

## **INVESTIGATION OF THE HAWESWATER AQUEDUCT WITH AN INNOVATIVE RAPID SCANNING GROUND PENETRATING RADAR SYSTEM**

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The Haweswater Aqueduct in the United Kingdom was commissioned in 1955 and at 109 km in length and 2.6 m in diameter, is a major feat of engineering. The aqueduct supplies over 570 million liters of water per day from reservoirs in the Lake District to customers in Manchester and northwest England. The asset owner commissioned an investigation of over 40 km of concrete tunnel sections to determine the structure and condition of the aqueduct. The key objectives included determining the concrete lining thickness; identification of voids, defects or deterioration within the concrete; and mapping structural components to confirm accuracy of historical construction records. Additionally, the survey methodology needed to address the challenging conditions such as; the limited access opportunity to minimize service interruption to 2.2 million customers; the stringent hygiene requirements of working within a potable water supply system; and safe work practice for working within confined spaces.

This paper presents innovative rapid scanning ground penetrating radar (GPR) system that was developed over two-year period for the investigation of the Haweswater Aqueduct. After a series of trials within mock-up tunnels at a dedicated training facility, a multi-channel ground penetrating radar (GPR) and video system mounted on bespoke electric vehicle was selected. This enabled the collection of continuous longitudinal profiles at various positions around the tunnel radius. High frequency antennas were used to investigate the concrete lining, while lower frequencies penetrated deeper into the host rock. The main survey was completed within 8 days by multiple teams working 24 hours per day. In total, more than 800 profile kilometers of GPR were collected. Processing and interpretation of data ran in parallel with data collection and supported further detailed investigations and targeted core sampling within a few days of the survey.