downstream network capacity. This work was facilitated by the ability to manage flows in this section of the sewer network.

Conclusion

Northumbrian Water (NWG) have invested £3.5m to resolve historic sewer flooding problem which was leading to the contamination of farm land. The scheme now provides protection from sewer discharge on a section of the network previously blighted by hydraulic incapacity. The scheme has been delivered on time and within budget through collaborative working between NWG and Esh/Stantec and all key stakeholders in the scheme including Durham County Council, the Environment Agency, internal stakeholders to NWG and land owners and their representatives. The use of off-site manufacture reduced the programme significantly and allowed the turn of flows to take place within 8 months of the scheme going to site.

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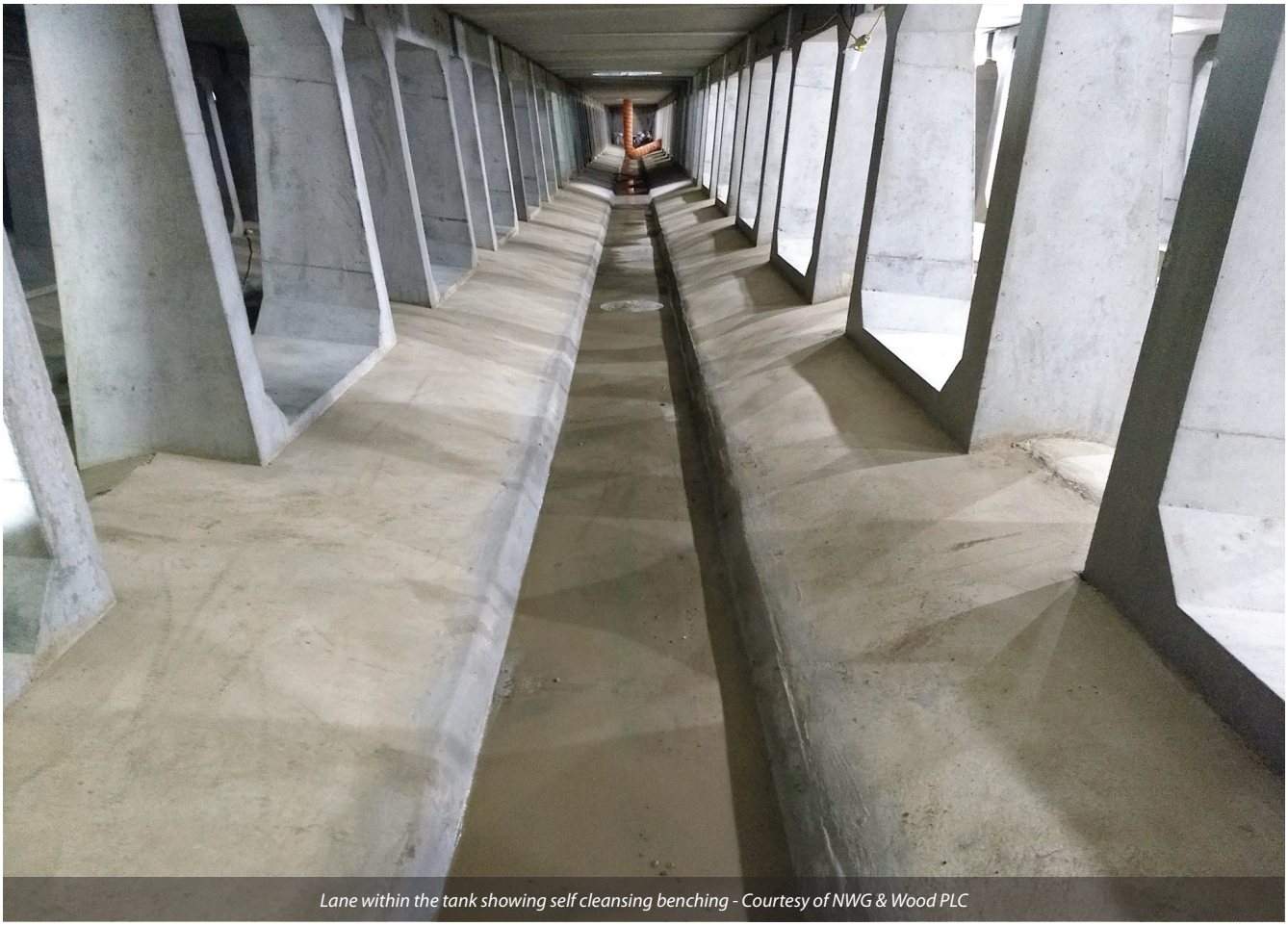

Lane within the tank showing self cleansing benching - Courtesy of NWG & Wood PLC