ECORYS

Study supporting the revision of the EU Drinking Water Directive

Annexes

Client: European Commission, DG Environment

Rotterdam, May, 2016

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Annex A Evaluation matrix

Table 0-1 Effectiveness

Evaluation questions Judgement criteria	Indicators	Actions to obtain evidence	Information sources
EQ1 To what extent has the Directive achieved its objectives, e.g. to reduce contamination of water intended for human consumption and to protect human health?			
JC1.1 Compliance rates of parameters show an improvement in water quality in the EU for the period under review.	% changes in compliance rates of concentrations, distinguished for relevant microbial, chemical or indicator parameters[1]	Analyse and compare trends in compliance rates for EU countries	Country reports, experts and national authorities, stakeholder conference
JC1.2 The improvement of drinking water quality has had a positive effect on human health	Causal link between a reduction in non-compliance and human health can be established	Review of existing literature which links quality of drinking water with human health	Literature, experts
JC1.3 The DWD can be considered the main factor in the improvement of the quality of water intended for human consumption	Other factors (pieces of legislation) known to have an influence on drinking water quality.	Determine possible (other) causes for variations in parameter concentrations.	Desk research
EQ2 Have the provisions of the DWD been effective for protecting human health and why?			
JC 2.1 The specific provisions in the DWD (parameters requirements, monitoring, remedial actions and information to consumers) have been effective for protecting human health.	i) Health indicators; latest reseach and WHO recommendations ii) Scientific evidence and expert opinion consider that these provisions as the most important: - Frequencies, quality and relevance of information at the level of MS	Analyse the specific provisions and determine their value in relation to the overall objective of the DWD	Desk research and interviews Stakehodler survey
JC2.2 Other provisions have enabled MS to implement the DWD effectively	Number of complaints, comments by stakeholders and critical articles relating to the general provisions	Review and analyse the literature, questions to the EP, media articles and comments and papers by stakeholders which indicate (dis-) satisfaction with the general provisions	Literature, EP website, media sources, submitted comments and papers during the review process

[1] Reference is made to the parameters listed in Annex I of the DWD

Evaluation questions Judgement criteria	Indicators	Actions to obtain evidence	Information sources
EQ3 What main factors, in particular related to water bodies, agriculture and distribution networks, have influenced, or stood in the way of, achieving the objectives of the DWD?			
JC3.1 The majority of non-compliance cases can be related to agricultural or industrial pollution (affecting water bodies) or treatment and distributon systems.	Non-compliance of parameters and their sources Derogation cases Quality of information from MS	Analysis of causes of contamination of drinking water, as undertaken in Task 4; ii) Identify cases where companies have decided to limit or stop intake from a source	Report on Task 4 MS authorities Commission staff Stakeholder conference
EQ4 What results did the DWD achieve beyond its main aim to protect human health, and **the Directive cause any other unexpected or unintended changes ?**			
JC 4.1 The DWD has led to other than human health related results and caused other unexpected or unintended changes	Unexpected/unintended changes (e.g. better organised utilities, increased consumer awareness of water quality)	i) Carry out literature review; ii) List possible candidates for influence of DWD and describe the cause-effect relationship	Desk research Commission staff, Experts Stakeholder conference

Table 0-2 Efficiency

Evaluation questions Judgement criteria	Indicators	Actions to obtain evidence	Information sources
EQ5 To what extent are the costs involved with implementing the DWD justified given the benefits which have been achieved?			
JC5.1 The benefits of implementing the DWD (at MS level) has outweighed the costs	Cost per capita, (operational, capital, admin,) Benefits, to be quantified where feasible	i) Gather cost estimates from a number of operators/utilities; ii) Gather data on benefits derived from (improvements in) clean drinking water; iii) Initial analysis on the relationship between compliance rates and health benefits;	Reports from water utilities National authorities Experts Literature
EQ6 Have there been technical or other developments since the elaboration of the Directive that could contribute to achieving the objective more efficiently?			
JC6.1 Techniques for monitoring and analysis of drinking water quality, and the application of risk-based approached have contributed to the reaching the objective of the DWD more efficiently.	Efficiency of new analysis methods (speed of detection and cost of analysis); Efficiency and costs of regular monitoring versus of risk based approaches	Gather information on cost of Rik Based approaches; and describe the advantages of thes approaches in term of costs and (added) benefits.	WHO National authorities Experts Literature
EQ7 To what extent does the Directive allow for efficient policy monitoring?			
JC7.1 Data gathering and reporting requirements of the DWD allow for efficient policy monitoring by the Commission	Timeliness of information processing Costs of data collection under the DWD	i) Assess the costs involved in data collection of MS and the Commission to obtain sufficient data to carry out policy analysis; ii) Describe and analyse the steps in the reporting process; iii) Gather evidence /views of the efficiency of policy monitoring	National authorities Experts Stakeholder conference

Table 0-3 Coherence

Evaluation questions Judgement criteria	Indicators	Actions to obtain evidence	Information sources
EQ8 To what extent are the DWD provisions internally coherent?			
JC8.1 The DWD provisions are internally coherent	Provisions which overlap, or show discrepancies/ contradictions Impacts of overlaps or discrepancies	Assess the consistency between the articles/ paragraphs/ annexes as defined in the Directive both vertically (how strong is the contribution of each provision towards the objective of the Directive) and horizontally (do provisions have an internal overlap, meaning are there contradictions or discrepancies).	Expert opinion (KWR) Interviews Desk research
EQ9. To what extent can effects (on quality of drinking water) be linked to provisions in other EU legislation -in particular regarding pollution prevention (for example regarding chemicals, pesticides, fertilisers) water abstraction, preparation and distribution (including materials and products used)?			
JC9.1 The DWD provisions are externally coherent and new EU legislation has been consistent with the provisions of the DWD	EU legislation with direct relevance for (quality of) drinking water	Review EU legislation related to the DWD, in particular regarding pollution prevention (e.g. regarding chemicals, pesticides, fertilisers), water abstraction, preparation and distribution. Analyse information from interviews, public reports and so on on the topic. Identify pieces of legislation that are critical for the success of the DWD.	Eur-Lex Interviews with Commission staff, experts

Table 0-4 Relevance

Evaluation questions Judgement criteria	Indicators	Actions to obtain evidence	Information sources
EQ10 To what extent is the DWD approach still appropriate and are the specific provisions still relevant?			
JC10.1Provisions of the DWD are still relevant	Provisions according to WHO guidelines. Stakeholders consider the provisions still relevant	Identify alternative approaches to provisions in the DWD . Determine similarities and differences between approaches. Determine if the DWD has been adapted to technical and scientific progress	EUR-lex, WHO guidelines, international treaties, stakeholder conference, literature
JC 10.2 Citizens' expectations go beyond what is currently regulated in the DWD	Issues or actions currently not regulated by the DWD have been identified by the Citizens' Initiative or through other fora	Identify issues or actions currently not regulated by the DWD identified by the Citizens' Initiative or other fora	Stakeholder survey Desk research
JC10.3 Provisions of the DWD are (still) supported by WHO guidelines and relevant give the the latest scientific developments	Provisions DWD and corresponding WHO guidelines Stakeholders mention provisions which lost in relevance	Identify alternative approaches to the specific provisions in the DWD; Determine similarities and differences between the approaches Determine if the DWD has been adapted to technical and scientific progress	EUR-Lex, WHO guidelines, International treaties stakeholder conference[2], literature

[2] For a list a experts and organisation (to be) contacted see Annex C)

Table 0-5 EU added value

Evaluation questions Judgement criteria	Indicators	Actions to obtain evidence	Information sources
EQ11 What has been the EU added value of the Directive?			
JC11.1 The DWD has achieved objectives that could not have been achieved through national legislation (or: the establishment of the DWD has conferred additional value to the EU compared to what would have been achieved without the DWD)	List effects at MS level which would not have occurred without the EU legislation on drinking water quality.	Identify what could be possible effects of having EU legislation on Drinking Water quality through conducting interviews and collecting evidence off these effects. Identify if these effects would have been achieved without EU legislation.	Regulators/water utilities Stakeholder conference
EQ12 Is there any possibility to compare EU legislation on drinking water quality with what is in place in other regions?			
JC12.1 Countries which do not have similar legislation in place have more human health problems related to drinking water	i) Differences in legislation between countries at similar level of development. ii) Value of economic and social 'damage' of polluted drinking water in developing countries.	Review the drinking water legislation in USA, Canada, Australia and New Zealand and analysethe effectiveness of the drinking water legislation in these countries. Review the literature on drinking water situation in developing countries.	Desk research Drinking water legislation in the respective countries Expert opinion from WHO

Annex B Changes in drinking water contamination and their causes

B.1 Introduction

This Annex provides the background information needed to answer the first evaluation question: *To what extent has the DWD achieved its objectives, e.g. to reduce contamination of water intended for human consumption and to protect human health*?

The first section (B1) gives an overview of the change in non-compliances (drinking water contamination data) of all parameters and in more detail for selected parameters in time. The next section (B2) gives the causes of non-compliance as reported by MS and concludes with an discussion on the possibility of assigning these causes to the DWD.
To this end, we have:
1. Collected non-compliances (drinking water contamination data) of the selected parameters in time (based on MS reporting during the period 2005-2013) and the generic information on causes by MS (data in excel sheets);
2. Presented likely dominant reason (e.g. in in picture above or tables etc.; just as indication from expert knowledge). This will be evaluated based on information provided by MS on the likely cause of reported non-compliances.

In this analysis we used the following main categories of causes of non-compliances:
- Catchment related, resulting from either application to soil or water systems (e.g. nutrients, pesticides);
- Treatment plant related;
- Public distribution network related;
- Domestic distribution network related;
- Other causes (not specified);
- Combined (not specified);
- Unknown.

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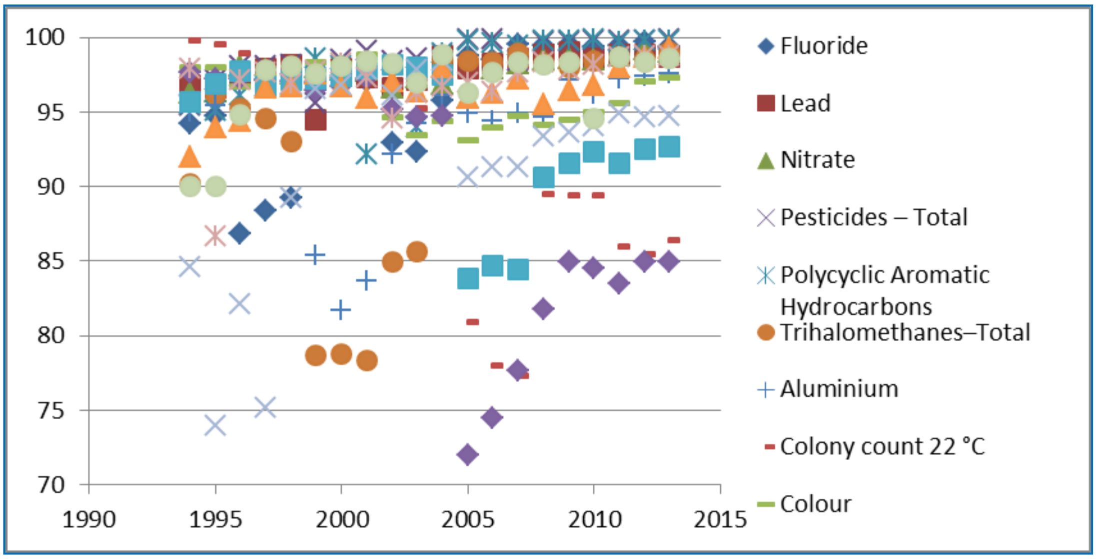
B.2 Trends and spatial variation in water quality

B.2.1 Trends in compliance in water quality between 1993-2013 at EU level

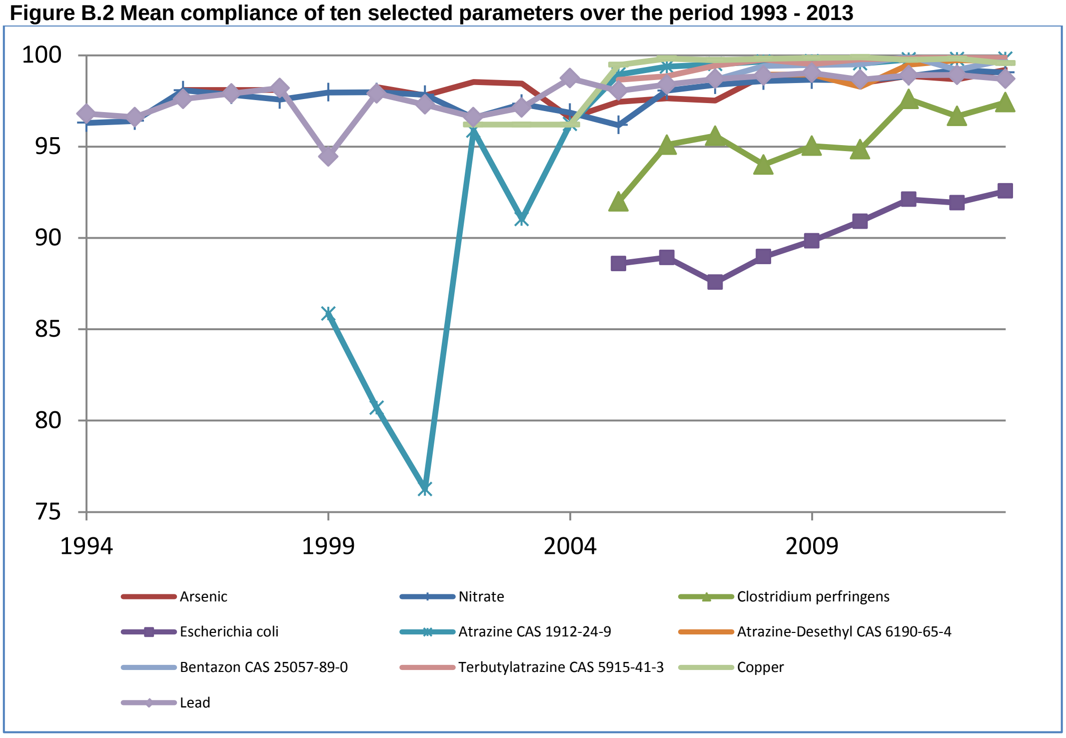
Based on summary reports at MS level (1993-2005) and more detailed information since 2005 in excel sheets (see http://rod.eionet.europa.eu/obligations/171), including the period 2005-2013, trends of the water quality at EU level was evaluated in terms compliance of parameters that have been monitored during the whole period 1993 – 2013. This was only the case for 9 parameters in about 2-4 countries. We took the mean for all MS (each value represents a parameter). Results are presented in Figure B.1 All parameters showed an increase in compliance with time.

Figure B.1 Mean compliance of nine parameters over the period 1993 – 2013 that were all continuously monitored



We also evaluated the trends in mean compliance for the ten selected candidate parameters . Results (Figure B.2) show again an increase in compliance with time for all parameters, changes being largest for *E. coli*, *Cl. perfringens*, and Atrazine. For all other parameters it changed from ca 95% to near 100% compliance.

Figure B.2 Mean compliance of ten selected parameters over the period 1993 - 2013



B.2.2 Trends in water quality between 2005-2013 at MS level

Trends in mean compliance of all parameters and selected parameters

Based on excel sheets, scatter plots are given of trends of the water quality at MS level (each value represents a member state) for the period 2005-2013 in terms of mean compliance of (i) all parameters (Figure B.3) and (ii) ten selected candidate parameters (Figure B.4).

Figure B.3 Mean compliance, in % of total, of all (available) parameters over period 2005 – 2013

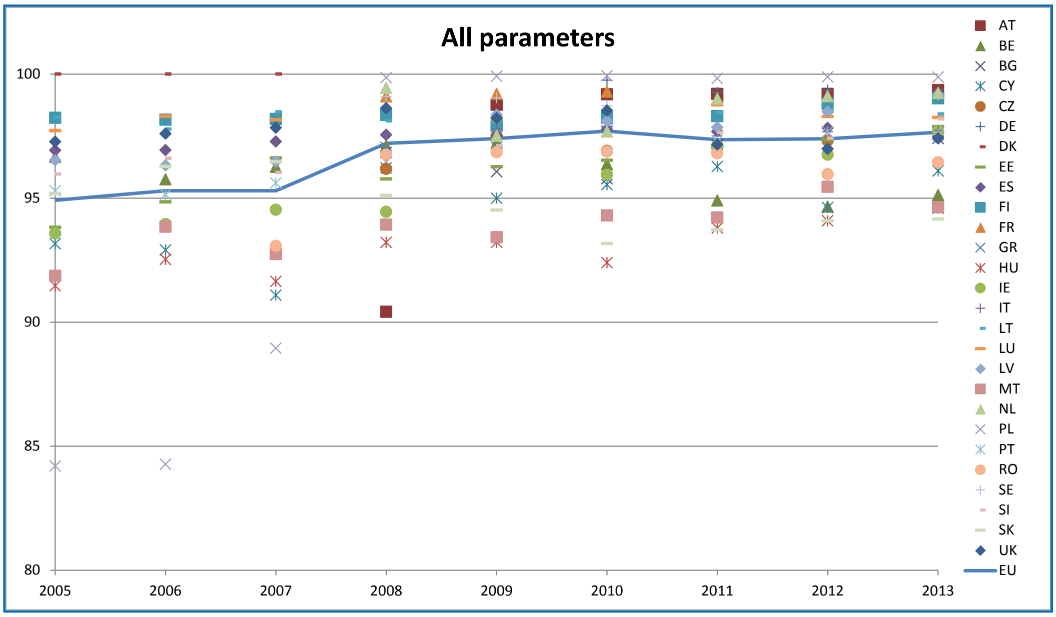
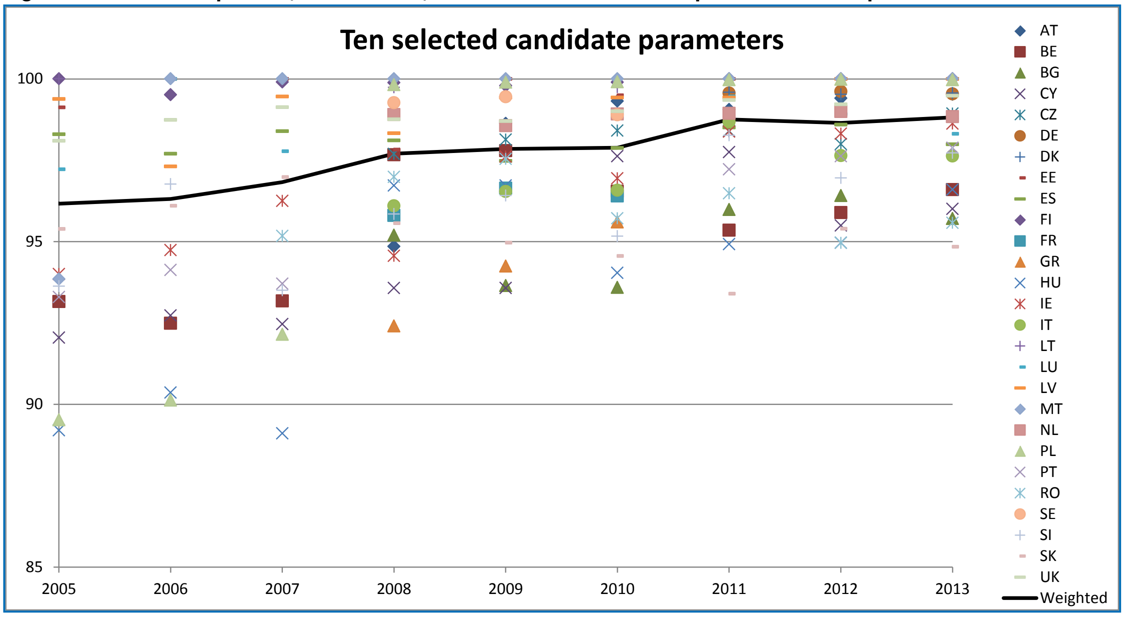


