

## SUMMARY

### I REASONS

Chlorine is used throughout the world as a disinfectant for water supply, and has probably made a greater contribution to the prevention of waterborne disease than any other form of water treatment. However, one disadvantage of the use of chlorine is that it can result in customer complaints of unpleasant taste and odour, either from chlorine itself or from reaction of chlorine with other materials in, or in contact with, the water.

The categorisation of customer contact data was modified in 2006, providing the Drinking Water Inspectorate (DWI) with more detailed information regarding the nature of taste & odour (T&O) contacts, including those relating to chlorine. This provides the DWI with the opportunity to gain a better understanding of any relationships between chlorine concentrations within the distribution network and customer contacts relating to chlorine T&O.

### II OBJECTIVES

The aim of this project was to use data held by the DWI over the period 2006 to 2008, to ascertain whether there is any relationship between the chlorine concentrations, or variability in concentration, and chlorine T&O contacts. This data consists of the regulatory sampling results and customer contacts that the companies in England and Wales are required to report to the DWI.

The project had the following specific objectives:

- To extract information from DWI data systems and review the information to identify the most appropriate analysis and statistics to meet the overall objectives of the work;
- To compare the data at zone level on the frequency of customer contacts in relation to chlorine taste and odour (T&O) with the chlorine residual data;
- To compare the data on the frequency of contacts relating to chlorine T&O with the chlorine residual variability measures, and;
- To assess the statistical significance of any correlations identified in the analyses.

### III APPROACH

A multiple linear regression analysis technique was used to assess the strength of any relationships between the frequency of customer contacts relating to chlorine T&O and any explanatory factors, such as residual free or residual total chlorine (RDF or RDT respectively). Three measures of chlorine were selected to represent specific characteristics of chlorine concentration within each zone; mean concentration (central tendency), standard deviation (variability) and maximum-minus-mean (sudden peaks in concentration).

Other water quality parameters were included in the regression analysis to represent other factors that may also influence the frequency of chlorine T&O contacts. These parameters were colour to represent chlorine demand, turbidity to represent issues with distribution mains and conductivity to represent the varying hardness of the supply water.

### IV CONCLUSIONS

- The statistical analysis of the data held by the DWI identified a weak relationship between mean residual free chlorine concentrations and the frequency of chlorine T&O contacts, at a national level (England and Wales). However, the inclusion of either colour or conductivity suggested that there is a stronger relationship between colour or conductivity

and chlorine T&O contacts than there is between the mean residual free chlorine and chlorine T&O contacts, reducing confidence in the reliability of this relationship.

- No other statistically significant associations were found between other measures of chlorine residual or variability and T&O contacts at the national level, across all three years analysed.
- There were marked differences between water companies which may mask any trends that exist between chlorine concentrations and the frequency of chlorine T&O contacts.
- The analysis of data from three carefully selected water companies suggests that relationships between chlorine concentration and the frequency of chlorine T&O contacts are present for one of these companies. However, these relationships are weak.
- For this one company, the term used to indicate sudden peaks in chlorine concentrations, produced consistently significant models across all three years (2006 to 2008). The relationships observed indicated that the frequency of chlorine T&O contacts increased as the magnitude of the peaks in chlorine concentrations increased. This relationship, although statistically significant, is not strong.
- Including both the mean conductivity and mean colour values, separately within the statistical models, have strengthened the identified relationship between chlorine concentration and the frequency of chlorine T&O contacts.
- The comparison of chloraminated and chlorinated zones in one other company showed a distinct difference in the frequency of chlorine T&O contacts, with chlorinated zones exhibiting a much higher frequency of chlorine T&O contacts than chloraminated zones.
- The relationship observed at the national level (mean residual free chlorine and chlorine T&O contacts) was not found to be statistically significant for any of the companies that were studied in detail, further reducing the confidence in the robustness of the relationship.
- The detailed assessment of a small sample of zones suggests that factors such as income, employment, health and education did not play an important role in determining the frequency of chlorine T&O contacts within these zones.

## **V RECOMMENDATIONS**

It is recommended that further work is undertaken to understand why robust relationships between chlorine concentration or variability and the frequency of chlorine T&O contacts could not be identified at a national level, as follows:

- The weak relationship identified at national-level was not identifiable at individual company level. Further analysis of individual companies might identify the reason for this. This would also provide the opportunity to determine whether relationships do exist, beyond the one company identified in this study.
- Company specific factors, such as source water, operational practices, etc., should be examined further to determine the influence these factors may have on the T&O contacts. In particular, the study into socio-economic factors should be extended.
- There are a number of recommendations relating to the type and format of the data reported to the DWI which would facilitate studies of this nature in the future, as follows:
- A zone reference field should be added to the customer contact dataset in order to facilitate the links between the contacts data, sample results and site data.
- Consistent zone referencing should be used between these three datasets.
- Customer contact data should be reported by the date it was received by the water company. This would allow time series analysis to be conducted.