Calculation and composition of indices published in the Chief Inspector's Report

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Calculation methods for MZC

Introduction

The Chief Inspector's Report presents summaries of monitoring data submitted by water companies to the Drinking Water Inspectorate (DWI).

Recent work within DWI has led to the development of indices within the water safety plan framework. Using these indices, the Inspectorate can present the data collected from water companies to better illustrate the overall quality of drinking water and the performance across the water supply chain (treatment, distribution, building water systems).

This document describes the methods by which figures used in the report have been calculated.

Indices

Overall drinking water quality

This measure was first published in the Chief Inspector's Report – Drinking Water 2004 where it was called MZC % (Mean zonal compliance) and comprised the average of the MZC % figures for 39 different parameters that are tested to establish the quality of water.

The parameters comprising this index are listed below.**Code**	**Parameter**	**Place of sampling**
A001	Colour	Consumers' taps
A002	Turbidity	Consumers' taps
A003	Odour	Consumers' taps
A004	Taste	Consumers' taps
A009	Sodium	Consumers' taps
A012	Nitrate	Consumers' taps
A013A	Nitrite	Consumers' taps (samples taken at works not included).
A013C	Nitrite/Nitrate formula	Calculated from samples taken at consumers' taps.
A021	Aluminium	Consumers' taps
A022	Iron	Consumers' taps
A023	Manganese	Consumers' taps
A024A	Copper	Consumers' taps
A027	Fluoride	Supply point or consumers' taps
B001A	Arsenic	Supply point or consumers' taps
B002	Cadmium	Supply point or consumers' taps
B003	Cyanide	Supply point or consumers' taps
B004	Chromium	Consumers' taps
B005	Mercury	Supply point or consumers' taps
B006A	Nickel	Consumers' taps
B007B	Lead	Consumers' taps
B008A	Antimony	Supply point or consumers' taps
B009	Selenium	Supply point or consumers' taps
B010	Pesticides - Total substances	Supply point or consumers' taps
B011F	PAH - sum of 4 substances	Consumers' taps
C002	*E.coli*	Consumers' taps (samples taken at works/reservoirs are not included)
C003	Enterococci	Consumers' taps
D005A	Boron	Supply point or consumers' taps
D007	Benzo(a)pyrene	Consumers' taps
D008	Tetrachloromethane	Supply point or consumers' taps
D009B	Tetrachloroethene/Trichloroethene - Sum of 2 substances	Supply point or consumers' taps
D011	Total Trihalomethanes	Supply point or consumers' taps
F001	1,2 - Dichloroethane	Supply point or consumers' taps
F002	Benzene	Supply point or consumers' taps
F003	Bromate	Supply point or consumers' taps
P002	Aldrin	Supply point or consumers' taps
P028	Dieldrin	Supply point or consumers' taps
P043	Heptachlor	Supply point or consumers' taps
P044	Heptachlor epoxide	Supply point or consumers' taps
P999	Pesticides - other substances*	Supply point or consumers' taps

***P999 - Other substances –** Companies carry out a great deal of pesticide monitoring. However, the specific number and types of pesticides monitored for vary considerably from one company to another, and so a method is needed not only to standardise the results, but also to avoid attaching too much weight to the pesticide parameters as compared to others in the MZC% value. The method adopted is to pool the results for all pesticides other than aldrin, dieldrin, heptachlor and heptachlor epoxide, and to treat them as a single 'other pesticides' parameter (P999 in the table shown above).

Treatment

The indices used to represent water company treatment performance are as follows :

Process control index

This index is based on a selection of parameters which are, in general terms, controlled by the processes in place at water treatment works. Its focus is on chemical parameters.

It is calculated by taking the average of Mean Zonal Compliance figures for the following parameters

Code	Parameter	Place of Sampling
A001	Colour	Taken in zones
A012	Nitrate	Taken in zones
A013B	Nitrite	Taken in works
A021	Aluminium	Taken in zones
A027	Fluoride	Taken in zones or supply points
D011	THM	Taken in zones or supply points
F003	Bromate	Taken in zones or supply points

Disinfection index

This index is based on a selection of parameters which inform about the effectiveness of disinfection and pathogen removal.