Figure B.4 Mean compliance, in % of total, of ten selected candidate parameters over period 1993 - 2013

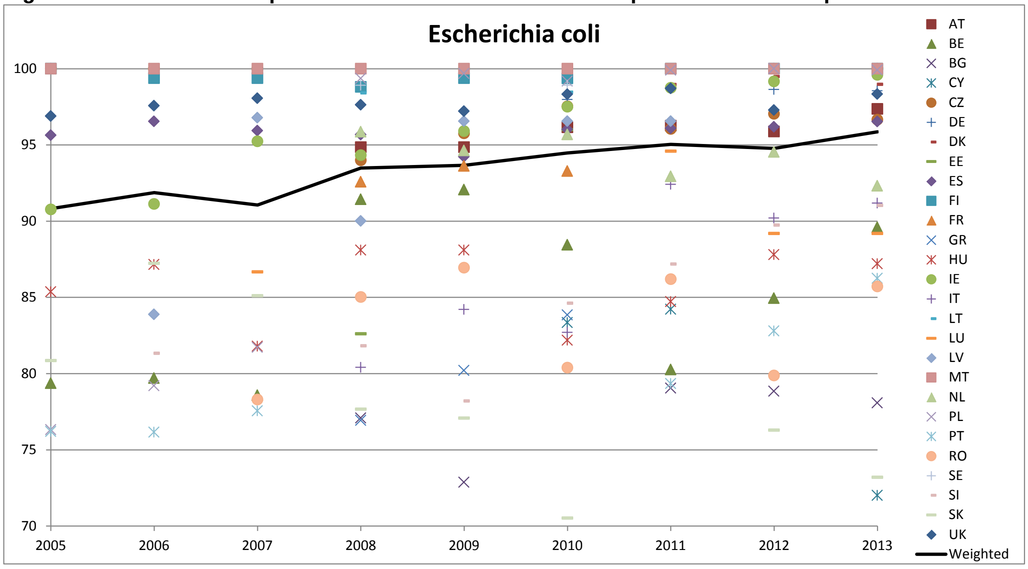


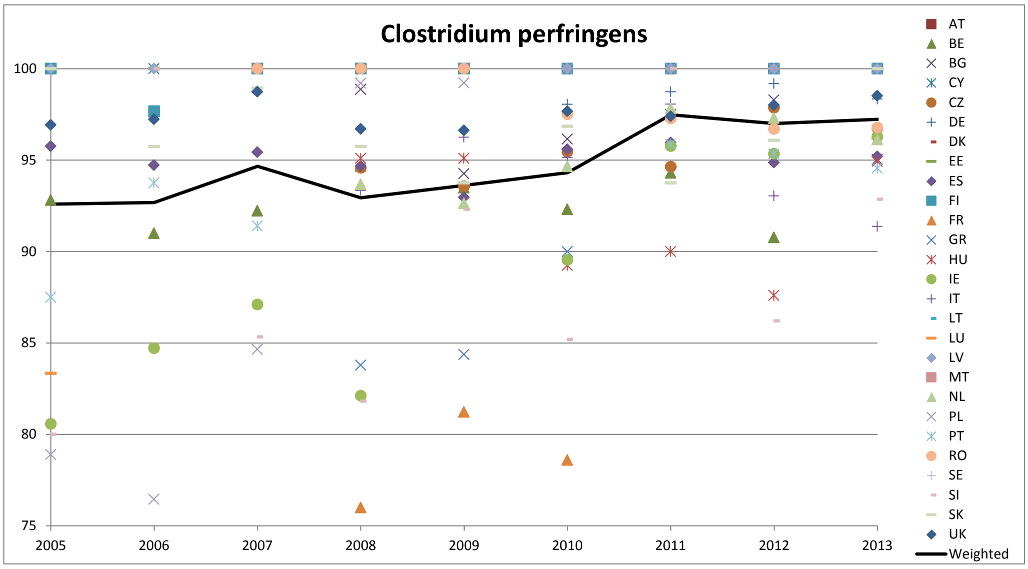
As with the mean compliance of nine parameters over the period 1993 – 2013 (Figure B.1), results show an increasing mean compliance with time over the period 2005-2013, both in the whole EU and in each separate MS, both for all parameters (Figure B.3) and the ten candidate parameters (Figure B.4). The mean compliance for each of the ten candidate parameters separately is given in Figure B.5.

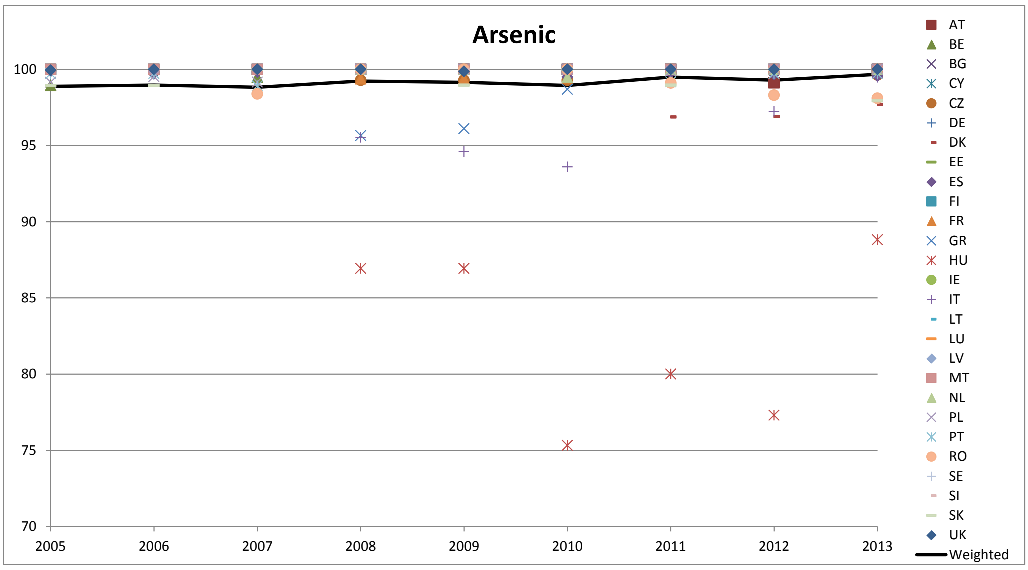
Relative large exceedances, up to 15-20% even recently, occur for the microbial parameters (*E. coli* and *Cl. perfringens*), arsenic, nitrate and lead, while the exceedances for organic compounds (pesticides) is always below 5%.

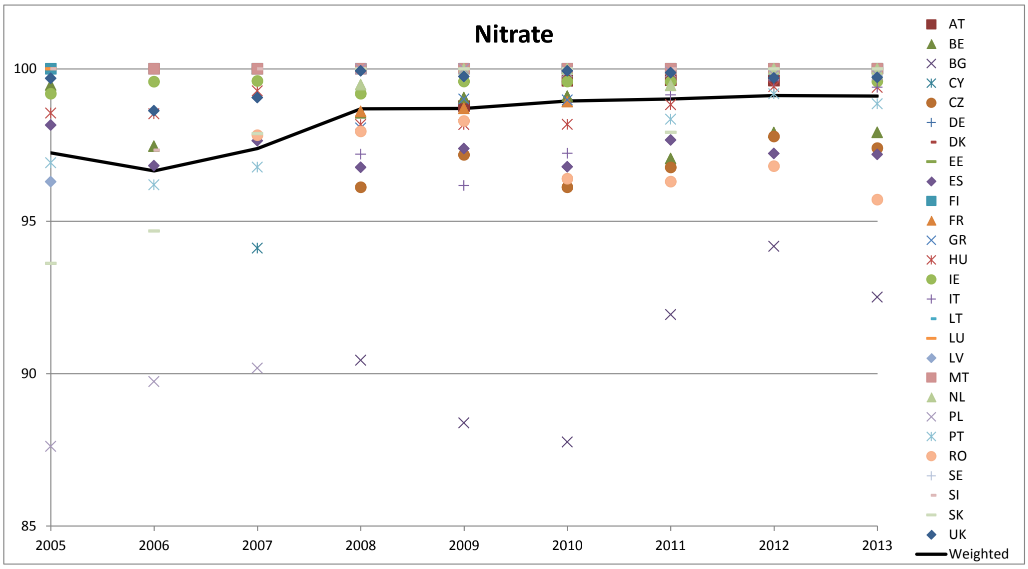
An overview of the total number of reported non-compliances and the contribution of selected MS with relatively high contributions is given in Table B.1

Figure B.5 The mean compliance for each of the ten selected parameters for the period 2005-2013









Nitrate
100
95
90
85
2005
2006
2007
2008
2009
2010
2011
2012
2013
AT
BE
BG
CY
CZ
DE
DK
EE
ES
FI
FR
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HU
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IT
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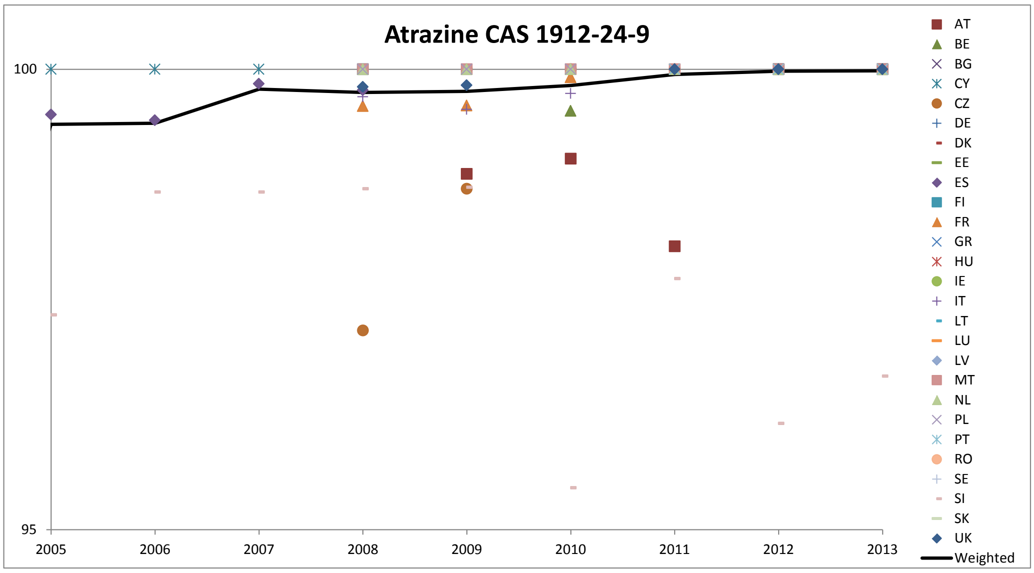
LU
LV
MT
NL
PL
PT
RO
SE
SI
SK
UK
Weighted



Atrazine CAS 1912-24-9
100
95
2005
2006
2007
2008
2009
2010
2011
2012
2013
AT
BE
BG
CY
CZ
DE
DK
EE
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SK
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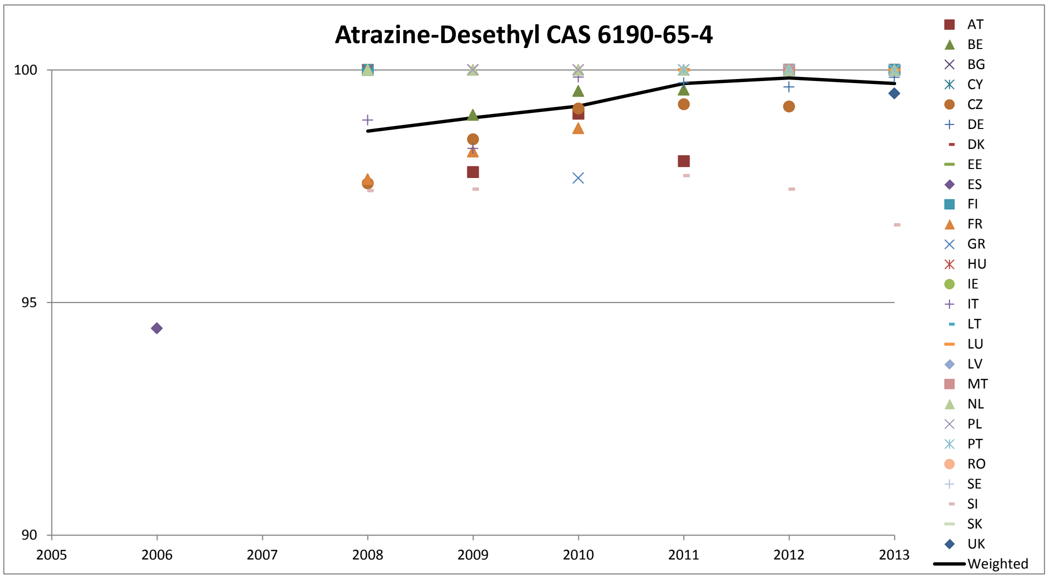
Weighted



Atrazine-Desethyl CAS 6190-65-4
100
95
90
2005
2006
2007
2008
2009
2010
2011
2012
2013
AT
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BG
CY
CZ
DE
DK
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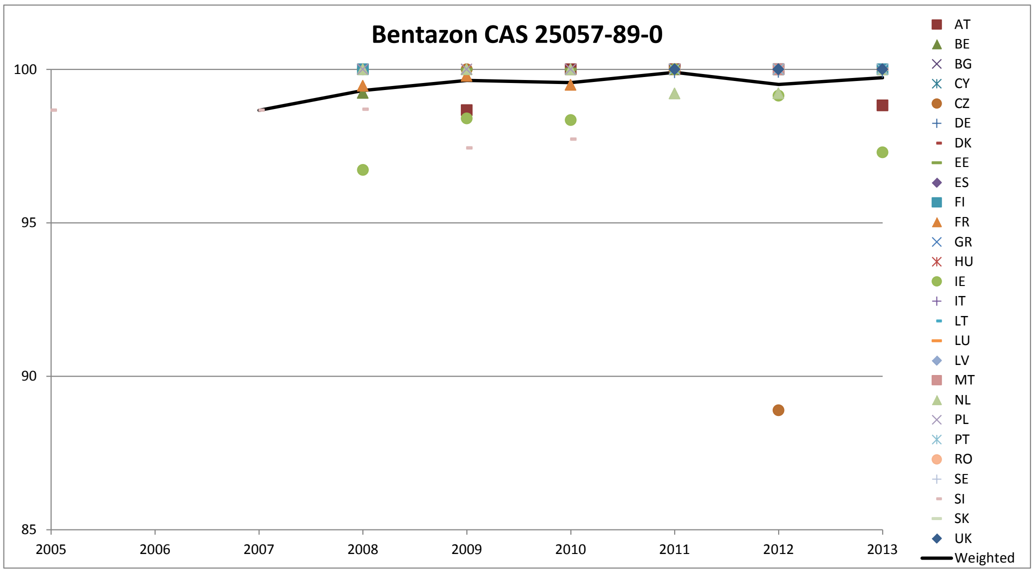
Bentazon CAS 25057-89-0
100
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2005
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BG
CY
CZ
DE
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PL
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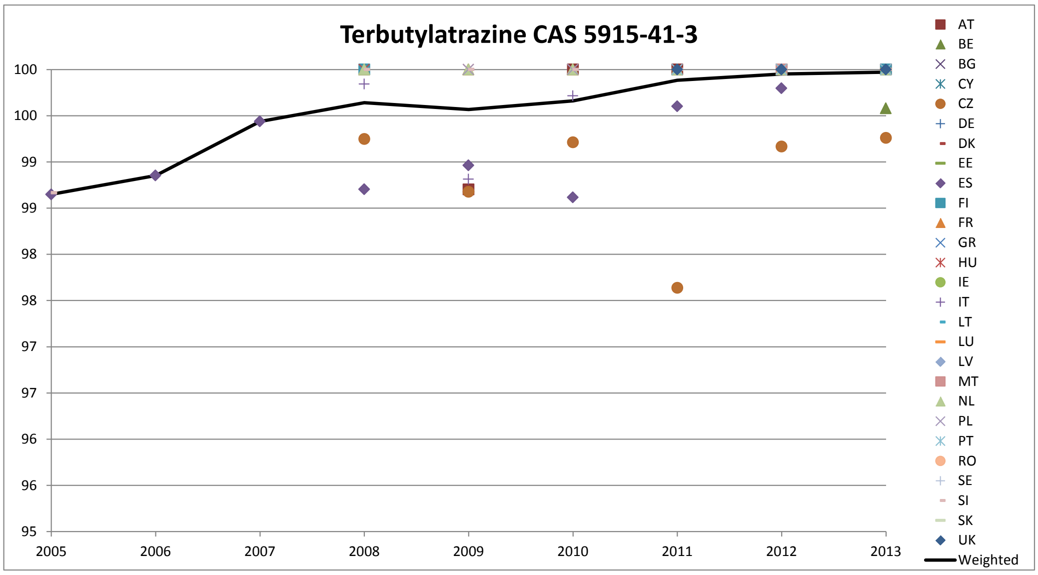
SE
SI
SK
UK
Weighted


