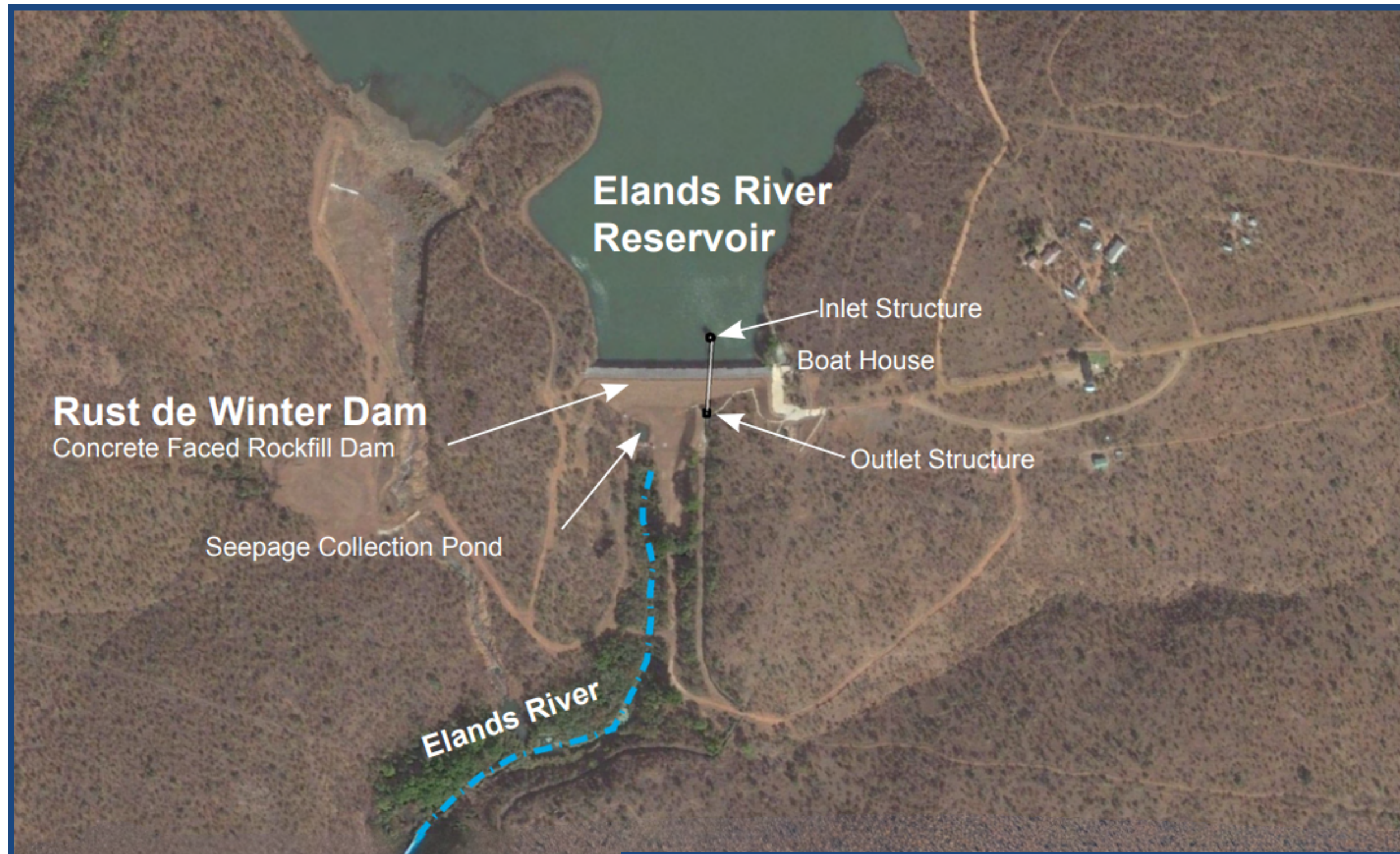


CASE STUDY: Understanding The Cause Of Seepage - Rust De Winter Dam

USING TECHNOLOGY TO IDENTIFY DIFFICULT TO LOCATE SEEPAGE OUT OF A DAM

Willowstick LLC



Seepage appeared along the downstream abutment and the cause was unknown

Introduction

The Rust de Winter Dam is located on the Elands River within the "Rust-de-Winter" Nature Reserve in the Limpopo Province, South Africa. The dam was built in 1934 to supply irrigation water and serve as a strategic reserve for the Rhenosterkop Dam located 40km downstream.

