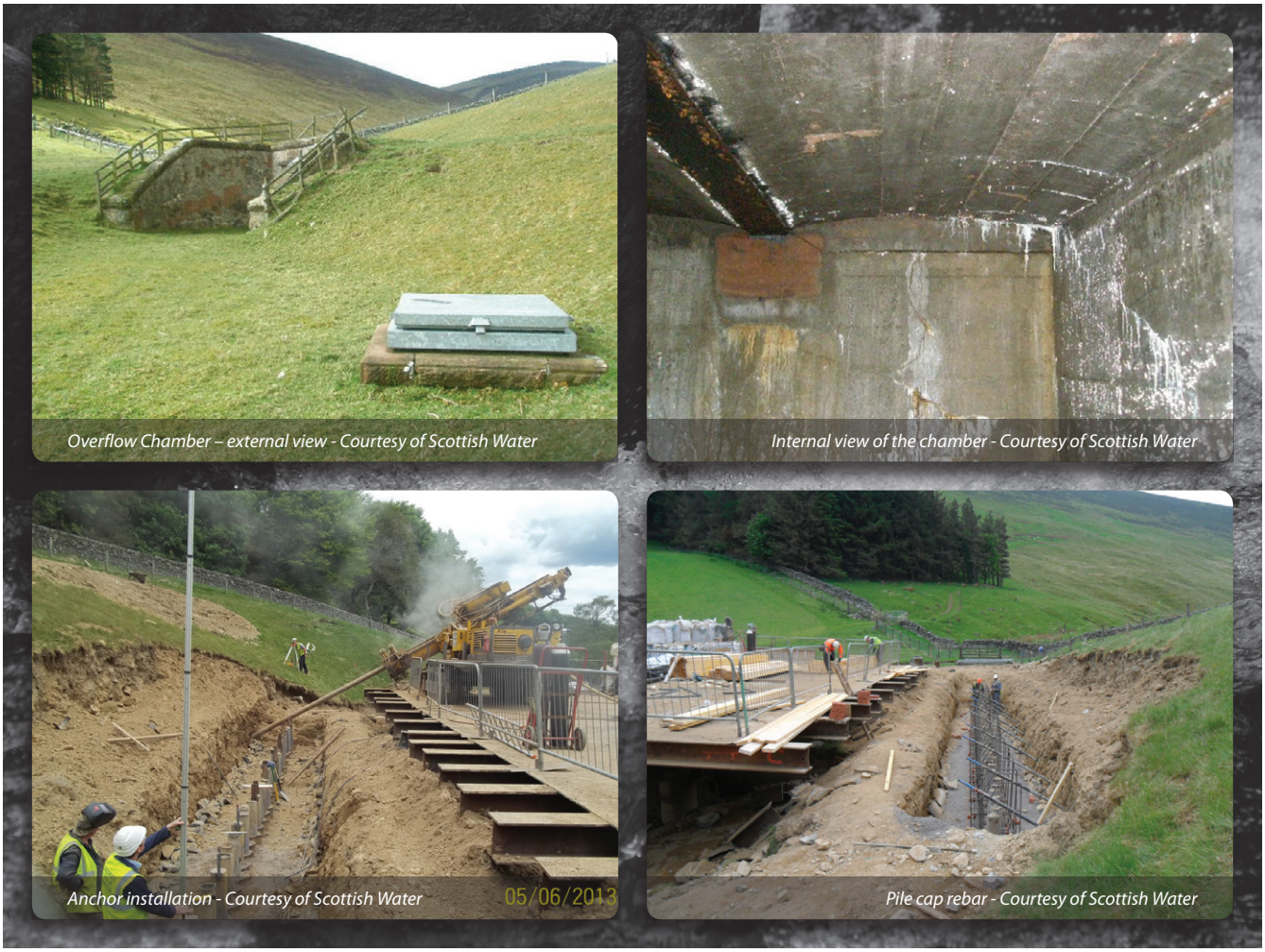
Talla Aqueduct

overflow chamber stabilisation

by Simon Renton IEng AMICE

The original Talla Aqueduct tunnel was constructed in the 1890s and supplies Edinburgh and the new Glencorse Water Treatment Works with raw water. The aqueduct runs in a single tunnel for most of its length, split by seven siphons and a number of bridges. The construction is a mixture of cut and cover and excavated tunnel. Typically the tunnel sections are constructed or lined with mass concrete approximately 380mm thick. There is approximately 19.8km of cut and cover construction, 14.4km of tunnels and 11.2km of siphons. The tunnel sections are approximately 1.8m wide and 2.2m in height and include an arched roof. Access to sections of tunnel are at regular intervals in the cut and cover sections. Siphon chambers are provided at the inlet and outlet to the siphon pipes and overflow chambers are also located up the line of the aqueduct.



