



THE PROBLEM

In 2008 a dive inspection unexpectedly observed extensive erosion of the earthen canal lining above a culvert extending beneath the Tekapo Canal. This led to urgent mitigation measures to stabilise the canal over the short term. As a result the owner wanted to better understand conditions along the entire 26km long Tekapo Canal and identify any additional deficiencies that needed to be addressed. Mitigation concept options were developed in areas assessed as deficient.

ENGINEERING STUDY

A comprehensive study of Tekapo Canal was performed. First, the regulatory and owner's operational criteria were interpreted in relation to the canal. Next, the potential failure modes were determined. Internal erosion under static and earthquake loading were the primary failure modes. Overtopping was generally not considered a risk, except at a very large fill section under extreme seismic shaking. This condition was studied using numerical modelling and analyses by experts. Then the canal was divided into segments having similar engineering conditions. Design and construction information from each segment was collated. Next a quantitative risk assessment was performed via a series of workshops that identified foreseeable failure mechanisms at each segment, and calculated the risk of failure and incidents needing major repair. Finally, risks of failure and major repair were assessed against the regulatory and owner's operational criteria to determine deficiencies.

Repair concepts were developed for the deficiencies identified. Concepts were evaluated by risk analysis to determine their risk reduction. Concepts had to meet an established tolerable level of risk. Those that did were evaluated further for concept design, constructability assessment, construction methodology, programme, cost estimate and canal outage time. Multiple repair concept options were presented for some deficiencies.

ENGINEERING SOLUTION

Three areas were identified as deficient, each with unique characteristics requiring unique solutions.

Where the canal lining had eroded beneath a culvert the embankment needed to be stabilised, and the canal relined with a membrane lining system. Options for remove and replacement or compaction grouting were developed for stabilising the embankment.

Where lining defects were dispersed over a 1.1km section of canal a composite solution was developed. This consisted of groundwater dewatering, cofferdams, canal dewatering, inspection and repair of defect areas, relining with a membrane lining system, and drainage buttresses.

At a fill embankment up to 45m high the canal embankment was built with filters that do not extend up to the canal water level. Here several options were developed to raise the filter. Repair options consisted of: 1) degrading the exterior embankment and reconstructing with a filter; 2) a secant pile granular filter; or 3) a biopolymer filter trench.

CLIENT

Meridian Energy Ltd

LOCATION

Tekapo, New Zealand

THE CANAL

Tekapo Canal was constructed between 1971 and 1977 to link Lakes Tekapo and Pukaki as part of the Upper Waitaki Power Scheme. The 26 km long earth lined canal has a capacity of 130m³/sec and maximum flow velocity of 1m/sec.