To improve the dam's flood handling capacity in 2011 the South African Department of Water and Sanitation raised the dam 2.7m, and increased the length of the dam from 200m to 248m. The dam owners had been monitoring seepage for a number of years, with this type of dam it would be a natural reaction to assume that the leak was through the upstream membrane where there are many joints. However, they were unsure of its exact cause leading them to engage Willowstick Technologies to complete a Magnetometric Resistivity (MMR) investigation with the purpose of identifying any seepage flow paths at the dam.



Seepage collection pond and weir designed to capture and monitor seepage from the dam

SUMMARY

LOCATION

South Africa - Africa

CHALLENGE

The dam leaked and the client didn't know where it was coming from

SOLUTION

A Willowstick groundwater investigation was performed and identified preferential flow paths

BENEFIT

After the investigation the owner had a clear understanding of the leakage through the dam.

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Investigative Approach

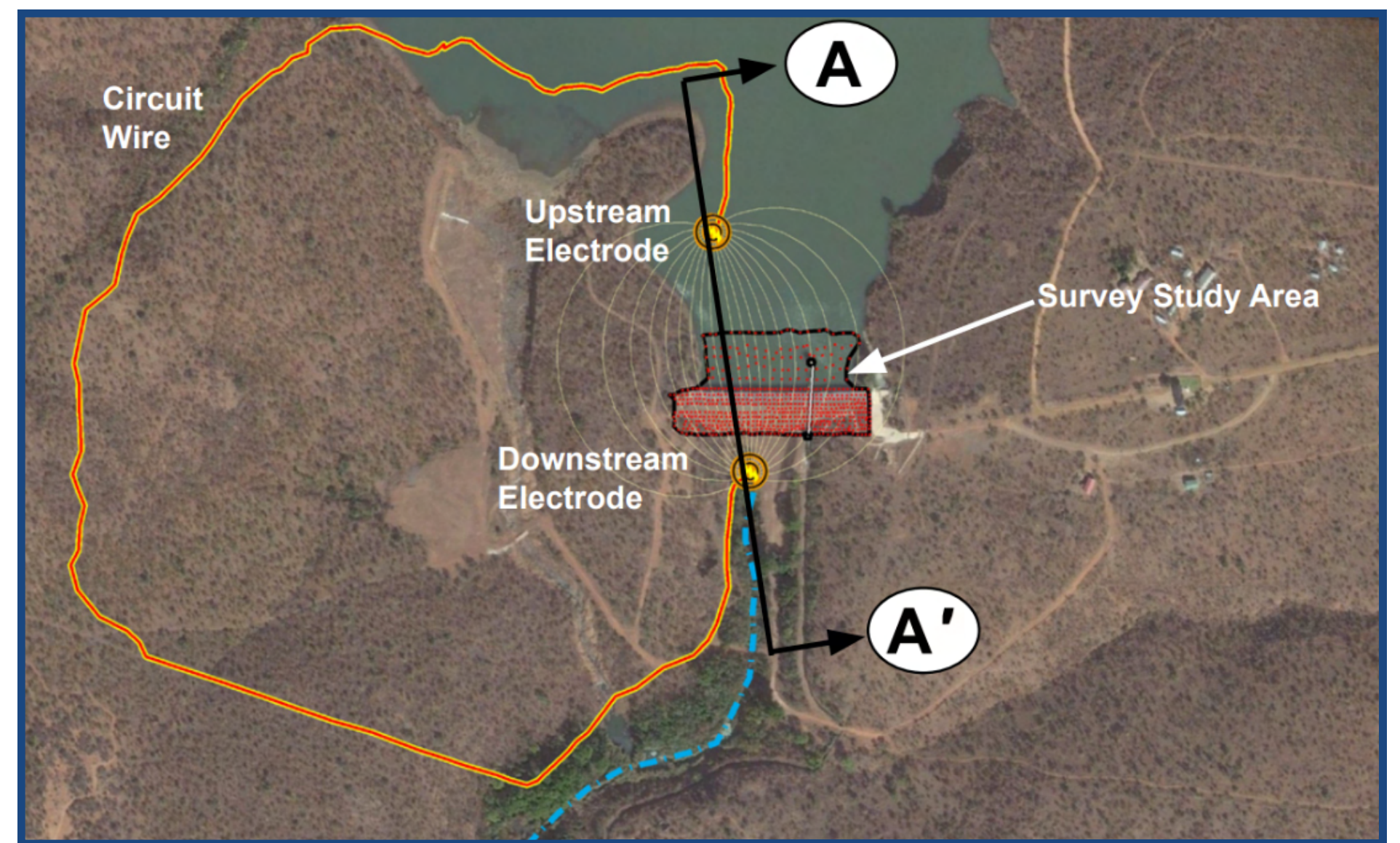
The MMR method, employed by Willowstick Technologies, uses electrodes that are placed strategically upstream and downstream of the investigation area, and the water between them is energized with a low-voltage, low amperage, alternating current with a 380 Hz frequency. As the signature electric current flows between the electrodes, it concentrates in the conductive zones where reservoir water escapes the impoundment. The current creates a signature magnetic field which is measured from the surface using Willowstick Instruments. The collected magnetic field data is used to create 2D maps and 3D models of Electric Current Distribution (ECD) that reveal the exact location and depth of the conductive zones between the electrodes which are interpreted as seepage flow. Using this technique, investigative teams have accurately identified seepage and groundwater flow paths for over 300 projects in locations around the world.