Terbutylatrazine CAS 5915-41-3
100
100
99
99
98
98
97
97
96
96
95
2005
2006
2007
2008
2009
2010
2011
2012
2013
AT
BE
BG
CY
CZ
DE
DK
EE
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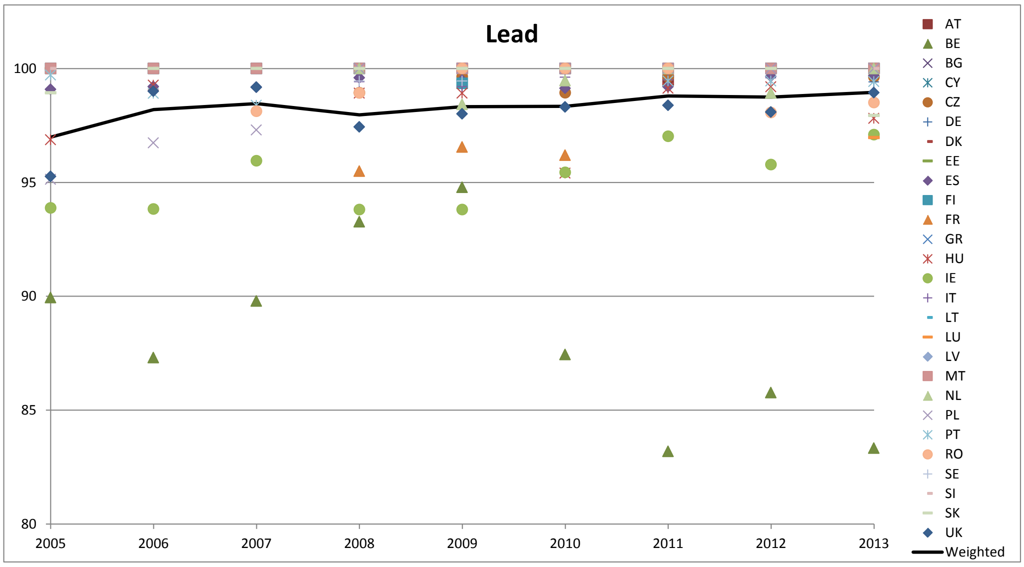
Lead
100
95
90
85
80
2005
2006
2007
2008
2009
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2013
AT
BE
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CZ
DE
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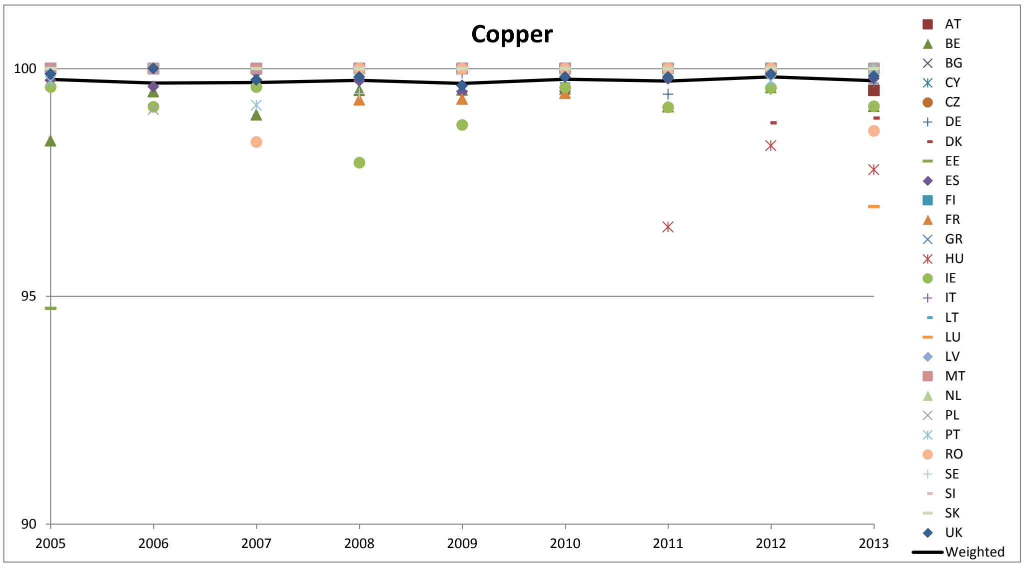


Table B1 Number of reported non-compliances (NC) for the ten selected candidate parameters at EU level, including selected MSMS with relatively high contributions. For the latter both the absolute number (NC) as the percentage (NP) of reported non-compliances are given.

Parameter		MS	NC	NP	Parameter		MS	NC	PB
Arsenic Total		HU	192	72%	*E. coli*		BE	185	7%
		EU	268				BG	300	12%
							DE	156	6%
Atrazine CAS 1912-24-9		ES	6	15%			ES	238	9%
		FR	12	30%			HU	183	7%
		SI	12	30%			IT	181	7%
		EU	40				PT	186	7%
							RO	394	15%
Atrazine-Desethyl CAS 6190-65-4		FR	88	70%			SI	107	4%
		SI	18	14%			SK	192	7%
		EU	126				UK	100	4%
							EU	2561	
Bentazon *CAS* 25057-89-0		FR	8	35%					
		SI	6	26%	Lead		BE	207	29%
		EU	23				DE	52	7%
							ES	99	14%
Cl. perfringens		BE	76	7%			FR	57	8%
		ES	278	24%			IE	106	15%
		FR	78	7%			UK	130	18%
		HU	82	7%			EU	707	
		IE	238	21%					
		UK	112	10%	Nitrate		BG	111	22%
		EU	1153				ES	146	29%

							RO	78	16%
Copper		DE	34	30%			EU	503	
		IE	18	16%					
		EU	112		Terbutylatrazine CAS 5915-41-3		ES	16	76%
							EU	21	

Changes in numbers of water supply zones in EU with exceedances per parameter

Another way of presenting the improvement in water quality is the trend in the number of WSZ (WSZ) with water quality concentrations that exceed the parametric value. This trend is shown in Table 2 at EU level for all distinguished DWD parameters for the period 2005-2013. Overall, the number of exceedances decreased between 2005 and 2013 for the sum of all microbial parameters, chemical parameters and indicator parameters. For some parameters there are no clear trends, i.e. large fluctuations over the years, but some show clear trends, including cadmium, nitrate, *Cl. perfringens*, colour, iron, manganese and turbidity.

In Table B.3, results are given of trends in the number of WSZs between 2005 -2013 at MS level with water quality concentrations that exceed the parametric value for the selected 10 candidate parameters. Overall, there is an improvement, especially in countries with initial large (IE, PT, UK) or very large (PL) exceedances. In many countries with small exceedances in 2005, there is hardly any trend. In ES, exceedances are comparatively high and they remain so.

Table B.2 Number of water supply zones with water quality concentrations that exceed the parametric value for all distinguished parameters in the DWD at EU level.

Type	Parameter	2005	2006	2007	2008	2009	2010	2011	2012	2013
Microbiol.	*Enterococci*	307	307	710	260	261	306	302	365	328
	E. coli	653	631	669	344	341	416	480	487	476
Chemical	1,2-*dichloroethane*	1			1		1	0	0	0
	Antimony	30	10	5	7	8	2	5	9	4
	Arsenic	19	77	91	41	44	70	79	80	68
	Benzene	1	1	3				1	1	1
	Benzo(a)pyrene	16	18	23	20	17	14	8	8	10
	Boron	5	29	12	4	17	8	12	15	6
	Bromate	17	19	7	25	33	13	12	10	7
	Cadmium	29	24	15	1	2		3	5	1
	Chromium	3	4	4	3	3		3	1	2
	Copper	8	12	15	15	20	19	24	17	24
	Cyanide	1						0		
	Fluoride	32	35	46	25	28	20	61	51	50
	Lead	170	179	148	102	89	119	103	99	157
	Mercury	5	8	9	5	1	2	4	4	6
	Nickel	64	53	62	82	101	94	98	111	106
	Nitrate	235	224	211	93	92	95	84	80	89
	Nitrate/nitrite formula3	211	180	176	56	59	58	30	30	28
	Nitrite ex water works	93	83	71	23	23	29	15	17	11
	Nitrite in distribution at tap	7	30	47	54	58	53	59	55	50
	Pesticides – Total	5	7	15	11	20	8	0	34	6

Type	Parameter	2005	2006	2007	2008	2009	2010	2011	2012	2013
	Polycyclic Aromatic Hydrocarbons	10	22	11	10	8	4	3	4	3
	Selenium	1	4	3	21	26	18	1	7	7
	Tetrachloroethene and *Trichloroethene*	2	6	4	14	10	4	10	10	7
	Trihalomethanes– Total	104	74	93	68	138	113	71	102	74
Indicator	Aluminium	284	290	319	274	256	259	235	226	207
	Ammonium	98	219	393	154	166	161	153	141	158
	Chloride	90	107	112	94	82	72	71	69	70
	Cl. perfringens	239	230	203	210	200	196	150	164	154
	Coliform bacteria	1936	2049	2203	1201	1265	1411	1545	1522	1536
	Colony count 22 °C	639	727	726	277	314	377	595	638	606
	Colour	693	591	565	181	180	184	206	170	138
	Conductivity	18	16	19	5	8	6	4	2	2
	Hydrogen Ion Concentration	414	381	400	157	156	142	264	247	203
	Iron	1700	1762	1800	670	653	702	883	841	807
	Manganese	1377	1476	1446	334	333	363	448	393	392
	Odour	256	282	265	138	131	119	178	131	118
	Oxidisability	93	59	80	26	30	29	38	34	20
	Sodium	41	94	115	82	75	81	70	67	74
	Sulphate	150	185	191	133	147	127	140	144	155
	Taste	122	120	74	103	93	102	134	114	101
	Total Indicative Dose	13	5	2	6	6	5	1	1	1
	Total organic carbon (TOC)	13	44	35	314	313	304	26	22	38
	Turbidity	1416	1498	1539	349	350	390	420	413	368
Pesticides	2,6-*dichlorbenzamide* CAS 2008-58-4	1	1	1	2	2	1	1	3	1
	2.4 D CAS 94-75-7			1		3	2		1	4
	Atrazine CAS 1912-24-9	4	4	2	11	12	5	3	4	1
	Atrazine-Desethyl CAS 6190-65-4				42	39	27	8	7	3
	Bentazon CAS 25057-89-0	1	1	2	3	6	5	2	4	2
	Bromacil CAS 314-40-9				1	3	3	2	2	1
	Desethylatrazine [1)]	4	3	2		3	2	0	0	1
	Diuron CAS 330-54-1		2		1	1		1		

Type	Parameter	2005	2006	2007	2008	2009	2010	2011	2012	2013
	Isoproturon CAS 34123-59-6						2	1		1
	MCPA CAS 94-74-6		1		3	4	1	4	11	6
	Mecoprop CAS 93-65-2 (US EPA 2014); former CAS 7085-19-0								2	1
	Pesticides CAS xxx	4	1	3	22	15	25	23	17	5
	Simazine CAS 122-34-9	8	3		2	2		0	0	3
	S-Metachlor CAS 87392-12-9				2	1		1		1
	Terbutylatrazine CAS 5915-41-3	6	5	3	6	7	7	5	2	2
	Acrylamide	1								
	Colony count 37 °C	2	2	6				54	49	55
	Disinfectant residual							2		
	Hardness							6	3	3
	Hydrocarbons							1		
	Nitrite	13	15	6	9	8	7	1	4	2
	Non Volatile Organic Carbon	4	4	4						
	Tesidual free chlorine			30						
	Vanadium							5	6	0
	Vinylchloride							0	0	0
Total number of WSZ [2)]		4170	4388	4764	5838	5861	6357	6894	7001	7195

[1]This pesticide is equal to Desethylatrazine (is synonym of Atrazine-Desethyl CAS 6190-65-4), see e.g. http://www.restek.com/catalog/view/6305.

[2]Note that the number of WSZ that is monitored varies per parameter not all parameter. So this number can only be used as an indication.

Table B.3 Number of WSZ with water quality concentrations that exceed the parametric value for all the selected 10 candidate parameters at MS level

MS	2005	2006	2007	2008	2009	2010	2011	2012	2013
AT					9	15	16	13	10
BE	16	29	25	46	44	74	108	95	80
BG				83	81	97	58	53	62
CY	7	8	8	1	1	5	3	6	7
CZ				41	26	25	36	21	25
DE							72	63	79
DK	9	9	9				6	6	6
EE	1			4		1			

MS	2005	2006	2007	2008	2009	2010	2011	2012	2013
ES	113	153	143	111	141	118	107	116	177
FI		2	1	2	3	1			
FR				121	105	86			
GR				22	20	18			
HU	11	103	122	80	80	144	74	73	52
IE	90	77	57	80	51	43	23	24	20
IT							128	138	140
LU							2	3	3
LV	1	5	1	3	1	1	1		
MT	4								
NL	29	50	48	17	25	19	18	17	19
PL[1]	**686**	**593**	**535**	8	5	9	3	2	3
PT	142	136	140				101	87	74
RO			82	68	61	81	55	101	101
SE				4	1	2			
SI	39	17	38	32	28	24	12	17	11
SK	26	22	17	25	27	31	35	25	30
UK	161	159	118	122	102	83	80	84	77
Grand Total	**1335**	**1363**	**1344**	**870**	**811**	**877**	**938**	**944**	**976**

1 These numbers for PL could be an artefact due to data quality.

Table B.4 provides, the results for the ten candidate parameters per MS. There is overall an improvement in all countries, but the variation is large especially in the exceedance of *E. coli* and *Cl. perfringens* that show a rather erratic behaviour, sometimes increasing and then decreasing in several countries.

Table B.4 Number of WSZ (or percentage of WSZ were we can also scale to water supply) at MS level with water quality concentrations that exceed the parametric value for each of the selected 10 candidate parameters

Par.	MS	2005	2006	2007	2008	2009	2010	2011	2012	2013
Arsenic	AT								1	
	BE						1			
	CZ				2	2	2			1
	DE					1	1	3	2	2
	DK	4	4	4				4	4	3
	ES	1	3	2		1	4	2	3	4
	FR				7	8	4			
	GR				3	2				
	HU	2	62	69	29	29	57	28	32	17
	IT							36	35	35
	NL						1			
	PL	9	6	11				1		
	PT	1	1	4				3	1	1
	RO			1				1	2	3
	SK	1	1			1		1		2
	UK	1								
		19	77	91	41	44	70	79	80	68
Atrazine CAS	AT					1	1	2		

Par.	MS	2005	2006	2007	2008	2009	2010	2011	2012	2013
1912-24-9	BE						1			
	CZ				3	2				
	DE					2				
	ES	2	3	1	1					
	FI					1				
	FR				6	5	1			
	IT							0	1	0
	SI	2	1	1	1	1	2	1	3	1
		4	4	2	11	12	5	3	4	1
Atrazine-Desethyl CAS 6190-65-4	AT					2	1	2		
	BE					2	1	1		
	CZ				2	2	1	1	1	
	DE							3	4	2
	FR				38	31	19			
	SI				2	2	5	1	2	1
				42	39	27	8	7	3	
Bentazon CAS 25057-89-0	AT					1				1
	BE				1					
	CZ								1	
	DE							1	1	1
	FR				1	3	4			
	IT								1	
	NL		1	1				1	1	
	SI	1		1	1	2	1			
		1	1	2	3	6	5	2	4	2
Cl. perfringens	AT									1
	BE	3	2	2	9	11	14	11	18	7
	BG				1	5	4	3	2	7
	CZ							11	4	6
	DE					7	18	10	6	14
	ES	38	57	52	42	58	37	37	48	46
	FI		1							
	FR				29	22	27			
	GR				4	4	4			
	HU				11	11	24	13	16	7
	IE	49	37	32	44	22	24	10	11	9
	IT							2	1	2
	NL	8	15	20	9	12	8	4	4	6
	PL	50	53	37	2	2				
	PT	44	23	32				15	17	19
	RO				2	1	3	3	3	6
	SI	14	0	10	14	6	4		4	2
	SK		4	1	4	5	3	3	2	
	UK	33	38	17	39	34	26	28	28	22
		239	230	203	210	200	196	150	164	154
Copper	AT									1
	BE			2	1	1	1	2	1	2

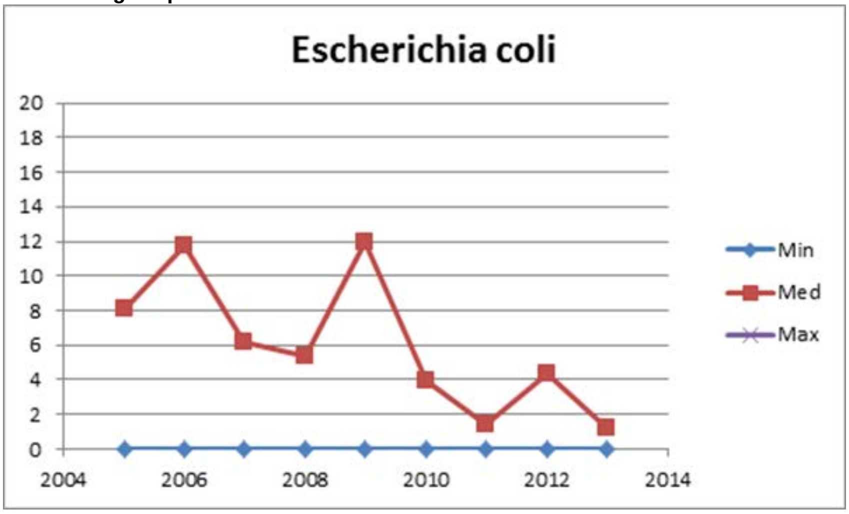
Par.	MS	2005	2006	2007	2008	2009	2010	2011	2012	2013
	DE					1	6	11	9	7
	DK	1	1	1					1	1
	EE	1								
	ES	2	4	1	2	4	4	2		2
	FR				3	5	5			
	HU							4	2	3
	IE	1	2	1	5	3	1	2	1	2
	IT							0	0	0
	PL		1	1						
	PT	1	4	3					1	
	RO			2						3
	SE				1					
	UK	2		4	3	6	2	3	2	3
		8	12	15	15	20	19	24	17	24
E. coli	AT					4	12	10	11	7
	BE	7	4	4	18	17	26	47	37	25
	BG				58	53	69	39	40	41
	CY	7	8	7	1	1	5	3	6	7
	CZ				17	12	7	11	8	9
	DE					22	42	28	29	35
	DK	4	4	4				2	1	2
	EE				4		1			
	ES	43	40	49	34	49	34	36	36	34
	FI		1	1	2	1	1			
	FR				2	2	2			
	GR				13	13	13			
	HU	8	36	51	33	33	49	26	21	21
	IE	23	22	12	14	10	6	3	2	1
	IT							83	89	94
	LT				1					
	LU							2	3	3
	LV		5	1	3	1	1	1		
	NL	20	33	25	7	10	9	13	10	13
	PL	369	326	292	6	3	8	1		1
	PT	84	90	83				75	63	48
	RO			69	56	46	62	40	78	73
	SE				2		2			
	SI	21	14	26	14	17	12	10	8	7
	SK	18	12	14	21	21	28	29	23	26
	UK	49	36	31	38	26	27	21	22	29
		653	631	669	344	341	416	480	487	476
Lead	AT							1		
	BE	5	19	17	14	11	28	40	34	40
	BG							1		
	CZ				3	1	3	1		1
	DE					2	13	16	8	13
	ES	7	8	9	3	4	7	7	3	65