Overflow Chamber – external view - Courtesy of Scottish Water

Internal view of the chamber - Courtesy of Scottish Water

Anchor installation - Courtesy of Scottish Water 05/06/2013

Pile cap rebar - Courtesy of Scottish Water

Overflow chamber structure

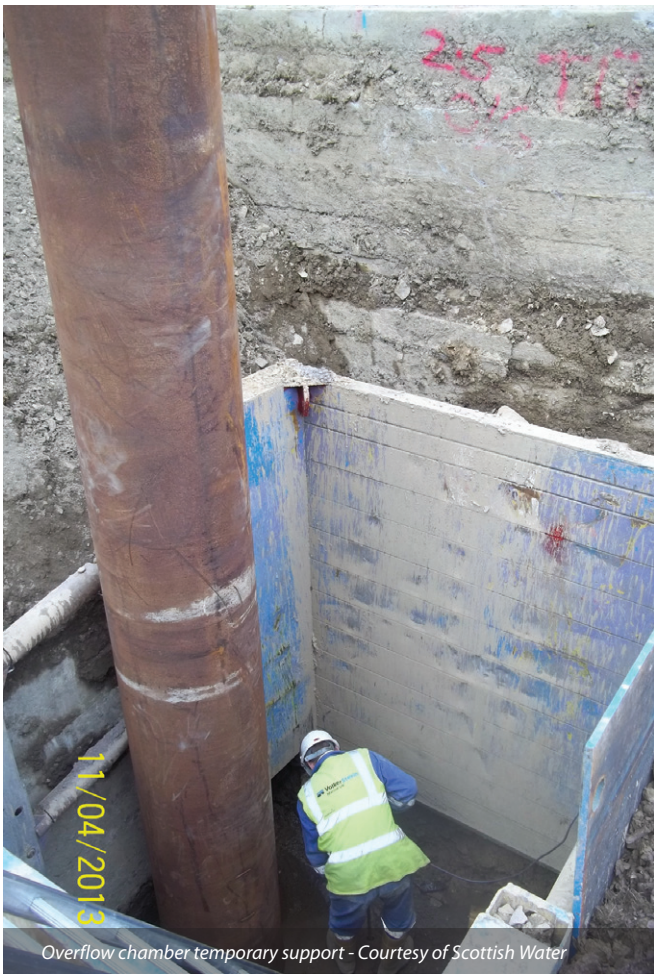
One such overflow chamber structure is buried completely on three sides and partially on the fourth as it sits in a saddle at the foot of a hill. Ground level in front of the door is at approximately mid-depth of the structure. From this level it slopes up behind the masonry faced retaining walls to a plateau over the structure and aqueduct before sloping up again at an angle of approximately 35-40º behind the chamber.

The burn has been diverted around the overflow chamber in a lined channel passing close by on the east side. The overflow from the pipe from the chamber discharges into this burn via a 12" dia pipe incorporating a change of direction chamber with security cover.

Chamber inspection history

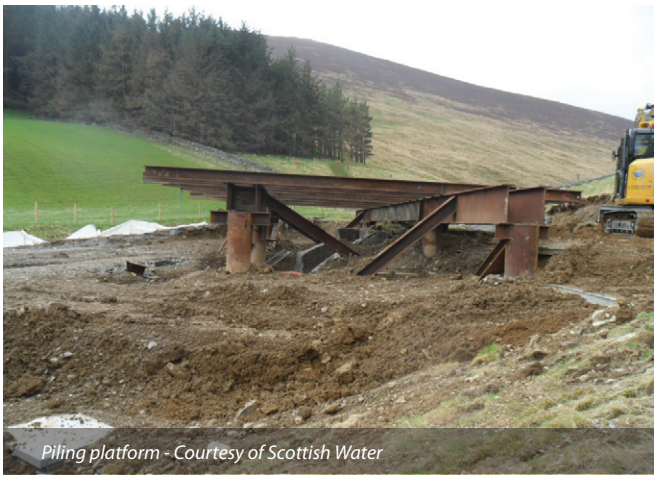
Visual inspections of the tunnel and its associated chambers in recent years had identified the need to carry out some work to refurbish parts of the tunnel to ensure it could continue to serve the City of Edinburgh well into the future.