Data Processing

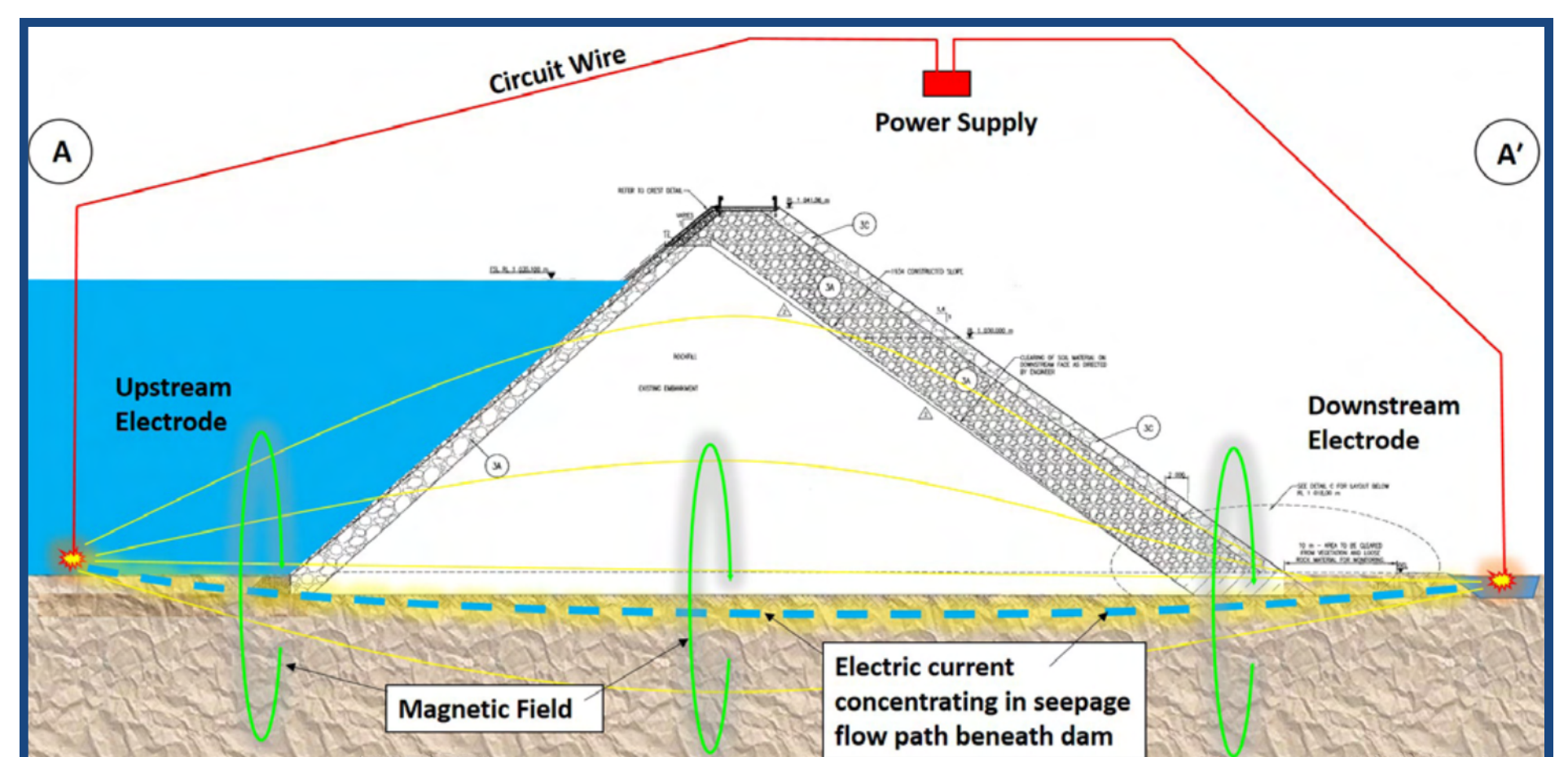
An electric current was injected into the subsurface and the resulting magnetic field was measured using the Willowstick instruments.