It is calculated by taking the average of Mean Zonal Compliance figures for the following parameters

Code	Parameter	Place of Sampling
C001	Coliforms	Taken at treatment works
C002	*E.Coli*	Taken at treatment works
A002A	Turbidity	Taken at treatment works

Distribution systems

This section includes two measures which describe the cleanliness and integrity of the distribution system from where water leaves the treatment works up to the point of supply to consumers.

Distribution maintenance index

This index is based on a selection of parameters to reflect the age, condition and maintenance status of the pipes (mains) and to a lesser extent the reservoirs which comprise the distribution networks of companies. In 2004, this index was reported under the name of OPI (TIM).

It is calculated by taking the average of Mean Zonal Compliance figures for the following parameters

Code	Parameter	Place of Sampling
A002	Turbidity	Taken in zones
A022	Iron	Taken in zones
A023	Manganese	Taken in zones

Reservoir integrity Index

Microbiological sampling takes place at service reservoirs as a check on its integrity and general hygienic status.

It is calculated by taking the average of Mean Zonal Compliance figures for the following parameters

Code	Parameter	Place of Sampling
C001	Coliforms	Taken at service reservoirs
C002	*E.coli*	Taken at service reservoirs

Building water systems

Domestic water systems (buildings), particularly the consumer's drinking water tap, is the point where water is drawn for consumption and is therefore judged by consumers to be satisfactory or not, as the case may be. One index appears describing the quality as reflected by a set of parameters that may be influenced by the design or condition of domestic water systems.

Parameters influenced by domestic water systems

The index is calculated by taking the average of mean zonal compliance figures for the following parameters.

Code	Parameter	Place of Sampling
A003	Odour	Taken in zones
A004	Taste	Taken in zones
C001A	Coliforms	Taken in zones
C002	*E.coli*	Taken in zones
C003	Enterococci	Taken in zones
B006A	Nickel	Taken in zones
B007B	Lead	Taken in zones
A009	Sodium	Taken in zones
A024A	Copper	Taken in zones

Calculation of compliance figures

Whilst the above section describes the composition of indices, the following describes the calculation of the underlying figures.

The basic principle is that any index is built up from compliance values for the parameters that constitute the index.

For some indices the data used is monitoring data taken in zones (and/or supply points), for others, samples taken at treatment works or service reservoirs are included. Whichever parameters are selected, then the principle remains the same.

For any specified collection of zones and/or supply points, the index figure is comprised of:

- the arithmetic mean of the mean zonal compliance values for all parameters defined as constituting the index

For any specified collection of water treatment works or service reservoirs, the index figure is comprised of:

- the arithmetic mean of the compliance values for each treatment works or service reservoir for all parameters defined as constituting the index

Additionally compliance can be calculated at the level of a company, a region, a country or for the whole industry.

Explained here are:

- Mean zonal compliance for a parameter
- Mean zonal compliance for a company
- Mean zonal compliance for a region
- Mean zonal compliance for a country (England and Wales)
- Overall compliance
- Consumer contact rates

Mean zonal compliance for a parameter

Definitions

Zonal compliance

For any one zone, the zonal compliance for any parameter is:

- the percentage of samples meeting the PCV.

Interpretation of supply point samples

In previous years, where a parameter was monitored at a supply point rather than in the zones its results were assigned to each of the zones served by that supply point. That approach led to an element of double-counting and is no longer being used. Instead, each supply point is viewed as though it were another zone within the company, and 'supply point compliance' is calculated in exactly the same way as zonal compliance.

Mean zonal compliance

For any parameter, mean zonal compliance (MZC%) is defined as:

- the arithmetic mean of the zonal compliance values for any specified group of zones.

For those parameters that are monitored at a mixture of supply points and zones, it would be too cumbersome to refer to 'Mean zonal and/or supply point compliance'. In all that follows, therefore, the term 'mean zonal compliance' will be taken to mean:

- the arithmetic mean of the zonal compliance values for any specified group of zones and/or supply points.

Four specific groupings are of particular interest:

- all zones in a Company;
- all zones in a Region (a special case being all zones in Wales);
- all zones in England; and
- all zones in England and Wales.

The detailed MZC% calculations for these various groupings are illustrated with worked examples in the following sections.

In addition, this year, indices based on samples taken at treatment works and at service reservoirs are included. Compliance for these is measured In a similar way to mean zonal compliance by taking the number of samples meeting the standard as a percentage of total samples taken for the specified parameter.