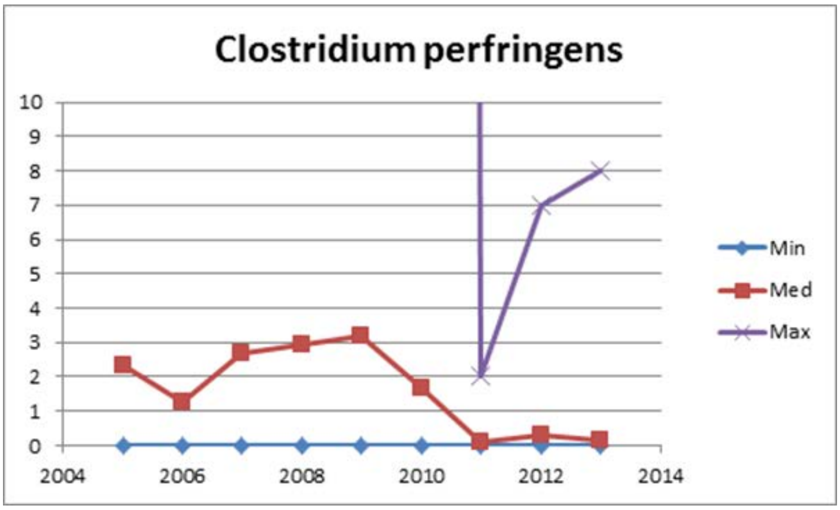
Par.	MS	2005	2006	2007	2008	2009	2010	2011	2012	2013
	FI					1				
	FR				23	14	20			
	HU		1		2	2	9	1	1	3
	IE	15	15	11	15	15	11	7	10	7
	IT							1	3	1
	NL	1		1		3	1		2	
	PL	69	48	39						
	PT	1	4	6				2	2	2
	RO			3					6	4
	SE				1	1				
	SK	1								2
	UK	71	84	62	41	35	27	26	30	19
		170	179	148	102	89	119	103	99	157
Nitrate	AT						1	1	1	
	BE	1	4		3	2	2	7	5	5
	BG				24	23	24	15	11	14
	CY			1						
	CZ				9	7	11	9	6	7
	DE					2	2		4	5
	ES	15	33	26	24	21	26	21	25	26
	FR				12	15	4			
	GR				2	1	1			
	HU	1	4	2	5	5	5	2	1	1
	IE	2	1	1	2	1	1	1		1
	IT							6	8	8
	LV	1								
	MT	4								
	NL		1	1	1					
	PL	189	159	155			1	1	2	2
	PT	11	14	12				6	3	4
	RO			7	10	14	16	11	12	12
	SI		2							
	SK	6	5	2				2		
	UK	5	1	4	1	1	1	2	2	4
		235	224	211	93	92	95	84	80	89
Terbutylatrazine CAS 5915-41-3	AT					1				
	BE									1
	CZ				1	2	1	3	1	1
	ES	5	5	3	5	4	6	2	1	
	SI	1								
	Total	6	5	3	6	7	7	5	2	2

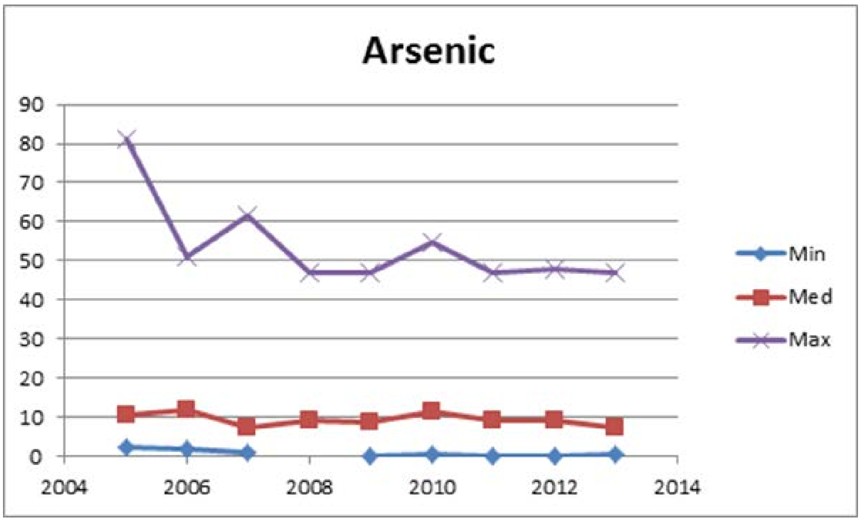
Trends in concentrations of selected candidate parameters

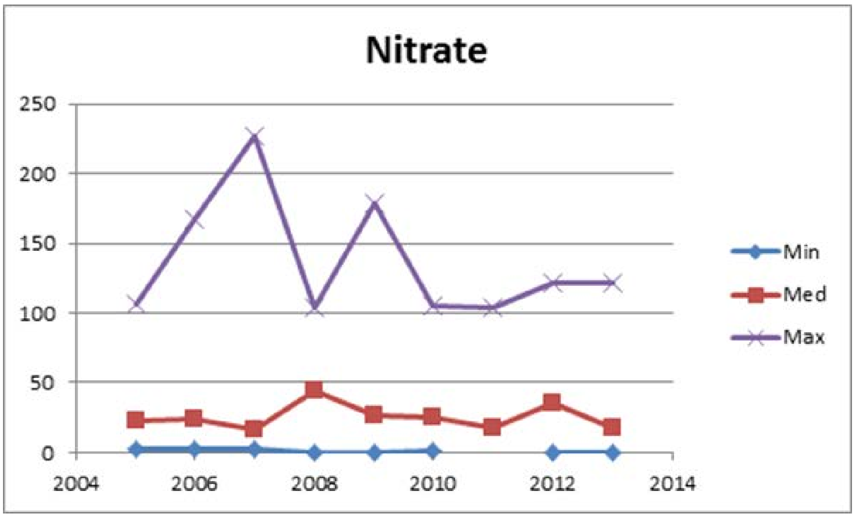
The excel sheets since 2005 do not only give information on non-compliances but also on actual concentrations, but only in terms of annual minimum, median and maximum concentrations. Trends in annual minimum, median and maximum concentrations over the period 2005-2013 thus derived for the ten candidate parameters at EU level are given in Figure B.6.

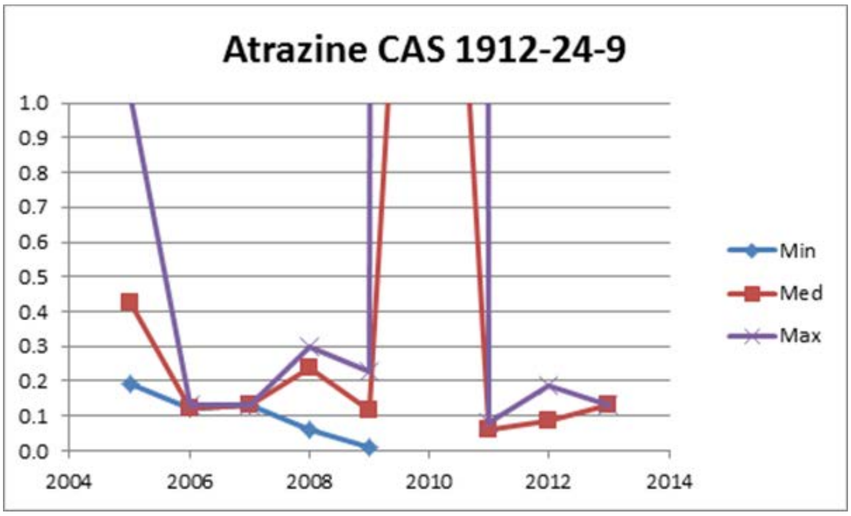
Figure B.6 Trends in water use weighted minimum, median and maximum concentration at EU level of the ten selected parameters over the period 2005 – 2013. All chemical parameters are given in µg/l. The microbiological parameters are in counts/100ml

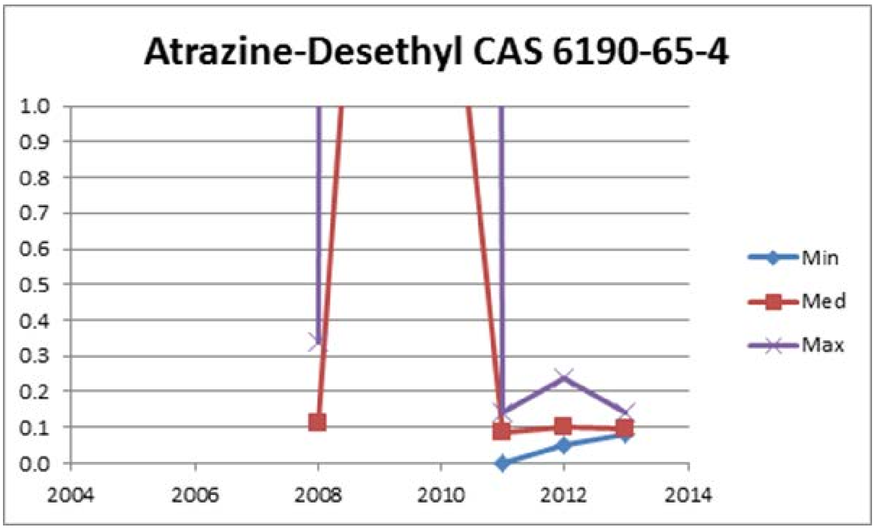


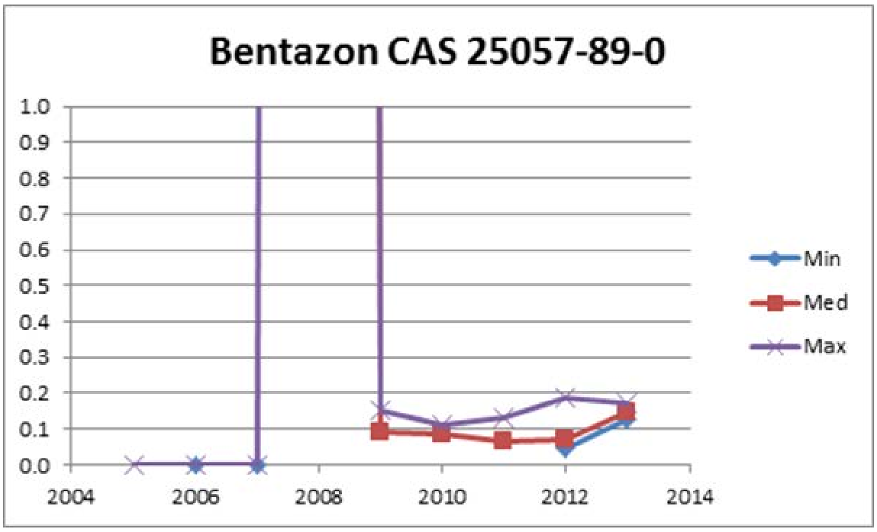


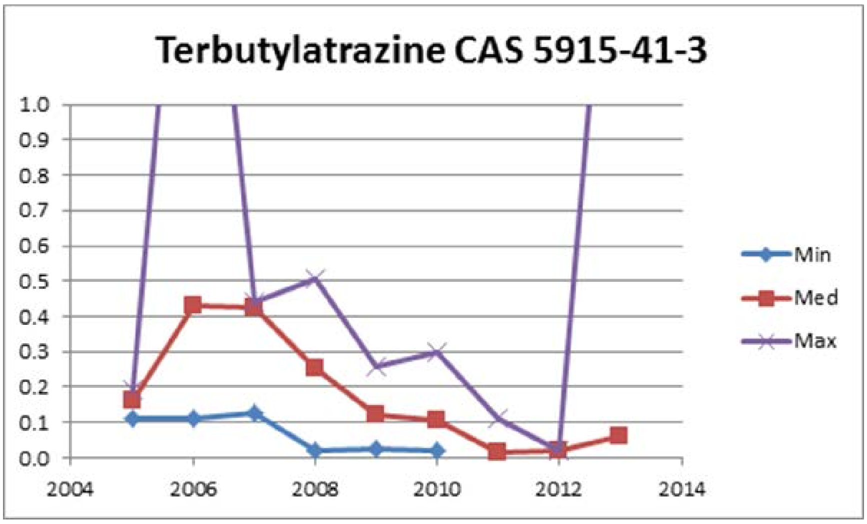


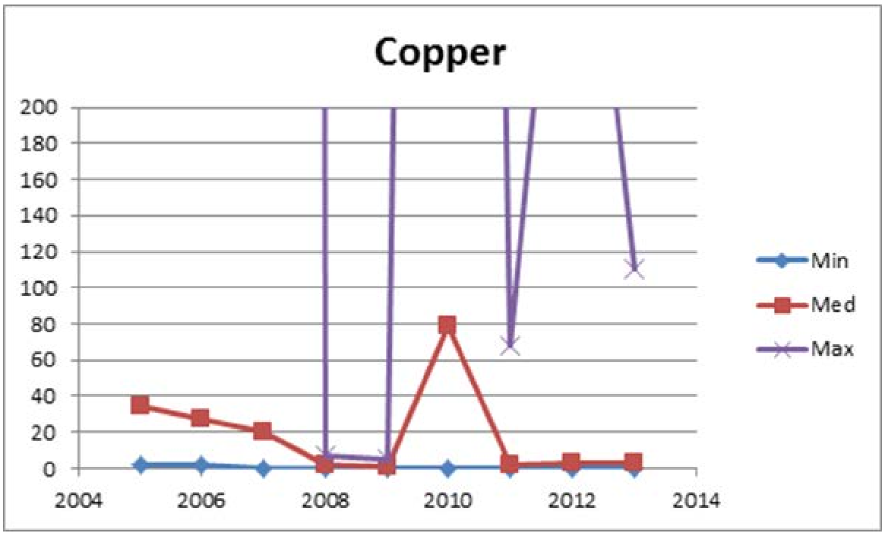

Nitrate
250
200
150
100
50
0
2004
2006
2008
2010
2012
2014
Min
Med
Max

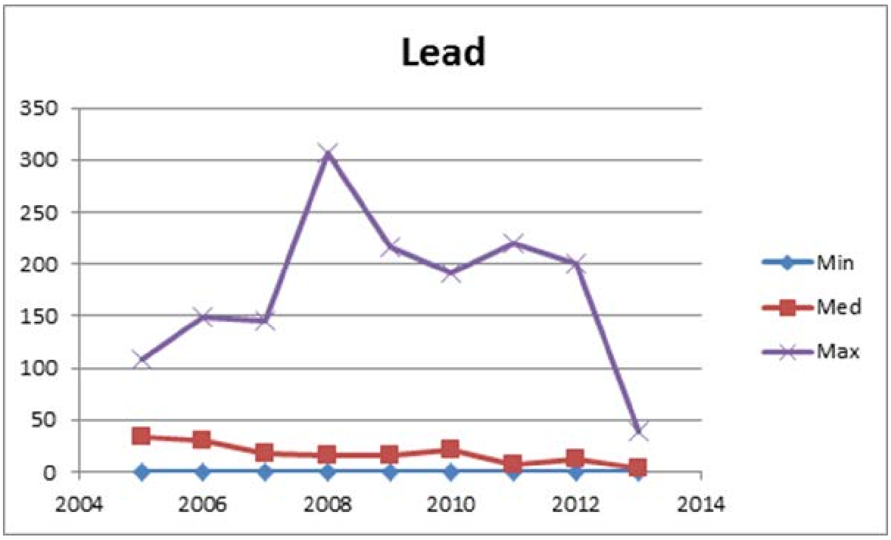

Atrazine CAS 1912-24-9
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
2004
2006
2008
2010
2012
2014
Min
Med
Max


Atrazine-Desethyl CAS 6190-65-4
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
2004
2006
2008
2010
2012
2014
Min
Med
Max


Bentazon CAS 25057-89-0
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
2004
2006
2008
2010
2012
2014
Min
Med
Max


Terbutylatrazine CAS 5915-41-3
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
2004
2006
2008
2010
2012
2014
Min
Med
Max


Copper
200
180
160
140
120
100
80
60
40
20
0
2004
2006
2008
2010
2012
2014
Min
Med
Max



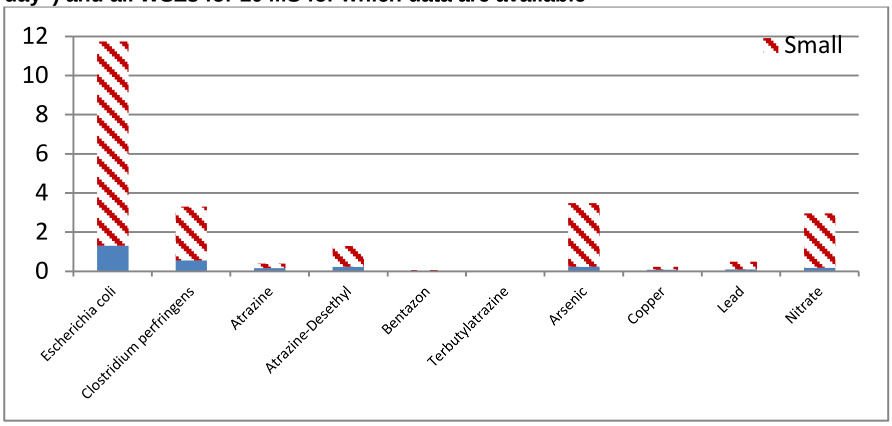
Results show a decrease in the median concentration of both lead and Escherichia coli. The mean non-compliance value for lead in the period 2008-2013 is about 40 µg/l, a fourfold exceedance of the standard (10 µg/l).

Beware that median concentrations are not always calculated in national databases. For example, in the NL, the database only contains minimum, average and maximum concentrations at a given sampling location and in the dataset, the average concentration is thus provided instead of the median.

B.2.3 Variation in current water quality in large and small WSZs (mean 2010-2013)

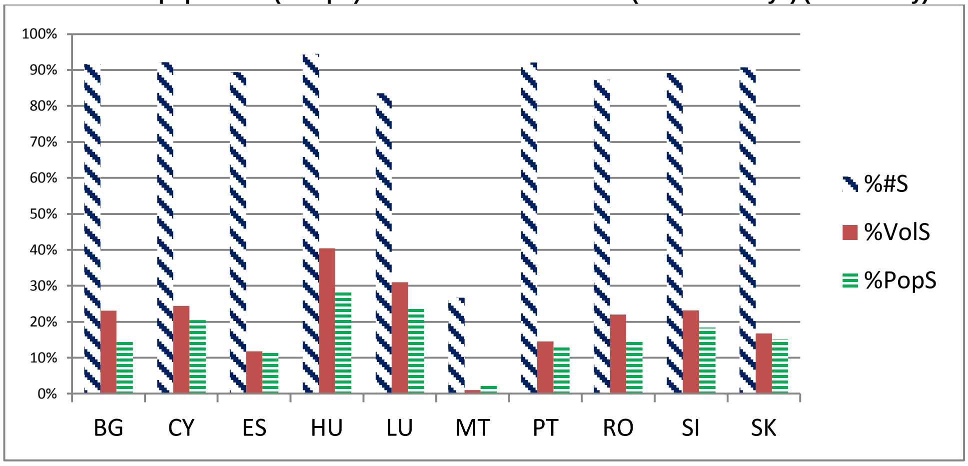
In general water quality is poorer in small than in large WSZs. This is illustrated in Figure B.7 for the ten candidate parameters, in terms of percentage non-compliance based on an analyses of all individual large and small WSZs at EU level for the period 2010-2013. Results are based on the ten MS for which data were available for both WSZs, i.e. BG (Bulgaria), CY (Cyprus), ES (Spain), HU (Hungary), LU (Luxemburg), MT (Malta), PT (Portugal), RO (Romania), SI (Slovenia) and SK (Slovakia). While non-compliance is always less than 2% and mostly near negligible for all ten parameters in large WSZs, it is up to 12% for E Coli in small WSZs (Figure B.7)

Figure B.7 Percentage compliance of the ten candidate parameters for large and small WSZs (< 1000 m^3 day^{-1}) and all WSZs for 10 MS for which data are available



Although the total number of small WSZs is much larger than that of the large WSZs, the total water production and the population depending on it is much smaller compared to large WSZs as illustrated in Figure B.8.