To identify areas of greater or lesser conductivity through the subsurface study area, a model was created of the site to predict the magnetic field response expected at each measurement station given the position of electrodes, circuit wire and topography. By comparing the observed magnetic field to the predicted magnetic field, a Ratio Response Map was created that removed electric current bias from the data set and showed areas of anomalous electric current flow (greater or lesser than predicted).

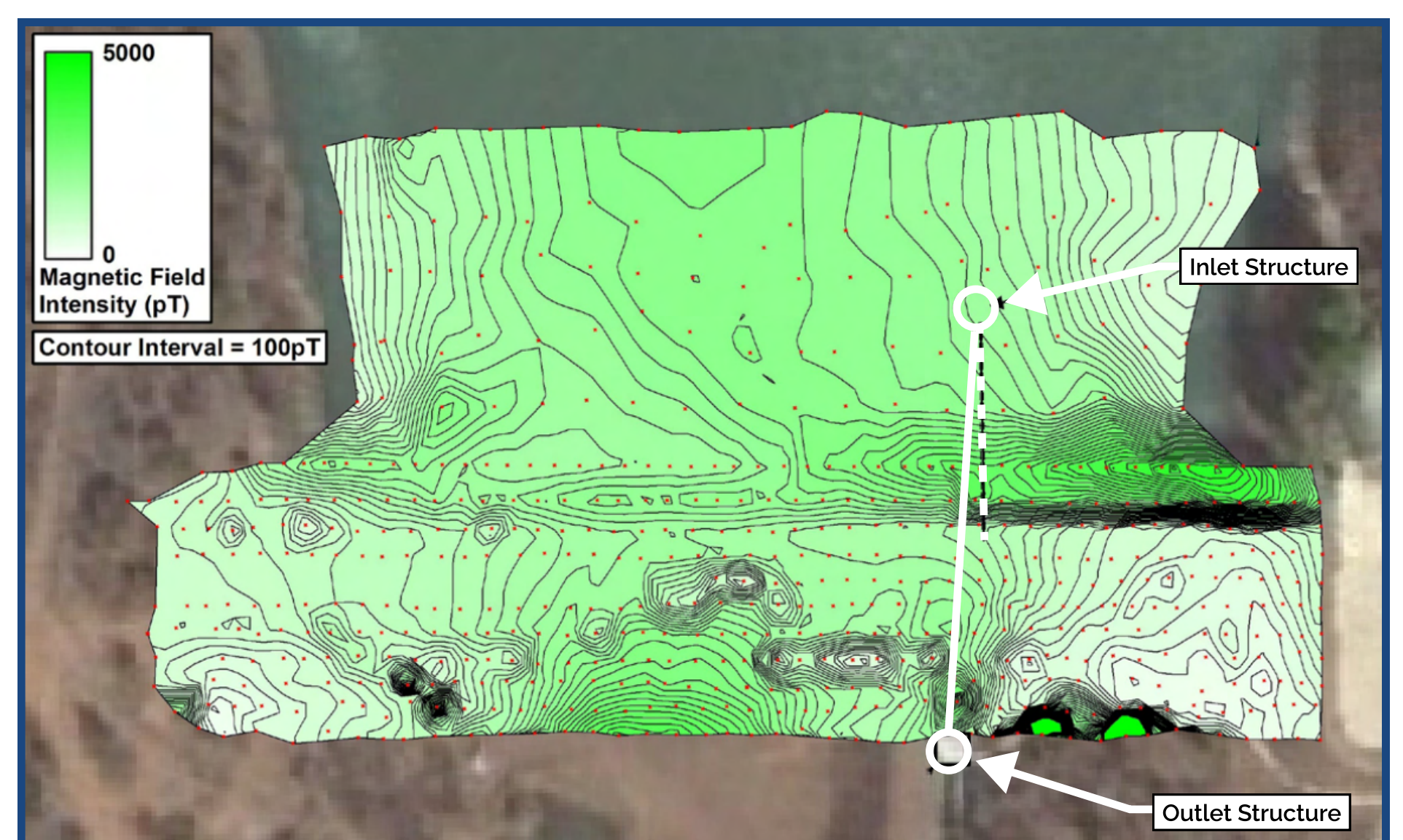
To assign depths to the model, the ratio response data was subjected to an inversion algorithm which generated the ECD model in 3D space, and the preferential groundwater flow paths were identified within the model.



