In 1854, the British scientist John Snow demonstrated that cholera was spread through contaminated water after he was able to trace a virulent outbreak of cholera to a particular water pump that had been contaminated by raw sewage. Besides removing the handle from the pump so that it could not be used, Snow also used chlorine to purify various community water sources. His action pioneered the use of chlorine as a disinfectant. And it is now the most commonly used disinfectant in water distribution systems worldwide.

A properly designed chlorine disinfection system provides an immediate kill of harmful bacteria and viruses and a protective residual throughout the water distribution system (WDS), thereby preventing recontamination.

Dosing with too much chlorine has a number of negative side effects. It increases water treatment costs and has a deleterious effect on the taste and odour of the water. Increased chlorine levels also raise the risk of forming disinfection by-products (DBPs), which may be harmful to human health. Therefore, it is important to achieve a balance between an adequate chlorine residual for microbiological control and preventing high chlorine residuals that make the water distasteful or potentially harmful.

The Problem
Generally, the chlorine dosing rate at a water treatment plant is determined from operator knowledge and by monitoring residual chlorine concentrations and coliform levels in the distribution network. This is a sub-optimal method of operating, as the dosing rate is adjusted only some time after the chlorine concentration in the field is detected to lie outside a desirable range.

It would be beneficial to accurately predict the chlorine dosing rate that is required to achieve a balance between sufficient chlorination to ensure bacteriological quality and providing customers with water that they find pleasant to drink.

Our Solution
We developed and applied a technique to forecast water quality in chlorinated systems using artificial neural networks (ANN). ANN is a data-driven model, which does not require a detailed understanding of the reactions that take place in chlorinated systems. Rather the ANN uses existing data to detect complex non-linear relationships. As data continues to be collected, the ANN evolves and improves its ability to make accurate predictions. ANN is an ideal technique for predicting aspects of the behaviour of a complex water distribution supply system.

The Benefit
We applied the technique at the Hope Valley Water Treatment Plant. We showed that a data-driven modelling approach is a suitable method for estimating disinfectant concentrations in a water distribution network, especially in the case where the network is not well understood and the necessary data for a process based model are not available. The models we developed used routinely measured data, and we were able to make accurate predictions in a reasonable time and hence were suitable for operational conditions.