Figure B.8 Relative number of small WSZs (%#S), share of water production by small WSZs (%VolS) and number of population (%PopS) connected to small WSZs (< 1000 m^3 day^{-1}) (10 MS only)



In each of the ten MS, except for MT (Malta), nearly 90% of the WSZs are small, but in most cases less than 20% of the water production comes from these small WSZs and similarly mostly less than 20% of the population depends on those small WSZs.

Apart from the occurrence of exceedance, also the level of exceedance is of interest. This is illustrated in Table 5 presenting the percentage of large WSZs (as % of total) where the median concentration exceeds the limit of the ten candidate parameters. The results show that the percentage is mostly less than 1% except for *E. coli* and *Cl. perfringens* that was exceed in more than 50% of the measurements in nearly 5% of the WSZs in Denmark.

Table B.5 Percentage large WSZs (% of total based on annual water intake) per MS where there is a non-compliance in more than 50% of the measurements (the median concentration exceeds the limit) for each of the ten candidate parameters. NB: for 2 pesticides this never occurred

MS	% WSZs at which median concentration exceeds the limit							
	E. coli	*Cl. perfringens*	*Atrazine-Desethyl*	*Bentazon*	Arsenic	Lead	Copper	Nitrate
BG								0.54
CZ								0.11
DE	4.67	4.23		0.01	0.02	1.36	0.51	0.05
DK					1.21		0.77	
ES		0.04			0.03	0.47	0.27	0.42
HU		0.29			1.10			0.12
IT					0.01	0.00		
PL								0.02
PT					0.12	0.04		
RO					0.07			0.54
SI			1.06					
UK								0.04

B.3 Analysis of the causes of non-compliances

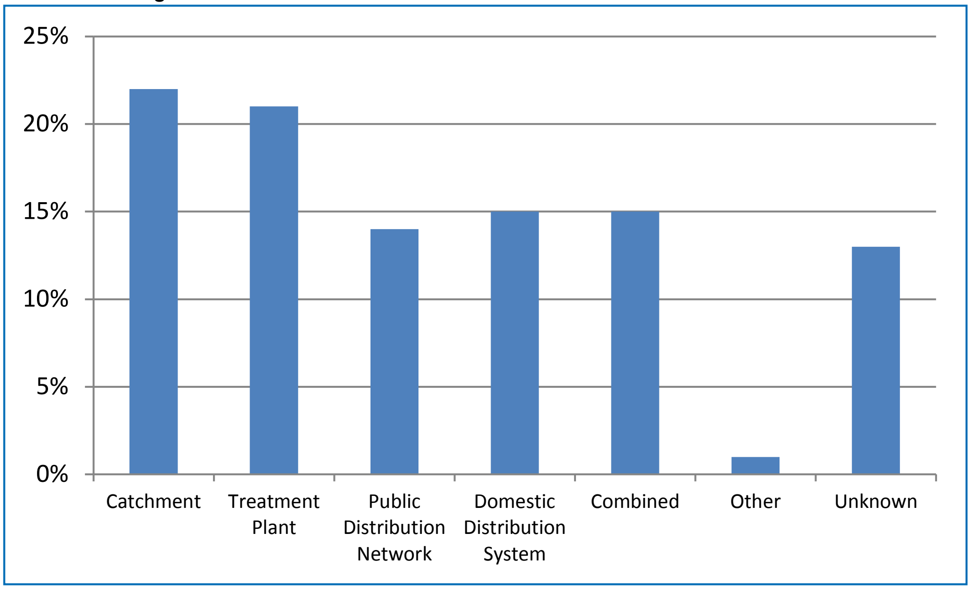
B.4.1 Reported causes by the MS

Based on the inventory of MS in 2013 non-compliances for all parameters and indicators were listed as well as for the 10 selected substances. In addition, the causes underlying the non-compliance as reported by MS were included. Here a distinction between 7 different causes was made:

1. Catchment related; representing the impact of geology, land use, soil type and hydrology;
2. Treatment plant related, representing the impact of the installations used to treat the water after abstraction from either groundwater of surface water;
3. Public distribution network related; representing the impact of the distribution network between the treatment plant and the domestic system;
4. Domestic distribution systems; representing the impact of the quality of the water distribution systems after supplying the water to the private home-owners;
5. Combined sources;
6. Other sources not specified;
7. Unknown.

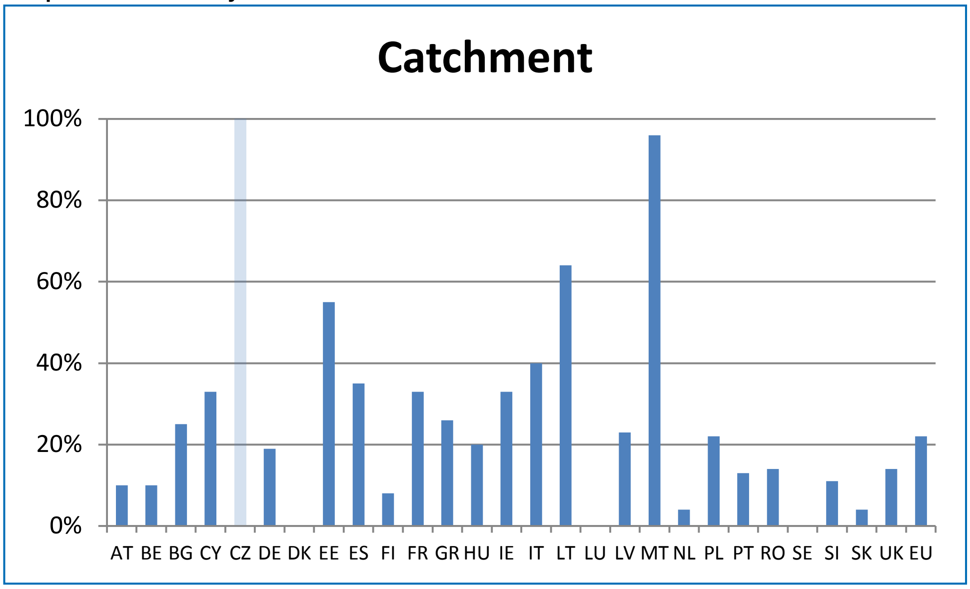
In figure B.9 the overall distribution of all reported non-compliances for all parameters included in the DWD at EU level (40695 in total) among the 7 groups distinguished is shown. This figure shows that the contribution of catchment related sources and treatment plant sources combined contribute to approx. 45% of all non-compliances. The sum of the distribution networks, including public and domestic distribution amounts to approx. 29% of the sum of all non-compliances. The remaining part is equally distributed among combined sources (15%) and unknown sources (13%).

Figure B.9 Overview of distribution of causes for the non-compliances of all parameters monitored in the DWD among the 7 main identified sources



Obviously significant differences in the distribution between countries and parameters exist. Figure B.10 shows for example the relative contribution of catchment related sources to the total number of non-compliances at country level. In some cases the total number of non-compliances is low (e.g. CZ, 18 in total) and these appeared to be all catchment related. For most countries the contribution of catchment related causes ranged between 10 and 25% with the exception of EE, LT, IT and MT where catchment related causes are higher than 40% of the total number of observed non-compliances.

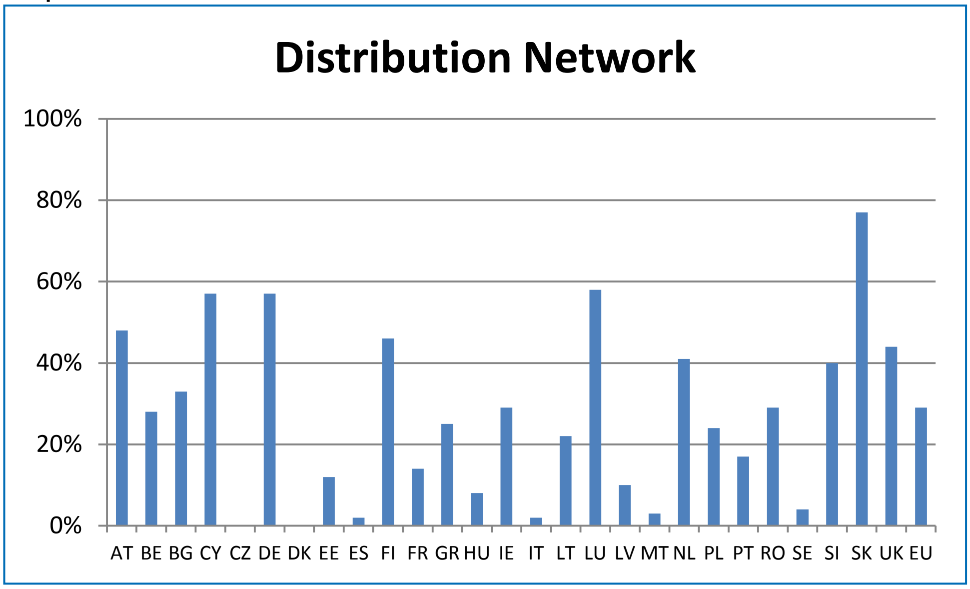
Figure B.10 Contribution of catchment related non-compliances relative to the total number of non-compliances at country level



Obviously, the overall number of non-compliances for the 10 selected parameters is less (5,514) compared to all parameters (40,695). The overall distribution of causes for non-compliances for the 10 selected parameters is, however, more or less equal to that of the all parameters.

Noteworthy exceptions to average values include (data shown in Appendix 1 to this Annex) a relatively high contribution of the domestic supply system in CY, DE, IE, LU, SLI, SK, UK, which partly (for LU, DE, SK) corresponds with relatively high contributions of the public distribution system. This is illustrated in Figure B.11 that shows the contribution of the combined effect of private and public distribution networks at country level

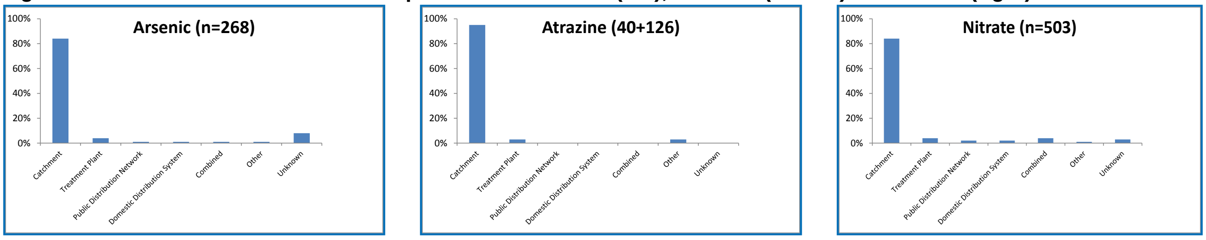
Figure B.11 Relative contribution of private and public distribution network to the total number of non-compliances at member state level



Differences between MS can have difference reasons including differences in land use (e.g. intensity of agriculture related to catchment controlled sources versus the quality of the distribution network). The results from the 10 selected substances shows three different main causes, depending on the substance considered:

1. Non-compliances related to *catchment*. This is the case for arsenic, nitrate, and all pesticides. For these substances more than 80% of all non-compliances are related to catchment as shown in Figure B.12. For Arsenic, this can be related the combined impact of geology and hydrology and for both pesticides and nitrate, this can be assigned to land use; more specifically the impact of agriculture, being the main source of these substances through application of manure, fertilizer and pesticides.

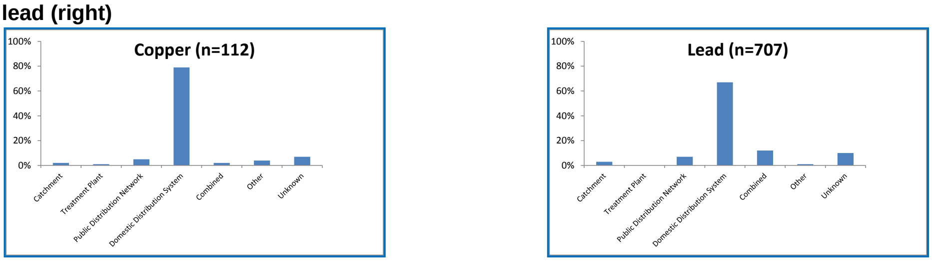
Figure B.12 Catchment related non-compliances for Arsenic (left), Atrazine (middle) and Nitrate (right)



The distribution for the other pesticides included here is similar to that of Atrazine and dominated by catchment related sources.

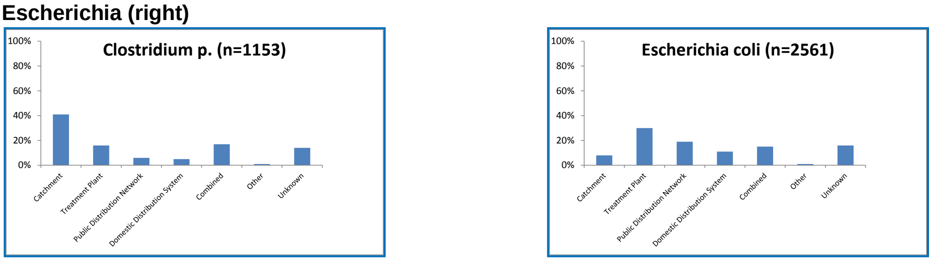
2. Non-compliances related to *the distribution network*. For both copper and lead the contribution of the distribution networks, and largely the domestic distribution network is the main reason for the observed non-compliances (Figure B.13). For lead approximately 10% of all non-compliances is of mixed origin probably including the impact of catchment as well.

Figure B. 13 (Private) distribution network dominated causes of non-compliances for copper (left) and lead (right)



3. *Mixed sources.* For both *Cl. perfringens* and *E. coli*, there appears to be no clear single factor that controls the presence of these indicators (Figure B.14) even though the contribution of the catchment (for Clostridium) and treatment plant (for Escherichia) are clearly higher than the other identified causes.

Figure B. 14 Contribution of difference sources to non-compliances for Clostridium (left) and Escherichia (right)



B.3.2 Analyses of trends in non-compliances in relation to causes as reported by MS

As shown by the overall trends in Section 2, a substantial increase in water quality has been documented when looking at the trends in water quality as such. As shown in the previous paragraph 3.1, a clear link with causes can be identified for specific parameters. Nitrate, arsenic and pesticides largely are controlled by catchment conditions, lead and copper are largely related to distribution systems and both clostridium and Escherichia coli have no dominant cause of non-compliance. Especially in the situation of lead and copper, where a reduction in non-compliances occurred with the cause mainly being to distribution system related, it is clear that the actions carried out within the DWD is the main cause for this improvement. This is most likely also, at least partly true for both *Cl. perfringens* and *E. coli*. For nitrate, arsenic and pesticides, it may be an improvement due to other directives regulating the application.

An additional question is to assess to what extent *trends* in causes related to non-compliances can be identified. In order to perform the trend analysis the data were first screened on the continuity of the data for all countries. It was decided to only use data from countries that, for an individual parameter, have delivered a continuous record of analyses. This limits the number of countries included to 12 (BE, CY, ES, HU, IE, LV, NL, PL, RO, SI, SK, UK). Here we used the remaining data for the period 2005 – 2013. In Appendix 1 the full results are shown.

Results from the data analysis show that:

- For both *Cl. perfringens* and *E. coli* there is a clear decrease in non-compliances for the 12 selected countries with an increase in treatment plant related causes in time;
- For all pesticides there is no real trend and the data show that the main cause of non-compliance remains catchment related. The remaining number of samples however is too small to derive meaningful trends in causes of non-compliances;
- For arsenic the data are dominated by non-compliances reported by Hungary (325 out of 388) which largely appear to be catchment related although 133 cases are not related to any cause (blank);
- For lead a substantial number of non-compliances are still reported for the UK, B, IE, Pl and ES. Despite a trend towards a lower number of non-compliances, the non-compliances related to domestic distribution networks increased from 2010 onwards. This shows that regional (or even national) data and trends derived from this are not necessarily in line with the overall trends observed at EU level.

Since the number of data remaining after screening for complete records is limited some results are clearly biased (e.g. in case of arsenic) by the number of countries and or (low) number of non-compliances. These data therefore do not allow for an in depth analysis of trends in causes and hence cannot be used to further evaluate the effectiveness of the DWD in relation to the quality of drinking water.

B.3.3 Analyses of trends in non-compliances in relation to causes as reported by MS

Analysis of the trends in remedial actions for the period 2005-2013 based on Eionet data from 12 countries with a continuous monitoring record for the parameters shows that:

- By far most of the most of the remedial actions are related to the microbiological parameters *E coli* (for 2561 WSZ) *Cl. perfringens* (1153), followed by lead (707), nitrate (503) and arsenic (268).
- The remedial actions for *Cl. perfringens* are mainly catchment related (292) (Action performed: terminate or mitigate the cause), whereas the remedial actions for *E. coli* are mainly treatment-related.

- The remedial actions for lead are mainly distribution related, but remarkably also catchment related.
- The remedial actions for nitrate are mainly catchment related with an emphasis on replacing source.

In the period 2005-2013 more and more MS reported remedial actions. Most of the performed are related to the microbiological parameters (*E Coli* and *Cl. perfringens*) and to a lesser extend to chemical parameters (lead, nitrate and arsenic).

B.3.4 The contribution of the DWD to the observed changes in water quality

The overall trends as reported in Section 2 of this annex illustrate the substantial increase in water quality. Furthermore, as shown in the previous Section, a clear link with causes can be identified for specific parameters. In short, non-compliances for land use related substances (including nitrate and pesticides) as well as substances controlled by geogenic processes such as arsenic largely are controlled by catchment conditions, whereas non-compliances of lead and copper are largely related to distribution system functioning. For some of the microbial indicators including clostridium and Escherichia coli no single dominant cause of non-compliance could be identified.

The question now arises to what extend the DWD can be held responsible for the observed increase in drinking water quality as illustrated in the previous chapters. The rationale for this is based on logic reasoning and expert judgement as presented below.