Survey layout and electrode configuration

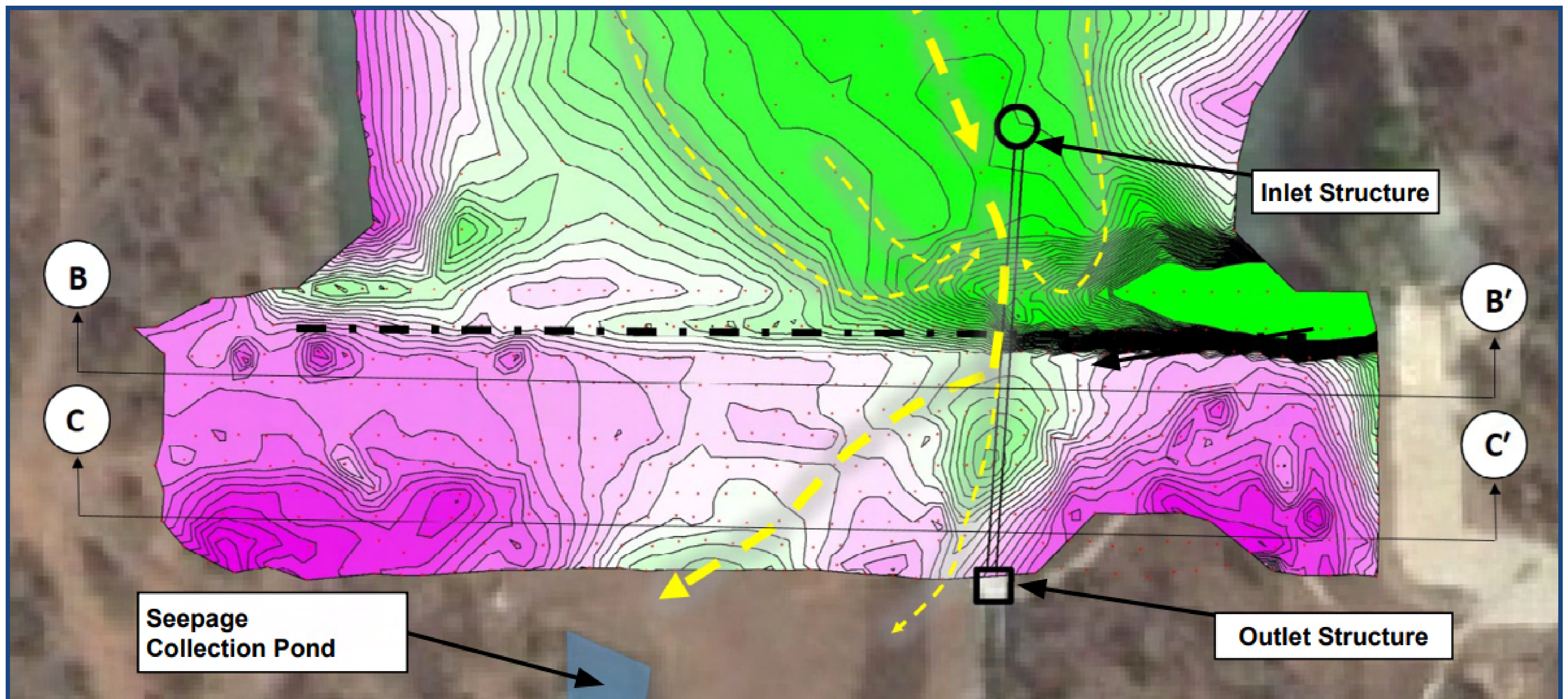


Survey layout and electrode configuration (vertical cross section)