The following examples are based on calculations using samples taken in zones but the methodology is essentially the same for indices based on samples from water treatment works and service reservoirs. Any differences are noted.

Mean zonal compliance for a company

Consider the example of manganese (parameter A023) in 'Company A'. The zonal compliance results for the 91 sampling locations are summarised below. The values are 100% in all but four zones. The sum of the 91 zonal compliance values is 9,091.796 (see the shaded column), and so the mean zonal compliance for manganese in 'Company A' is 9,091.796/91 = 99.910%. (Note that the third decimal place would not normally be reported, but is shown here and elsewhere simply to make the details of the calculation clearer.)

Sampling location	No. of cases	No. of samples	No. > PCV	% Zonal Compliance	Numerator of MZC calculation
Zones	87			100.000	8,700.000
	1	71	1	98.592	98.592
	1	58	1	98.276	98.276
	1	49	1	97.959	97.959
	1	33	1	96.970	96.970
Total	91				9,091.796
		Mean Zonal Compliance:		**99.910**	

Mean zonal compliance for a region

For indices based on samples taken in zones

Mean zonal compliance for a region is calculated in exactly the same way as described in the previous section, but with the zones (or supply points where relevant) now extending across all companies in the region.

There is an additional complication with Wales, Northern and Midlands regions because three companies have zones or supply points in two different regions, as summarised below and additionally there are zones which overlap the border.

Where zones overlap the border, the overlap is frequently small with low numbers of buildings or consumers on one side of the border. In these cases the zones have been allocated to the region in which the majority of the zone sits. Where there is a more significant overlap, the samples within the zone have been allocated to a region based on their geographical location. Their location is determined from grid references supplied with the sample data or calculated for post code information.

Type of sampling location		Dee Valley	Dwr Cymru	Severn Trent
Zones	Overlapping	Three in Wales/Northern	Three in Wales/Central	Three in Central/Wales
Zones	In neighbouring region	Three in Northern	Nine in Central	Four in Wales

For indices based on samples taken at water treatment works or service reservoirs.

Where indices are based on samples taken at water treatment works or service reservoirs, these may supply communities on either side of the boundary. In the nine zones described above as overlapping, sample data from any water treatment works or service reservoir supplying consumers on both sides of the border is included in the adjacent region as well as the region relating to their physical location.

Mean zonal compliance for England and Wales

When calculating the mean zonal compliance for a country, the calculation of figures for the country Wales is equivalent to the region Wales. In order to calculate mean zonal compliance for England, the samples in Wales are subtracted from the whole data set and the resulting data used to calculate the MZC for England.

Compliance for indices comprising multiple parameters

Definitions

For any specified collection of zones and/or supply points, the index figure is comprised of:

- the arithmetic mean of the mean zonal compliance values for all parameters defined as constituting the index

For any specified collection of water treatment works or service reservoirs, the index figure is comprised of:

- the arithmetic mean of the compliance values for all parameters defined as constituting the index

The arithmetic mean is used in order to give all parameters equal weight in the overall figure.

Four specific zonal groupings are of particular interest in calculating overall compliance: Company, Region (including Wales), England, and the industry.

Taking one example, the calculation of the Distribution Maintenance Index for a company is illustrated below.

Distribution maintenance index

For any specified collection of zones and/or supply points, the distribution maintenance index is defined as:

- the arithmetic mean of the mean zonal compliance values for the three parameters turbidity, iron and manganese.

Example

The table below lists mean zonal compliance values for turbidity, iron and manganese for each of three geographical groupings – ‘Company A’, Wales, and the industry. The derivation of each of the three MZC% values for manganese has been shown in previous sections. The sets of values for turbidity and iron are calculated similarly.

Parameter	**Mean zonal compliance %**		
	Company A	Wales	England and Wales
Turbidity	99.98	99.985	99.967
Iron	99.40	99.705	99.628
Manganese	99.83	99.853	99.894
Distribution Maintenance Index (%)	**99.74**	**99.847**	**99.829**

Once the MZC% values have been determined for the three component parameters, the distribution maintenance index is simply calculated as the arithmetic mean of the three components. For example, the distribution maintenance index for Wales is (99.985 + 99.705 + 99.853)/3 = 99.847% reported to two decimal places as 99.85%

Indices comprising other combinations of parameters are calculated in the same way using the figures for appropriate parameters.