Impact of DWD on substances controlled by land use and geology (nitrate, arsenic and pesticides)

For parameters such as nitrate, arsenic and pesticides where *catchment related causes* dominate, it can be deducted that that other directives regulating the inputs (e.g. the nitrates directive and pesticides directive; DIRECTIVE 2009/128/EC) could be held responsible for the observed trends in water quality especially if acceptable levels as regulated by those directives are equal to or lower than those imposed by the DWD. However, one has to consider, among others, the travel time and decay rate of such substances in relation to the timeframe during which the DWD has been in place. Considering the long time-delay in case of abstraction of *deep groundwater* for drinking water it is highly unlikely to observe impacts of measures reducing inputs in deep aquifers within a time scale of 1 to 2 decades. The travel time of water on average equals 1 meter per year which implies that it takes more than 20 years for dissolved nitrate to reach deep groundwater wells. This holds even more for arsenic that interacts with the solid phase resulting in retention (notably via sorption to oxides) . This line of reasoning suggests that for *deep* groundwater, observed changes in concentrations must have been due to the DWD, e.g. by mixing of waters or closing wells rather than a relation with reduced inputs as imposed by other Directives.

Since the impact of land use (emission) clearly will become noticeable in shallow groundwater (let alone surface water) it is likely that, such as in the Netherlands, several water abstraction zones using shallow groundwater have been closed due to increased levels of nitrate which was considered unacceptable because of the installation of the DWD. .In those cases, the Nitrates Directive was not able to prevent non-compliances for nitrate and an additional improvement of water quality was achieved due to the DWD. Despite the observed improvements in water quality, nitrate concentrations in subtracted (shallow) groundwater may still exceed the DWD standard. In order to prevent this, it is more effective to monitor the nitrate concentrations in shallow groundwater rather than in subtracted water.

In case of abstraction of shallow groundwater, however, or inlet of surface water for drinking water purposes it cannot be ruled out that reductions in concentrations and in non-compliance have resulted from increased efforts to reduce inputs of nitrate and pesticides as well. For nitrate in surface waters other Directives (in casu the Water Framework Directive) are more stringent than the DWD so here the DWD may have had an added effect in reducing surface water levels in addition to the WFD but the DWD is likely not to be the main driver for the observed increase in water quality .

An absolute scaling of the impact of the DWD relative to that of other directives that have become active during this timeframe (including Nitrates Directive, Pesticides Directive) is not possible since all of these Directives share to some extend the level of regulation (for nitrate and pesticides both the DWD and related Directives regulate drinking water quality at the same level)

Impact of DWD on lead and copper

For copper and lead, for which *distribution network related causes* dominate the exceedances, the DWD has clearly been one of the main drivers that has resulted in the decrease of the non-compliances. This holds in general for all parameters for which exceedances are related to causes in the distribution network, since the DWD is the single most important Directive addressing these substances after the water has been processed and enforces remedial action in case of non-compliances. A reduction of non-compliances can thus be attributed to the DWD.

On the other hand, the DWD has had limited or no impact on the quality of water *prior to* the interaction of water with the distribution network. Water quality in aquifers, either deep or shallow as well as that of surface water are largely controlled by natural processes (retention of metals by sediments and soils whereas inputs to the system are regulated to directives targeting environmental quality. This includes: (i) the Water Framework Directive, in which the acceptable Cu level in surface water is much lower than the acceptable level in drinking water regulated by the DWD and (ii) the Nitrates Directive and the Directive regulating additives in feeding stuffs (70/524/EEC), which both regulate application rate and quality of manure which indirectly also regulates supply of copper and zinc). Considering the allowed input levels either via fodder, manure or water and the strong retention of copper and lead to the solid matric it is highly unlikely that concentrations of copper in aquifers (i.e. before interaction with the distribution network) would reach levels at which the DWD becomes effective. Normal observed ranges of copper in shallow or deep groundwater are in the order of magnitude of 1 to several 10's of microgram per litre whereas the DWD regulates copper at levels in excess of 2000 microgram per litre.

Impact of DWD on mixed causes

For some parameters in the DWD, notably the microbiological parameters no clear main cause for the observed non-compliance was found. Based on the data supplied other than the chemical substances discussed earlier (nitrate, pesticides, copper, lead), increased levels of microbiological parameters are not so much related to land use or slow processes (infiltration to groundwater), but related to (partly unpredictable) incidents such as shortcuts in distribution systems leading to the accidental contamination of the drinking water distribution system with (treated) sewage effluent. The latter may also catchment related in case of contaminated surface water used for drinking water. Having a DWD in place clearly accelerates the chances of early detection even though the frequency of the monitoring periods can be such that outbreaks can occur and lead to widespread infections. It is thus very likely that the DWD has contributed to the decrease in microbiological parameters. An indicative illustration of an qualitative assessment of the likelihood that DWD has an impact on the drink water quality is given in the table below. It is, however, not possible to determine the extent to which the DWD indeed has resulted in a decline in exceedances of the non-compliances of microbiological parameters.

Table B.6 Illustration of an indicative qualitative assessment of the likelihood that DWD has an impact on drinking water quality in the catchment and distribution system and on the reduction of non-compliances

Parameter	Likelihood that DWD has an impact on water quality in a specific aquifer			Likelihood that the DWD has an impact on water during distribution	Likelihood that the DWD resulted in a reduction of non-compliances
	Surface water	Shallow GW	Deep GW		
Nitrate	+?	+	0	0	+
Pesticides	+	+?	0	0?	0
Arsenic	-?	-	0	0	+[3]
Microbial indicators	+	0	0	+	+
Copper	0	0	0	++	++
Lead	0	0	0	++	++

++ very likely that the DWD has an impact
+ likely that the DWD has an impact
0 likely that the DWD has no impact
- very likely that the DWD has no impact
? Not sure

B.4 Conclusions

Trends in mean compliance for all parameters and in more in detail for ten selected candidate parameters showed an increase in compliance with time for all parameters, changes being largest for *E. coli*, *Cl. Perfringens* and *Atrazine*. For all other parameters it changed from ca 95% to near 100% compliance. The causes of non-compliances varied from: (i) almost completely *catchment related* for arsenic (combined impact of geology and hydrology) pesticides and nitrate(application of manure, fertilizer and pesticides) to almost completely *distribution network* related for both copper and lead and *mixed sources* for both *Cl. perfringens and E. coli*. The increase in drinking water quality can unequivocally be described to DWD actions for *distribution network* related contamination by both copper and lead, and partly in case of *Cl. perfringens* and *E. coli*, while in case of pesticides and nitrate, adjacent directives may have played an important role.

[3] This effect is due to monitoring (an actions, most likely closing wells)

Appendix 1 to B. Overview of trends in non-compliances for the period 2005-2013 based on data from 12 countries with a continuous monitoring record for the parameters listed here

PARA	NCI_Year	-	(blank)	Catchment	Treatment plant	Public Distr.	Domestic distr.	combined	other	unknown	Grand Total
Arsenic	2005	9	3	2							14
	2006	6	62	3	1						72
	2007	11	70	2							83
	2008			28					1		29
	2009		1	29					1		31
	2010		4	58						1	63
	2011			24	1			1		7	33
	2012			29						8	37
	2013			19	2					5	26
Arsenic Total		**26**	**140**	**194**	**4**			**1**	**2**	**21**	**388**
***Atrazine* CAS 1912-24-9**	2005			4							4
	2006			4							4
	2007		1	1							2
	2008		1	1							2
	2009			1							1
	2010			3							3
	2011			1							1
	2012			3							3
	2013			1							1
***Atrazine* CAS 1912-24-9 Total**			**2**	**19**							**21**
***Atrazine-Desethyl* CAS 6190-65-4**	2005			4							4
	2006			2				1			3
	2007		2								2
	2008			2							2
	2009			4							4
	2010			6							6

PARA	NCI_Year	-	(blank)	Catchment	Treatment plant	Public Distr.	Domestic distr.	combined	other	unknown	Grand Total
	2011			1	1						2
	2012			2							2
	2013			1							1
***Atrazine-Desethyl* CAS 6190-65-4 Total**			**2**	**22**	**1**			**1**			**26**
***Bentazon* CAS 25057-89-0**	2005			1							1
	2006		1								1
	2007		1	1							2
	2008			2							2
	2009			2							2
	2010			1							1
	2011			1							1
	2012			1							1
***Bentazon* CAS 25057-89-0 Total**			**2**	**9**							**11**
Cl. perfringens	2005	50	42	52	1	3	5	42			195
	2006	53	46	43	5	2	3	65			217
	2007	37	43	33	1	2		55			171
	2008		79	49	21	2	3	3	1	18	176
	2009		91	24	19	6	7			15	162
	2010		38	51	14	3	5	3		29	143
	2011			58	5	3	22	3		18	109
	2012	1		69	12		8	13		31	134
	2013	1		55	21	1	2	1	1	23	105
***Cl. perfringens* Total**		**142**	**339**	**434**	**99**	**22**	**55**	**185**	**2**	**134**	**1412**
Copper	2005		2				1	2			5
	2006	1				4	2				7
	2007	1	5			1	4				11
	2008		5				5			1	11
	2009		10				4				14
	2010		4	2			1			1	8
	2011	1					10			2	13

PARA	NCI_Year	-	(blank)	Catchment	Treatment plant	Public Distr.	Domestic distr.	combined	other	unknown	Grand Total
	2012						5			1	6
	2013						10		3	2	15
Copper Total		**3**	**26**	**2**		**5**	**42**	**2**	**3**	**7**	**90**
E. coli	2005	369	75	20	16	11	21	53			565
	2006	326	105	27	7	12	12	47			536
	2007	292	147	15	24	15	12	76			581
	2008		71	20	51	20	22	9		52	245
	2009		69	13	45	26	27	8		46	234
	2010		38	37	57	26	30	11		68	267
	2011	6		8	57	45	30	40		44	230
	2012	7		5	61	67	19	40		44	243
	2013	2	1	3	51	75	25	34	3	43	237
Escherichia coli Total		**1002**	**506**	**148**	**369**	**297**	**198**	**318**	**3**	**297**	**3138**
Lead	2005	69	63		1	1	20	15			169
	2006	48	77			1	32	17			175
	2007	39	55			1	28	19			142
	2008		37			3	17	8		10	75
	2009		32			2	28	4		4	70
	2010		10	18		4	24	10		17	83
	2011	7				6	54	1		13	81
	2012	2				10	60	6	2	6	86
	2013					12	105	6		17	140
Lead Total		**165**	**274**	**18**	**1**	**40**	**368**	**86**	**2**	**67**	**1021**

PARA	NCI_Year	-	(blank)	Catchment	Treatment plant	Public Distr.	Domestic distr.	combined	other	unknown	Grand Total
Nitrate	2005	189	6	23		1		1			220
	2006	159	6	41		1	2	1			210
	2007	155	10	31	2	1					199
	2008		25	12	1		3	3		2	46
	2009		22	14	4			2		2	44
	2010		27	16	1			5		3	52
	2011	2		41	1					3	47
	2012	3		41		1	1			1	47
	2013	4		41	4					2	51
Nitrate Total		**512**	**96**	**260**	**13**	**4**	**6**	**12**		**13**	**916**
Terbutylatrazine CAS 5915-41-3	2005			6							6
	2006			5							5
	2007			3							3
	2008		5								5
	2009		4								4
	2010		6								6
	2011			2							2
	2012			1							1
	2013									1	1
Terbutylatrazine CAS 5915-41-3 Total			**15**	**17**						**1**	**33**

Appendix 2 to B. Overview of trends in remedial actions for the period 2005-2013 based on data from 12 countries with a continuous monitoring record for the parameters listed here. An explanation of the used codes is given below

PARA	NCI_Year	C1	C2	T	P1	P2	D1	D2	S	E	E1	E2	O [1]	None	Grand Total [2]
Arsenic	2005	1													2
	2006												1		4
	2007														2
	2008	29	1	7	1		1						1		40
	2009	31		8	2										42
	2010	57	1	5										1	65
	2011	3	2	3		1	1						3	7	42
	2012	2	4	7				1						3	41
	2013	1		19	1								6		30
Arsenic Total		124	8	49	4	1	2	1					11	11	268
Atrazine CAS 1912-24-9	2005	1	1												4
	2006														4
	2007														1
	2008		1	2			1				1		2		8
	2009	2	1	4									3		10
	2010	1	2	1											5
	2011		1										1		3
	2012	1											3		4
	2013												1		1
Atrazine CAS 1912-24-9 Total		5	6	7			1				1		10		40
Atrazine-Desethyl CAS 6190-65-4	2005	2	1								1				4
	2006														3
	2008	6	2	18	1						2	1	8		40
	2009	4	2	14								2	10		37
	2010	2	5	8								3	5		26
	2011	2	1	1									2		7
	2012	2											4		6

PARA	NCI_Year	C1	C2	T	P1	P2	D1	D2	S	E	E1	E2	O [1]	None	Grand Total [2]
	2013	1											2		3
Atrazine-Desethyl CAS 6190-65-4 Total		19	11	41	1						3	6	31		126
Bentazon CAS 25057-89-0	2005											1			1
	2007	1													1
	2008		1	1											3
	2009		2	2											6
	2010		1	3											5
	2011												1	1	2
	2012	2												1	3
	2013	2													2
Bentazon CAS 25057-89-0 Total		5	4	6								1	1	2	23
Cl. perfringens	2005	49		2		3					3		5		103
	2006	38		3		3					5		5		118
	2007	32		1		2									91
	2008	53		28	1	9		4					15	6	131
	2009	37		17	1	10		5			1		17	4	109
	2010	45		20		5	18	4			1		23	6	158
	2011	13		54	1	17	1	7					37	5	139
	2012	13		64	2	26		4			1		30	12	158
	2013	12	1	60		14	4	1	13				19	8	146
Cl. perfringens Total		292	1	249	5	89	23	25	13		11		151	41	1153
Copper	2005						1				1				4
	2006										2				6
	2007						1				1				5
	2008										5		4	1	10
	2009						1				3		4	1	10
	2010				3		6	2			1		1	1	15
	2011			2			6	2			4		3	2	23
	2012						1	5			2		5	1	16
	2013			2			4	5	1		2		4	2	23

PARA	NCI_Year	C1	C2	T	P1	P2	D1	D2	S	E	E1	E2	O [1)]	None	Grand Total [2)]
Copper Total				4	3		20	14	1		21		21	8	112
E. coli	2005	18		8		12		16			1		4		121
	2006	23		4		5		11			3		3		105
	2007	34		14	8	3	1	15					2		143
	2008	55		54	11	66	2	22			2	2	3	15	256
	2009	49	1	45	6	69	1	23			15		9	14	260
	2010	50	3	61	10	92	20	35		1	13	2	13	20	371
	2011	10		141	18	91	3	28		5	4	1	63	31	434
	2012	14		163	20	84	2	28			16		44	26	450
	2013	15	1	156	20	68	1	18	22		5		42	22	421
Escherichia coli Total		268	5	646	93	490	30	196	22	6	59	5	183	128	2561
Lead	2005			1							15				37
	2006					1	6				15				50
	2007						7				11				48
	2008				2		6				17		17	8	62
	2009	2			3		6				19		16	2	56
	2010		7	1	3	1	26				19		16	9	106
	2011				4		43	8			7		10	17	95
	2012		1		8	2	28	8			10		11	15	97
	2013	1		61	4	4	13	5	8		12		7	10	156
Lead Total		3	8	63	24	8	135	21	8		125		77	61	707
Nitrate	2005	5	2										6		29
	2006	2	2										6		45
	2007	5	1										1		34
	2008	17	7	10		8	3				1		3		61
	2009	13	20	10							6		5	1	64
	2010	23	9	8		1							2	1	57
	2011	21	11	26			1						5	4	73
	2012	8	1	29		6							6	5	66
	2013	11	10	32		1							3	8	74

PARA	NCI_Year	C1	C2	T	P1	P2	D1	D2	S	E	E1	E2	O [1)]	None	Grand Total [2)]
Nitrate Total		105	63	115		16	4				7		37	19	503
Terbutylatrazine CAS 5915-41-3	2005											1			6
	2006														5
	2007														3
	2009														1
	2011			3											3
	2012			1											1
	2013			1		1									2
Terbutylatrazine CAS 5915-41-3 Total				5		1						1			21
Grand Total		821	106	1185	130	605	215	257	44	6	227	13	522	270	5514

[1)] We skipped: C (15), P(21), D (11), s1 (3), E (6), Multiple (501), mv (540) and Unknown (22). Values in bracket refer to the number of WSZ for which the RA was reported.

[2)] Includes the number of RA from the RA that were skipped.

Code RA	Description remedial action (RA)
C	catchment related
C1	Action(s) to terminate or mitigate the cause
C2	Action(s) to replace source
D	domestic distribution system
D1	Replacement, disconnection or repair of defective components
D2	Cleaning, scouring and/or disinfecting contaminated components
E	Emergency actions for the consumers' health and safety
E1	Notification of and instructions to consumers for example, prohibition of use, boil water order, temporary limitations on consumption).
E2	Provision of a temporary alternative drinking water supply (for example, bottled water, water in containers, tankers)
Multiple	Multiple
mv	no data
None	None
O	Others
P	public distribution network related
P1	Replacement, disconnection or repair of defective components
P2	Cleaning, scouring and/or disinfecting contaminated components
S	Security measures to prevent unauthorised access
S1	Security measures to prevent unauthorised access
T	Establishing, upgrading or improving treatment
unknown code	unknown code

These results show that: according to the Eionet data for the period 2005-2013:
By far most of the RA are related to the microbiological parameters E Coli (for 2561 WSZ) *Cl. perfringens* (1153), followed by lead (707), nitrate (503) and arsenic (268);
The RA for *Cl. perfringens* are mainly catchment related (292) (C1: terminate or mitigate the cause);
The RA for E Coli are mainly treatment-related;
The RA for lead are mainly distribution related, but remarkably also catchment related;
The RA for nitrate are mainly catchment related with an emphasis on replacing source (C1).

In the period 2005-2013 more and more MS reported remedial actions. Most of the performed are related to the microbiological parameters (E Coli and Clostridium perfringens) and to a lesser extend to chemical parameters (lead, nitrate and arsenic).

Annex C Outbreaks and incidents in drinking water in the EU

C.1 Introduction

C.1.1 Aim

Apart from the question: has the DWD improved drinking water quality, there is also the question: has the DWD led to a reduction in health incidents, that are (partly) related to drinking water. Trends in microbiological and chemical compliance in the various MS have already been identified in Annex B by analysis of the official reported data to the European Commission, and the likely contribution of the DWD to improved drinking water quality has been assessed there. The objective of this chapter is to identify any trends in microbiological outbreaks and chemical incidences and the impact (if any) the DWD has had.