Signature magnetic field

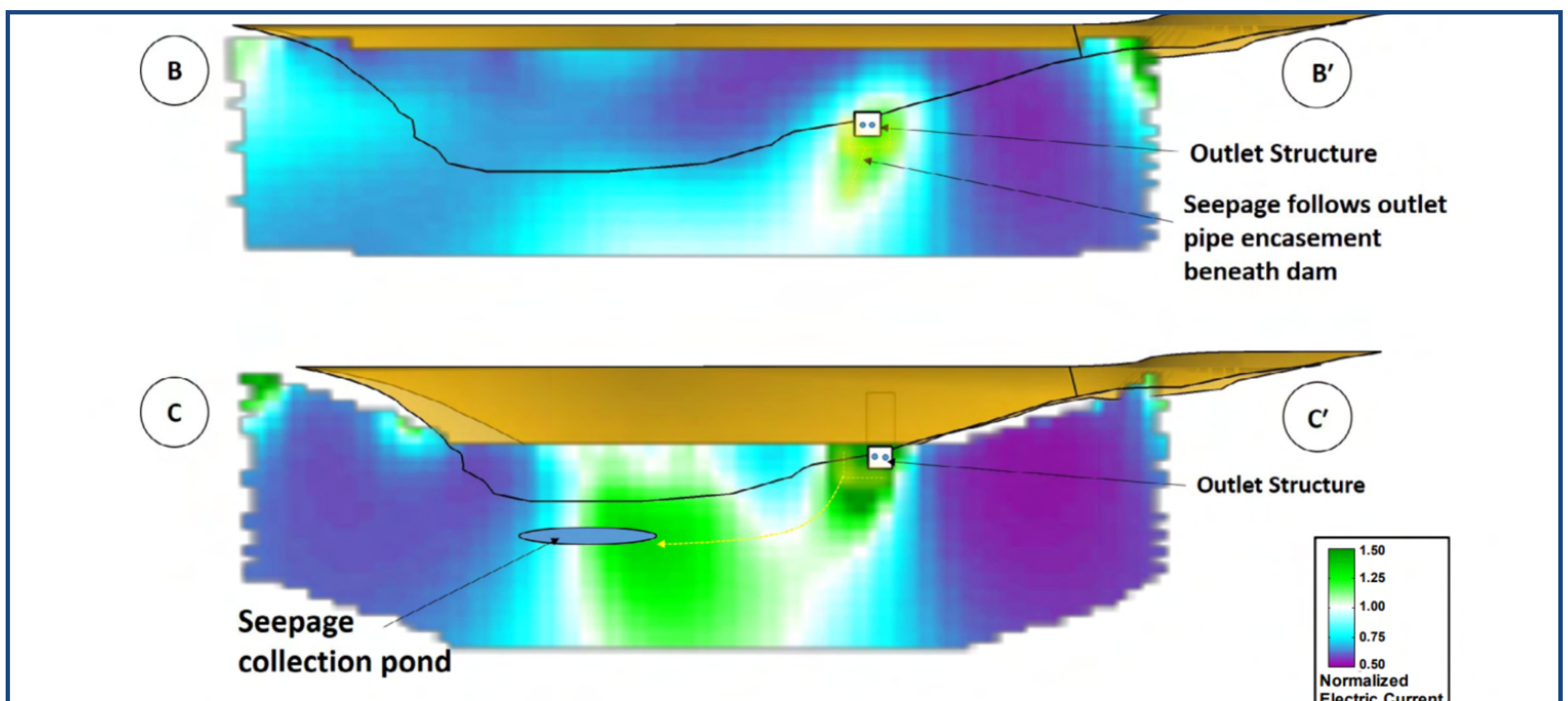
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Ratio Response Map, the yellow lines represent preferential seepage flow paths

Conclusion

After the investigation the owner had a clear understanding of the leakage through the dam. In fact it proved conclusively that there were no leaks through the upstream membrane or indeed through the right abutment as assumed. The leak was found to be under the membrane and its cutoff, then under the pipeline where blasting may well have shattered the rock, and then it swung sharply from the left hand side of the dam towards the right abutment where the leak manifested itself as a flow on the surface.



Profile view of ECD model slices