Yearly monitoring and review by the area asset planner eventually gave rise to an inspection of the chamber by consultant Carlbro in 2006 and a monitoring regime was put in place for a number of months along with some survey items to determine the concrete characteristics. Further geotechnical investigations carried out in 2007 confirmed that the overflow structure was founded on rock and that the backfill material around and over the structure is likely



Overflow chamber temporary support - Courtesy of Scottish Water

Temporary working platform - Courtesy of Scottish Water


Piling platform - Courtesy of Scottish Water

to have been won from the construction of the tunnel sections on either side of the chamber. Further tests and surveys revealed some evidence of ground movement and subsidence in the area immediately around the structure was observed.

Jacobs were employed by Scottish Water Capital Investment Delivery (CID) team to provide an outline design and specification for work to ensure the chamber could be returned to the best possible condition.

A tender of the works was issued to Scottish Water Construction Delivery Partners and George Leslie Ltd was selected as the preferred bidder.

Scope of the works

George Leslie was responsible for the design and construction of refurbishment and stabilisation works to the chamber. The work was planned to be designed and installed in such a way as not to stress any part of the existing chamber and aqueduct structures.

The design brief included a waterproof structure surrounding the existing chamber structure to exclude all water and thus remove all hydrostatic pressure from the existing chamber.

Bored pile retaining wall: George Leslie and their consultant partner Atkins designed and installed a waterproof bored pile retaining wall and capping beam tied back with rock anchors along the uphill (east) side of the overflow chamber to remove the loading on the structure from the hillside under which it is buried.

The anchor wall system was designed to carry all geotechnical and hydrostatic loads (including surcharge loads from vehicles/plant) from the uphill slope and thus remove all such loading from the existing chamber structure. New drainage works between the new bored pile retaining wall and the existing chamber structure in order to relieve all hydrostatic loading from the uphill side of the existing chamber structure was installed.

Mass concrete gravity walls: The replacement mass concrete gravity walls on the north, west and south sides of the chamber to remove the soil loadings on these sides of the structure was designed to carry all geotechnical and hydrostatic loads. In addition, the mass concrete wall system was to carry all loads from other parts of the works and existing structures as required.

The mass concrete walls were cast directly onto rock head. The walls were to incorporate reinforced concrete members to span over the aqueduct such that the aqueduct is protected and is not loaded by any part of the works. Compressible fillers were used where appropriate in order to achieve this.

Waterproofed roof structure: A new precast concrete roof structure with a waterproofed screed spanning from the bored piled wall onto a steel beam spanning across the overflow chamber structure above the existing roof level was installed. The soil over the existing structure was removed and replaced on top of the new roof over the chamber. The new roof structure was designed to remove all external loads from the existing chamber roof including soil and hydrostatic loads, snow loads, pedestrian and vehicular loads.

In addition, new drainage was installed to convey water away from the existing chamber roof to adjacent surface water drains.

Wing walls and drainage works: New waterproof mass concrete wing walls were installed with the same geometry as the existing wing walls that shall be demolished and again were cast directly onto rock head. New drainage works to the slopes above the structure, immediately behind the structure and over the chamber to lower the groundwater level around the structure and reduce water loading on the structure were installed.

Chamber repair works: Cracks in the internal structure surface of the chamber were repaired and all internal wall and roof surfaces were covered with a protective coating in order to stabilise the surface. Roof beams were cleaned to remove all rust and loose material and then painted with a protective paint system.

Aqueduct integrity

George Leslie's design for the bored pile wall and rock anchor works included the following:

- Construction of a temporary working platform on one side of the overflow chamber for piling, excavation, backfilling and other construction operations to avoid adding construction loading onto the overflow chamber and the aqueduct.
- Provision of a working platform over the live aqueduct channel within the overflow chamber to allow concrete repair works to be carried out. The platform was completely sealed to prevent any cleaning debris or effluent or repair materials entering the aqueduct at any stage of the works including during removal of the platform to avoid accidental pollution of the aqueduct.

Reinstatement of all ground to the existing levels and condition recorded on site during the pre-construction dilapidation survey was carried out with the agreement of the landowner.

The location of the contractor's accommodation and storage area was on private land and reinstatement and handover was once again agreed with the landowner and by the timescale of 30 August 2013.