C.1.2 Approach

Incidents and outbreaks reported in literature and obtained through contacts with drinking water regulators are presented. The information on outbreaks and incidents thus collected will be judged as being related to drinking water or not as for many microbiological outbreaks there is not always a single cause or the cause is unknown (and could be either drinking water and/or food). Then the impact of the DWD on the occurrence and frequency of events and outbreaks will be assessed.

In general a distinction is made between microbiological outbreaks and chemical incidents.

Chemical incidents include events in which there is unintended (or sometimes deliberate) release to the (aquatic) environment of chemicals with potential to cause harm to human health through drinking water. In the case of a microbiological outbreak the effects on human health are most acute and obvious. Chemical incidents will only become clear when there are acute physical effects or when consumers reject the tap water because of organoleptic aspects (taste, appearance, odour). Chronic effects of chemical incidents are much more difficult to notice.

Microbiological outbreaks through drinking water include events in which two or more people must be linked epidemiologically by time, location of exposure to water and illness characteristics and the epidemiological evidence must implicate drinking water as the probable source of illness.

C.2 Diseases due to chemicals

In the search for chemical incidents (through MS regulators, researchers and WHO), we were told by various experts that unless there is a ‘major’ event that is reported in the public press most incidents go unnoticed. Water companies are rather hesitant to report on such incidents and also if it is for a short period of time and they can restore the normal situation quickly such events do not have to be reported to the authorities. No national or European records are kept on chemical incidents. One EU regulator when asked for frequency and details of chemical incidents said that he could not remember any in the last ten years. When asked if that was the result of having the DWD in place he mentioned that that conclusion could not be made, but this was because of better environmental legislation and better practice.

There are some examples of incidents that can be mentioned and the remedial action that was taken to prevent (further) pollution of drinking water. When surface water used for the production of drinking water is polluted as is the case in the River Meuse example below, remedial action is taken by temporarily closing the water intake.

In August 2015 the River Meuse water used for the production of drinking water in the Netherlands did not meet the quality criteria and the intake by the water companies WML, Evides and Dunea was stopped. This remedial action was taken because the source of the pollution the wastewater treatment plant at a chemical factory did not operate properly and pyrazoles were discharged on the surface water and ended up in the Meuse. Temporary closure of the intake of river water is a common remedial action taken by surface water companies to protect the quality of drinking water. Since 2010 there have been five intake stops of River Rhine water due to the too high presence of pesticides. Communication Harry Römgens (Director RIWA Maas, TAPES conference September 2015). When a borehole is polluted they are often abandoned and alternative sources are exploited. In some cases groundwater does not comply with values for the chemical parameters in the DWD and alternative solutions are not readily available. Such examples are generally addressed through derogations and mostly concern, arsenic in some areas of the EU, fluoride or chromium VI. These are not incidents but structural problems. Here the DWD will have an impact as MS have to take remedial actions to comply with the requirements of the DWD.

However with respect to the chemicals incidents, it is, in general, not likely that the DWD has an impact on their occurrence. These incidences are mostly not related to the implementation of the DWD. Something goes wrong and this does not depend on having standards in place. Combined with the fact that no records are kept on occurrence of chemical incidents we decided to restrict the study to microbiological outbreaks.

A new approach to drinking water protection through a risk based safety plans however, will have an impact on incidents as all critical contamination points are systematically identified and protocols to safeguard the quality will be in place.

C.2.1 Likelihood of diseases due to non-compliances of chemicals

We evaluated the possible health impacts of exceedances of chemical parameters by comparing the reported median exceedance concentrations and maximum concentrations with the parametric value and comparing the ratio of both with the safety factor for the relevant chemical. results thus derived are given below. The total number of WSZs in the EU27 is and the criteria used for the assessment of the risk level in the WSZs is as follows:
When ratio of median exceedance/PM > SF: high risk for the related WSZ
When ratio of median maximum /PM > SF: median risk for the related WSZ
When ratio of maximum /PM > SF: low risk for the related WSZ
When ratio of maximum /PM < SF: no risk

It is not possible to assess the risk level in WSZs for non-threshold parameters, mostly carcinogenic substances. Most case of non-compliance for the chemical parameters cause no or a low risk. The exceptions are WSZ's were fluoride is exceeding the value in the DWD as there is not really a safety margin and non-compliance could result in adverse effects in humans. The other exception are WSZs with exceedance of nitrate and nitrite levels as there is no safety margin but the strict limit is already based on protection of the most vulnerable groups (pregnant women and infants) and the allocation to drinking water.

Table on median and maximum values in the EU MS and the risk of values found for chemical parameters

Chemical element	Nr. of WSZs with non-compliance	Parametric value (PM)		Ratio of average median exceedance/PM	Ratio of average maximum/PM	Ratio of absolute maximum/PM	Safety factor (SF) (n.t. non threshold)	Risk
Antimony	6	5	µg/l	1.7	1.8	2.9	>1000	No risk
Arsenic	76	10	µg/l	1.6	2.2	12.3	6/10.000 n.t.	..
Benzene	1	1	µg/l	3.2	48	48	1/1.000.000 n.t.	..
Benzo(a)pyrene	9	0.01	µg/l	16	48	436	<1/1.000.000 n.t.	..
Boron	11	1	mg/l	1.2	1.3	1.7	30	No risk
Bromate	10	10	µg/l	2.6	3.1	9.6	5/100.000 n.t.	..
Cadmium	3	5	µg/l	1.7	1.5	3.1	<10	No to low risk (smokers)
Chromium	2	50	µg/l	1.3	1.5	1.5	precautionary	No risk
Copper	22	2	mg/l	14	10	128	No tox based value	No risk bad taste
Cyanide	0	50	µg/l	0	0	0	n.a.	
1,2-dichloroethane	0	3	µg/l	0	0	0	n.a.	
Fluoride	54	1.5	mg/l	1.2	1.4	8.1	No safety factor S.F. = 1	Above 1.5 high risk of fluorosis
Lead	120	10	µg/l	6.2	8.0	110	Little of no S.F.	High risk
Mercury	5	1	µg/l	2.8	2.5	4.5	100	No risk
Nickel	105	20	µg/l	3.0	4.2	65	200-300	No risk
Nitrate	84	50	mg/l	1.3	1.5	6.1	Little or none but based on vulnerable groups	Low- medium risk for vulnerable groups
Nitrite	2	0,50	mg/l	1.3	1.9	3.2	Little or none but already based on vulnerable groups	Low-medium risk for vulnerable groups

Chemical element	Nr. of WSZs with non-compliance	Parametric value (PM)		Ratio of average median exceedance/PM	Ratio of average maximum/PM	Ratio of absolute maximum/PM	Safety factor (SF) (n.t. non threshold)	Risk
Pesticides — Total	13	0.5	µg/l	2.9	3.0	48.1	n.t. source protection not health based	Low risk
Polycyclic aromatic hydrocarbons (sum four compounds)	3	0.1	µg/l	4.0	4.9	10	n.t. precautionary	
Selenium	5	10	µg/l	1.4	1.5	1.9	WHO 40 ug/l	No risk
Tetrachloroethene and Trichloroethene	9	10	µg/l	3.1	8.7	42	100-1000	No risk
Trihalomethanes — Total	82	100	µg/l	1.2	1.3	3.6	n.t. 25-1000 for individual substances	Low risk
Vinyl chloride	0	0.5	µg/l	0	0	0		

C.3 Microbiological outbreaks

To collect information on microbiological outbreaks we both studied information available in literature, information supplied by MS regulators and microbiological experts from our network. In this chapter epidemiological information on outbreaks of mostly food and water borne diseases is addressed (3.1) and next we look at examples of trends in waterborne outbreaks (3.2). Finally we try and assess the impact of the DWD and other legislation on microbiological outbreaks (3.3).

C.3.1 Epidemiological information on outbreaks of food- and water borne diseases

The two microbiological parameters mentioned in the DWD *E. coli* and Enterococci, are mere indicator organisms that normally do not cause any threats to human health. They just indicate the possible contamination of the drinking water. Microbiological incidences causing disease are often reported for bacteria e.g. pathogenic *E. coli* also known as STEC/VTEC, Campylobacter, Shigella, Salmonella, Legionella pneumophila, and viruses as Calicivirus, Rotavirus, Norovirus and parasites as Cryptosporidium and Giardia. These organisms pose the most significant health risks associated with contaminated drinking water. In the case of an outbreak it is not always possible to find out what the contribution of drinking water is or has been. Epidemiological information for the abovementioned organisms does often not specify the actual source of contamination (food or water.

The European Centre for Disease Prevention and Control (ECDC) collects information on infectious disease outbreaks, including those for which water was confirmed as route of exposure. ECDC is currently working on a report with outbreak data for the entire WHO European Region, on the basis of a review of available databases and literature. All EU MS and three EEA countries (Iceland, Liechtenstein and Norway) send information at least annually from their surveillance systems to ECDC relating to occurrences of cases of the 52 communicable diseases and health issues under mandatory EU-wide surveillance. Reports are sent according to case definitions established by the EU[4].

The Annual Epidemiological Report 2014 gives an overview of the epidemiology of communicable diseases of public health significance in Europe, drawn from surveillance information on the 52 communicable diseases and health issues for which surveillance is mandatory in the European Union (EU) and European Economic Area (EEA) countries.

Most surveillance systems capture only a proportion of the cases occurring in their countries. Some cases of disease remain undiagnosed ('under-ascertainment'), and some are diagnosed but not reported to public health authorities ('underreporting'). The pattern of this under-ascertainment and underreporting varies by disease and country, involving a complex mix of healthcare-seeking behaviour, access to health services, availability of diagnostic tests, reporting practices by doctors and others, and the operation of the surveillance system itself. The direct comparison of disease rates between countries should therefore be undertaken with caution. In most cases differences in case rates reflect not only differences in the occurrence of the disease, but also in systematic differences in health and surveillance systems as described here.

The epidemiological information as collected and reported by ECDC does not concern DWD parameters. This is obvious as the DWD only has indicator organisms in the list of microbiological parameters. Information on microbiological outbreaks that might be casued by drinking water

[4] 2002/253/EC: Commission Decision of 19 March 2002 laying down case definitions for reporting communicable diseases to the Community network under Decision No 2119/98/EC of the European Parliament and of the Council. Official Journal, OJ L 86, 03.04.2002, p. 44–62.

besides other routes are shortly summarised for pathogenic coliform bacteria, Cyrptosporidium, Giardia, Campylobacter, Shigella and also for Legionella.

Pathogenic *E. coli*

Infection with pathogenic *E. coli* is mainly acquired by consuming contaminated food, such as undercooked contaminated beef or contaminated vegetables, or water, but person-to-person and direct transmissions from animals to humans may also occur. The main reservoirs for STEC/VTEC bacteria are ruminants such as cattle, goats and sheep. In 2012 10 EU countries reported 51 outbreaks from food and 10 waterborne outbreaks to ESFA (European Food Safety Authority), caused by pathogenic VTEC Strains. This represented 0.9% and 63% of all the reported food- and waterborne outbreaks in the EU. All 10 VTEC waterborne outbreaks were reported by Ireland and seven were reported to be linked to private water supplies or wells. In 2011 there was a large German outbreak, that was associated with contaminated food. The EU/EEA notification rate about 1.0 cases per 100 000 population has been reported since 2007 until 2010 (see figure A.E.1 and table A.E.1). However, a year after the outbreak a 1.5 fold increase in the EU/EEA notification rate and an increasing trend was observed compared with previous years. This is most likely due to the increased public health interest and detection of the STEC/VTEC cases as a response to the 2011 outbreak. There was an increasing EU trend for STEC/VTEC in 2008–2011. After removing the outbreak cases in year 2011, a statistically significant increasing EU trend could still be observed in 2008–2010. An increasing number of confirmed STEC/VTEC cases were observed in 2012 in the EU/EEA countries compared to previous years.

Figure A.E.1

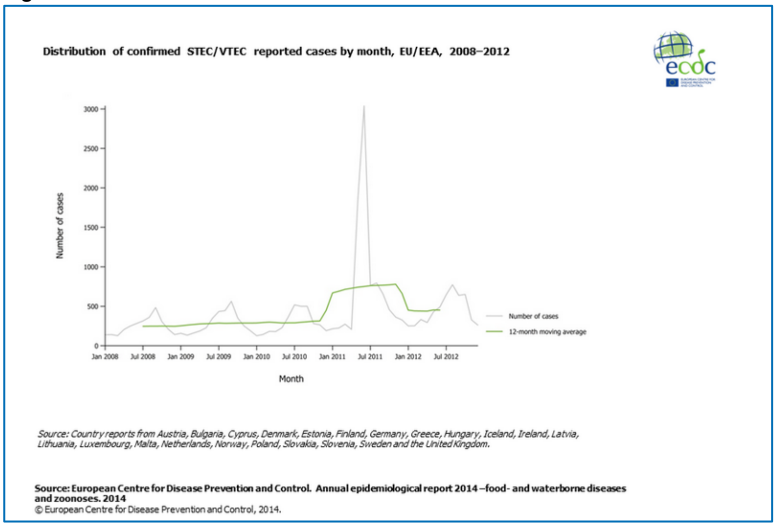


Table A.E.1 Number and rates of confirmed STEC/VTEC reported cases, EU/EEA, 2008–2012

Country	2008	2009	2010	2011	2012
	Cases	Cases	Cases	Cases	Cases
Austria	69	91	88	120	131
Belgium	103	96	84	100	105
Bulgaria	0	0	0	1	0
Cyprus	2	0	0	0	0
Czech Republic	-	-	-	7	9
Denmark	161	160	178	215	214
Estonia	3	4	5	4	3
Finland	8	29	21	27	30

Country	2008	2009	2010	2011	2012
	Cases	Cases	Cases	Cases	Cases
France	85	93	103	221	208
Germany	876	887	955	5 558	1 587
Greece	0	0	1	1	0
Hungary	0	1	7	11	3
Ireland	213	237	197	275	554
Italy	26	51	33	51	68
Latvia	0	0	0	0	0
Lithuania	0	0	1	0	2
Luxembourg	4	5	7	14	21
Malta	8	8	1	2	1
Netherlands	92	314	478	845	1 049
Poland	2	0	4	5	5
Portugal	-	-	-	-	-
Romania	4	0	2	2	1
Slovakia	8	14	10	5	9
Slovenia	7	12	20	25	29
Spain	24	14	18	20	32
Sweden	304	228	334	477	472
United Kingdom	1 164	1 336	1 110	1501	1 337
EU Total	**3 163**	**3 580**	**3 657**	**9487**	**5 870**
Iceland	4	8	2	2	1
Liechtenstein	0	-	-	-	-
Norway	22	108	52	47	75
EU/EEA Total	**3 189**	**3 696**	**3 711**	**9 536**	**5 946**

C.3.2 Cryptosporidium

Cryptosporidiosis is an important cause of acute diarrhoeal disease worldwide, and the burden of illness in childhood can be important. Cryptosporidiosis is caused by the intracellular protozoan parasite Cryptosporidium spp. Transmission is through the faecal-oral-route via contaminated water, soil or food products and the most common identified vehicles are contaminated drinking water and contaminated recreational water. Cryptosporidium oocysts excreted in the faeces are robust and can survive in the environment for extended periods. The oocysts are resistant to chlorine at the concentrations normally used for treating drinking water and swimming pools. There are well documented large outbreaks of cryptosporidiosis caused by the contamination of drinking water. Cryptosporidium oocysts are sensitive to ultraviolet (UV) light treatment.

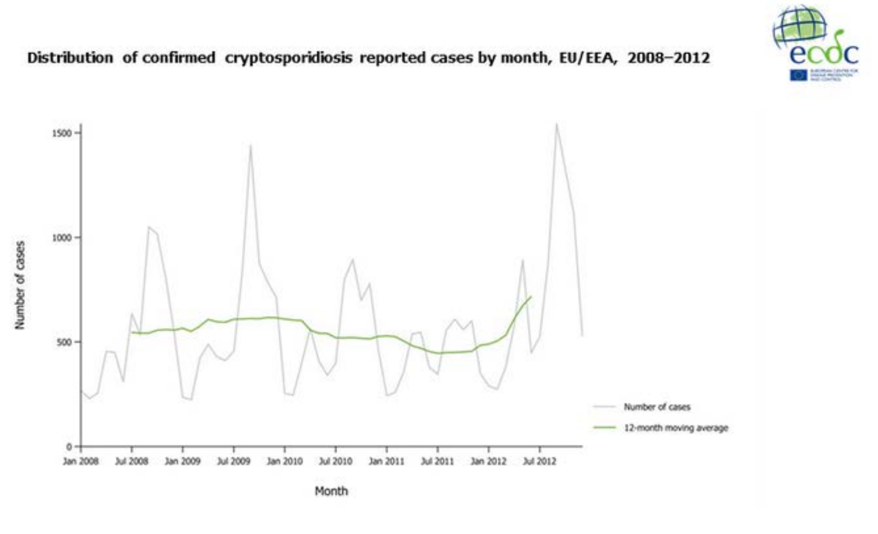
Out of the 21 EU/EEA countries reporting data on cryptosporidiosis, seven countries reported zero cases, three countries reported just one case and only seven reported 50 or more cases (see Table A.E.2 and Figure A.E.2). In addition, nine countries did not report data on cryptosporidiosis at all. It is therefore likely that cryptosporidiosis is underreported in most of the EU/EEA countries. The reason for this is most likely a lack of laboratory diagnosis of cryptosporidiosis in laboratories diagnosing diarrhoeal diseases. The number of cases reported has increased in several EU countries in 2012. Epidemiological situation in 2012 Cryptosporidium cases in 2012 were 68% higher than in 2011, with 9 591 cases reported.

Although outbreaks caused by contamination of drinking water or recreational water may happen at any time of the year, without primary diagnostic testing of faecal samples through recognised methods these outbreaks are unlikely to be detected. Human activities, such as drinking untreated water, recreational water activities, and contact with farm animals, increase the risk of becoming infected with Cryptosporidium.

Table A.E.1 Number and rates of confirmed cryptosporidiosis reported cases, EU/EEA, 2008–2012

Country	2008	2009	2010	2011	2012
	Cases	Cases	Cases	Cases	Cases
Austria	13	0	3	18	4
Belgium	397	470	275	244	495
Bulgaria	0	1	1	0	4
Cyprus	0	0	0	0	0
Czech Republic	0	0	1	0	4
Denmark	-	-	-	-	-
Estonia	0	0	0	0	0
Finland	11	11	19	22	50
France	-	-	-	-	-
Germany	1 014	1 106	918	930	1 385
Greece	-	-	-	-	-
Hungary	10	15	34	14	10
Ireland	412	445	294	413	558
Italy	-	-	-	-	-
Latvia	0	9	23	14	3
Lithuania	0	0	2	1	1
Luxembourg	0	0	1	1	0
Malta	0	0	1	0	0
Netherlands	-	-	-	-	-
Poland	1	5	0	1	2
Portugal	-	-	-	-	-
Romania	0	8	8	0	0
Slovakia	0	0	0	0	1
Slovenia	6	3	7	10	12
Spain	75	197	57	79	291
Sweden	148	159	392	379	238
United Kingdom	4 941	5 587	4 569	3571	6 533
EU Total	**7 028**	**8 016**	**6 605**	**5 697**	**9 591**
Iceland	-	-	-	-	-
Liechtenstein	-	-	-	-	-
Norway	-	-	-	-	4
EU/EEA Total	**7 028**	**8 016**	**6 605**	**5 697**	**9 595**

Figure A.E.2



Source: Country reports from Cyprus, Czech Republic, Estonia, Finland, Germany, Hungary, Ireland, Lithuania, Malta, Poland, Romania, Slovakia, Slovenia, Sweden and the United Kingdom.