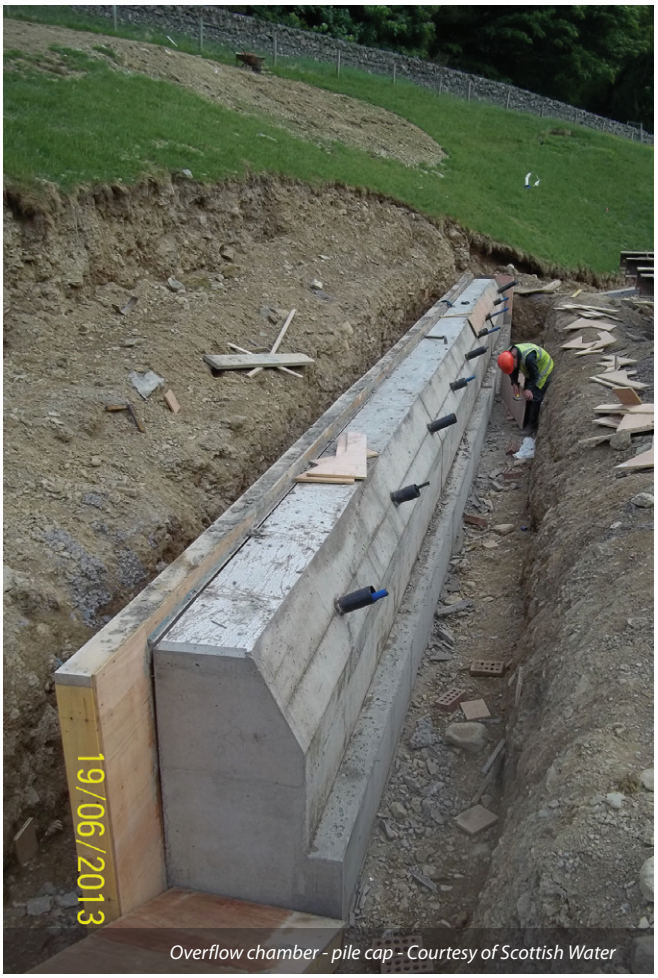
Conclusion

The aqueduct and its function was maintained during the works to ensure continuous uninterrupted raw water supply to the aforementioned water treatment works. George Leslie Ltd and their piling sub-contractor MG Piling should be commended on their work to a critical raw water supply asset and their inventive use of a working platform arrangement for the piling.

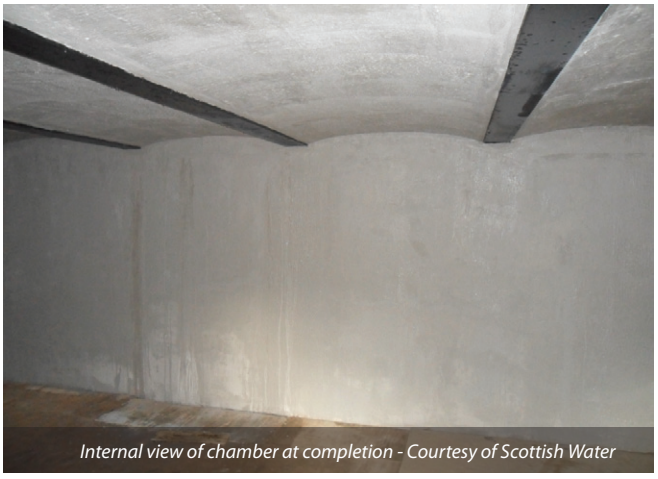
The work was constructed to the design proposed with minimal impact on the landowner in challenging circumstances due to the project location.

Thanks go to Scottish Water Operations and Asset Management colleagues for their help and assistance in delivering this project safely and within the project budget and timescale.

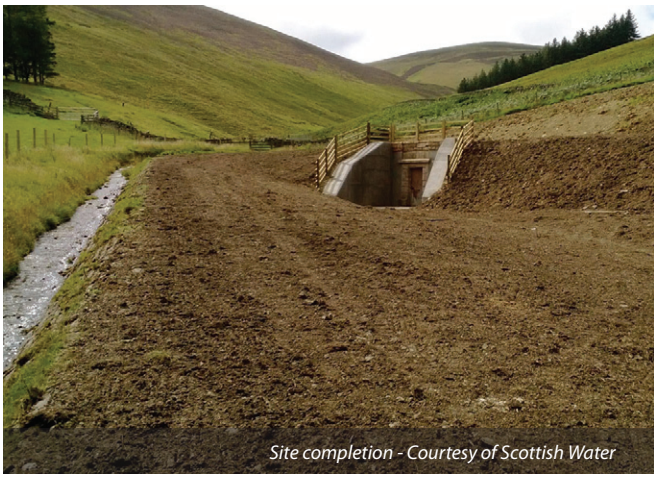
The Editor & Publishers would like to thank Simon Renton, Project Manager - Non-Infrastructure with Scottish Water Capital Investment Delivery, for providing the above case study for publication.



Overflow chamber - pile cap - Courtesy of Scottish Water


Internal view of chamber at completion - Courtesy of Scottish Water


Overflow chamber reinstatement - Courtesy of Scottish Water


Site completion - Courtesy of Scottish Water