C.3.3 Campylobacteriosis

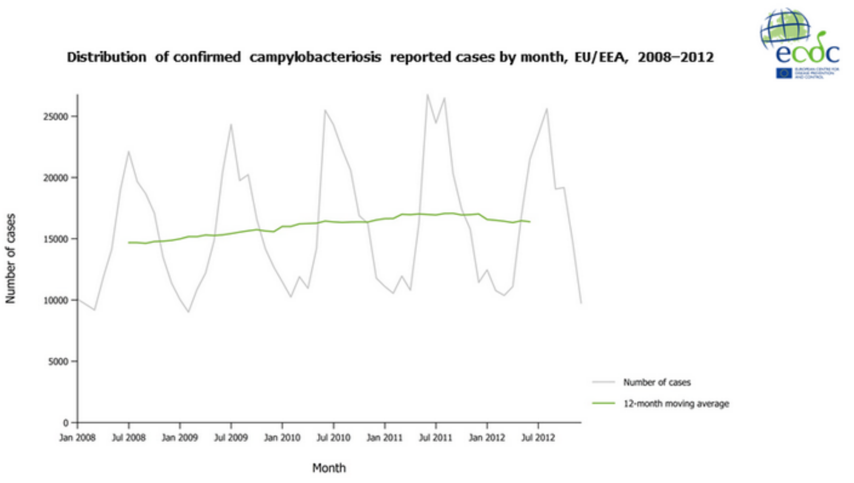
Human campylobacteriosis has remained the most commonly reported gastrointestinal disease in Europe since 2005. Handling, preparation and consumption of broiler meat has been estimated to account for 20%–41% of human campylobacteriosis cases. Campylobacter also has the potential to cause large waterborne outbreaks. In Belgium, 64 children at a youth camp became ill after using water from a local source contaminated by C. jejuni. Denmark reported a waterborne outbreak due to C. jejuni in a Danish town with over 400 cases recorded. The sources of infection causing sporadic disease seem to derive from chicken, but the routes of transmission remain unclear, as do the drivers for increases in the elderly, the seasonality and the urban-rural differences (that are not accessible with this data). Outbreaks of Campylobacteriosis occur, but most diseases appear as sporadic cases and the main route of transmission is rarely identified. Outbreaks are associated with the ingestion of contaminated food (mainly chicken or unpasteurised milk) or water. At the EU level, the rate of human campylobacteriosis increased between 2007 and 2011 but has reduced slightly in 2012.

Table A.E.2 Number and rates of confirmed campylobacteriosis reported cases, EU/EEA, 2008–2012

Country	2008	2009	2010	2011	2012
	Cases	Cases	Cases	Cases	Cases
Austria	4280	4502	4 404	5129	4 992
Belgium	5 111	5 697	6 047	7 716	6 607
Bulgaria	19	26	6	73	97
Cyprus	23	37	55	62	68
Czech Republic	20 067	20 259	21 075	18743	18 412
Denmark	3470	3 353	4 037	4060	3 720
Estonia	154	170	197	214	268
Finland	4 453	4 050	3 944	4 267	4 251
France	3 424	3 956	4 324	5 538	5 081
Germany	64 731	62 787	65 110	70 812	62 880
Greece	-	-	-	-	-
Hungary	5 516	6 579	7 180	6 121	6 384

Country	2008	2009	2010	2011	2012
	Cases	Cases	Cases	Cases	Cases
Ireland	1 752	1 810	1 660	2 433	2 392
Italy	265	531	457	468	774
Latvia	0	0	1	7	8
Lithuania	762	812	1 095	1 124	917
Luxembourg	439	523	600	704	581
Malta	77	132	204	220	220
Netherlands	3 341	3 782	4 322	4 408	4 248
Poland	270	359	367	354	431
Portugal	-	-	-	-	-
Romania	2	254	175	149	92
Slovakia	3 064	3813	4 476	4 565	5 844
Slovenia	898	952	1 022	998	983
Spain	5 160	5 106	6 340	5 469	5 488
Sweden	7 692	7 178	8 001	8 214	7 901
United Kingdom	55 609	65 043	70 298	72 150	72 578
EU Total	**190 579**	**201 711**	**215 397**	**223 998**	**215 217**
	98	74	55	123	60
Liechtenstein	2	-	-	-	-
Norway	2 875	2 848	2 682	3 005	2 933
EU/EEA Total	**193 554**	**204 633**	**218 134**	**227 126**	**218 210**

Figure A.E.3



Source: Country reports from Austria, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, Germany, Hungary, Iceland, Ireland, Latvia, Lithuania, Luxembourg, Malta, Norway, Poland, Slovakia, Slovenia, Sweden and United Kingdom.

C.3.4 Giardiasis

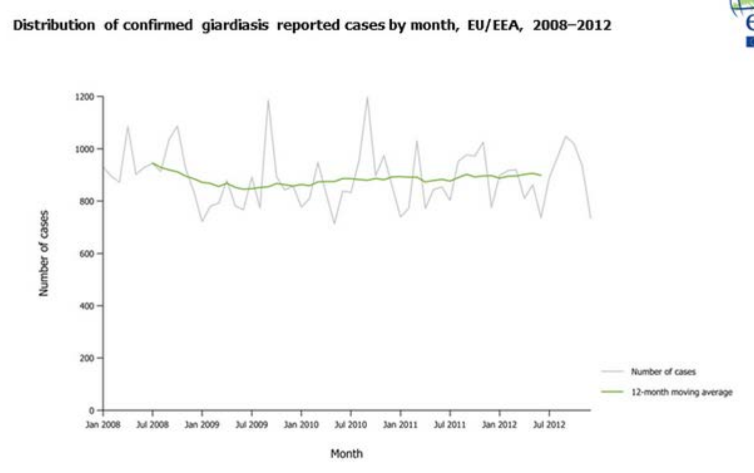
Giardia lamblia is a flagellated, cyst-producing intestinal parasite able to infect humans and animals. Giardiasis is the most common cause of parasitic diarrheal disease worldwide. Individuals become infected through ingesting contaminated food, soil, or water or by person-to-person transmission. Giardia cysts can survive for extended periods of time in the environment and a major reservoir of the parasite is contaminated surface water. Waterborne outbreaks due to inadequate treatment of drinking water are frequently reported and infants and children are at a particularly increased risk for infection. Infected individuals can remain asymptomatic or develop fatigue and bloating followed by acute or chronic diarrhoea that can lead to dehydration and malabsorption.

Cases of giardiasis were reported in 23 out of 31 EU/EEA countries (see Table A.E.4 and figure A.E.4). Out of these, three countries do not have surveillance systems covering the whole population and one potential high burden country is in the process of improving data completeness. In order to clarify the epidemiology of giardiasis further, improvement of the national surveillance systems is needed. The case rate of reported confirmed cases of giardiasis in EU and EEA countries has been relatively constant over the past five years. In 2012, no outbreaks of giardiasis or related public health events relevant at an EU level were recorded and monitored by ECDC in 2012.

Table A.E.3 Number and rates of confirmed giardiasis reported cases, EU/EEA, 2008–2012

Country	2008	2009	2010	2011	2012
	Cases	Cases	Cases	Cases	Cases
Austria	47	31	59	74	50
Belgium	1 213	1 218	1 212	1 383	1 244
Bulgaria	2 141	2 096	2 234	1 959	1 560
Cyprus	7	2	12	2	4
Czech Republic	79	47	51	45	49
Denmark	-	-	-	-	-
Estonia	264	207	257	245	254
Finland	427	378	373	404	394
France	-	-	-	-	-
Germany	4 763	3 962	3 980	4 230	4 228
Greece	-	-	-	-	-
Hungary	138	100	87	85	81
Ireland	70	62	57	56	54
Italy	-	-	-	-	-
Latvia	28	18	21	15	17
Lithuania	15	13	18	8	13
Luxembourg	1	2	0	0	2
Malta	2	2	5	10	2
Netherlands	-	-	-	-	-
Poland	3 096	2 184	2 271	1 670	1 655
Portugal	-	-	-	-	-
Romania	-	296	106	315	260
Slovakia	125	139	169	162	243
Slovenia	14	9	19	31	35
Spain	683	869	578	530	859
Sweden	1 529	1 210	1 311	1 045	1 081
United Kingdom	3 632	3 719	4 024	3 938	4 138
EU Total	**18 274**	**16 564**	**16 844**	**16 207**	**16 223**
Iceland	33	27	24	34	22
Liechtenstein	-	-	-	-	-
Norway	270	308	262	234	179
EU/EEA Total	**18 577**	**16 899**	**17 130**	**16 475**	**16 424**

Figure A.E.4



C.3.5 Shigellosis

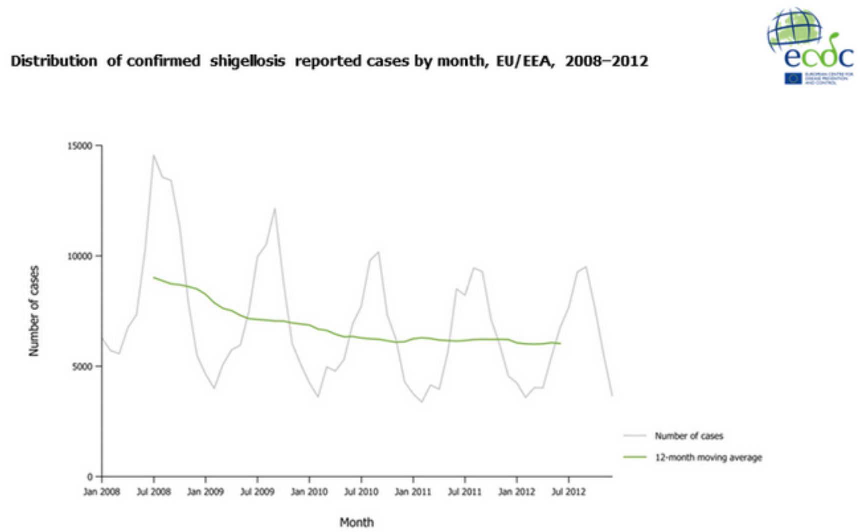
Shigellosis is caused by bacteria of the genus Shigella. Although a relatively uncommon and mostly travel-related infection in the EU, it remains the fifth most frequently reported cause of enteric infection. Outbreaks occur frequently but no public health threats associated with Shigellosis were reported at the EU level during 2012. In 2012, 7 336 confirmed cases of Shigella infection were reported from 28 EU/EEA countries. The reporting of cases has remained relatively stable in the previous five years (see Table A.E.5 and Figure A.E.5). Infections with some species may cause severe illness and death; most cases are less severe. Humans are the only significant reservoir. Transmission occurs by the faecal-oral route, either through person-to-person contact, including sexual contact, or through contaminated food or water. In 2012, the confirmed case rate for shigellosis was 1.6 per 100 000 population. Shigella is most common in children under five years of age, and very high rates in this age group are reported from some EU countries. Shigella infection, while relatively uncommon, remains of concern in some countries, and for some population groups within the EU/EEA. Bulgaria and Slovakia, in particular, continue to report high rates of infection, particularly among young children.

Table A.E.4 Number and rates of confirmed shigellosis reported cases, EU/EEA, 2008–2012

Country	2008 Cases	2009 Cases	2010 Cases	2011 Cases	2012 Cases
Austria	120	80	98	36	58
Belgium	418	348	342	317	340
Bulgaria	1 094	751	596	798	777
Cyprus	1	2	0	2	0
Czech Republic	227	177	387	157	266
Denmark	90	106	91	91	105
Estonia	69	52	46	22	34
Finland	124	118	162	126	93
France	848	1042	774	641	686
Germany	575	617	697	664	526
Greece	19	37	33	47	91

Country	2008	2009	2010	2011	2012
	Cases	Cases	Cases	Cases	Cases
Hungary	43	42	63	43	32
Ireland	63	71	60	42	29
Italy	-	-	-	-	30
Latvia	91	36	11	10	4
Lithuania	81	37	42	40	52
Luxembourg	9	18	22	16	14
Malta	3	1	2	4	0
Netherlands	343	438	523	550	708
Poland	31	21	24	18	13
Portugal	7	3	6	3	11
Romania	371	414	293	371	354
Slovakia	446	370	370	536	480
Slovenia	44	42	31	18	26
Spain	133	216	76	81	264
Sweden	596	469	557	454	328
United Kingdom	1 595	1 568	1 881	2 070	2 021
EU Total	**7 441**	**7 076**	**7 187**	**7 157**	**7 342**
Iceland	3	2	2	1	1
Liechtenstein	-	-	-	-	-
Norway	134	153	132	163	77
EU/EEA Total	**7 578**	**7 231**	**7 321**	**7 321**	**7 420**

Figure A.E.5



Source: Country reports from Austria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Malta, Netherlands, Norway, Portugal, Slovakia, Slovenia, Sweden and the United Kingdom.

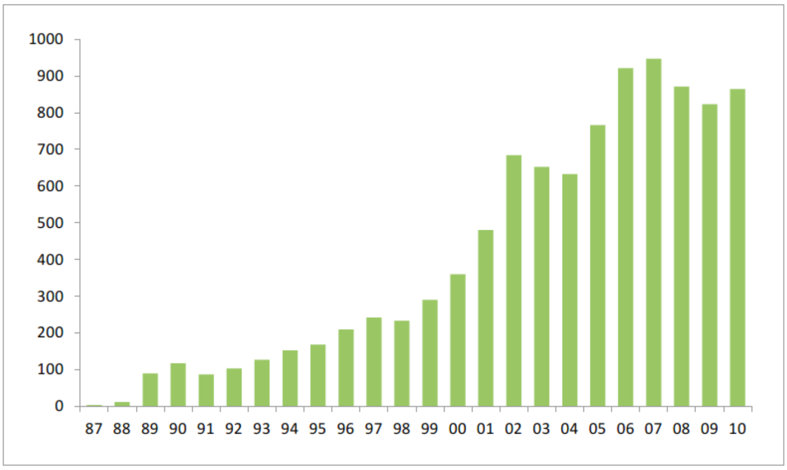
Source: European Centre for Disease Prevention and Control. Annual epidemiological report 2014 –food- and waterborne diseases and zoonoses. 2014

C.3.6 Legionella

For all parameters mentioned in the above it is not always obvious what the cause of the outbreaks is and which part of the outbreaks is water borne. For Legionella the link with water is always present. Legionella cases are caused by cooling towers and all kinds of water systems (hot tubs, whirl pools, air conditioning systems, decorative fountains, showers and in general water systems in sport facilities, hotels, hospitals and nursing homes). Data on Legionella cases have been collected for many years by the European Legionnaires' Disease Surveillance Network (coordinated bt the ECDC) since 1987. Figure A.E.6 represent the travel related legionnaires disease cases reported in Europe since then. Even though the cases only reflect travel related cases it shows a significant increase within the European countries from less than 100 in 1987 till more than 900 per year in 2010. The disease does not relate to the consumption of water but often has a relationship with the drinking water supply system. Cases of Legionella are caused by poor design, maintenance and operation of the water supply system and the quality of the water supplied. This significant increase seen in figure A.E.6 almost certainly reflects increased ascertainment of cases through improved national surveillance schemes and can also be attributed to improved collaboration and reporting by participating countries.

Figure A.E.6

Figure 1: Reported cases of travel-associated Legionnaires' disease 1987–2010



Source: EWGLINET.

C.3.7 Examples of trends in waterborne outbreaks.

In 2005 an inventory was made by the Microrisk project on outbreaks in public water supplies in the EU. Outbreaks of intestinal illness through drinking water in Europe are notoriously difficult to detect. Much of what is known about the burden of disease has been generated through outbreak documentation. What is evident from outbreaks involving public supplies is that harmful pathogens have the potential to reach a large body of consumers resulting in substantial economic and health-related costs, which is shown by the April 1993 Cryptosporidium outbreak in Milwaukee. As a result of a filtration failure at a public water supply many people suffered illness, many were hospitalised and a number died. In addition to public supplies waterborne outbreaks are often related to private supplies and recreational water. The Microrisk project summarised the outbreaks featuring enteric waterborne pathogens (*E. coli*, Campylobacter, Cryptosporidium, Giardia, Shigella, Salmonella, Norovirus and gastroenteritis of unknown aetiology) related to drinking water derived from public supplies in the European Union (EU). This survey excluded outbreaks related to recreational and private water source outbreaks. Reported outbreaks were omitted if the water source (public or private), year, or country of the outbreak was not reported, or if published material documenting the outbreak was not available. 30 additional Swedish outbreaks were identified via personal communication with Torbjorn Lindberg (SE regulator). Twenty-five of these outbreaks implicated groundwater supplies and five surface water supplies. In these outbreaks, the aetiological agent involved was often unknown (77%), in 20% of the outbreaks a viral agent was implicated, and in 3% Campylobacter was isolated from patients. These data were not incorporated as it was not possible to differentiate between small supplies which are part of a commercial/public activity and public drinking water supplies. In the years from 1990 to 2004 a total of 86 enteric disease outbreaks associated with EU public drinking water supplies. Outbreaks were identified in 10 of the 25 countries of the EU (table A.E.6).

Table A.E.6 Microrisk project (FP5)[5] Intestinal illness through public drinking water supplies in Europe between 1990 and 2014

Intestinal illness through drinking water in Europe

Table 2: Number of Outbreaks by Country, Pathogen and Water Supply, and Maximum Cases by Pathogen and Water Supply.

Country	No. Outbreaks	Pathogen Isolated in Cases								Water Supply			
		Bacterial		**Protozoal**		**Viral**							
		Campylobacter	*Shigella*	*Cryptosporidium*	*Giardia*	*Norovirus*	Viral (undete-rmined)	Mixed Pathogen	Gastroenteritis	Ground-water	Surface Water	Mixed	Not Reported
Finland	12	4	-	-	-	6	1	-	1	10	2	-	-
France	7	-	-	2	-	-	-	3	2	5	-	-	2
Germany	2	-	-	-	1	1	-	-	-	1	-	-	1
Greece	3	-	2	-	1	-	-	-	-	2	1	-	-
Italy	1	-	-	-	-	-	-	-	1	-	-	-	1
Netherlands	1	-	-	-	-	-	-	-	1	1	-	-	-
Rep. Ireland	2	-	-	1	-	-	-	-	1	1	1	-	-
Spain	6	1	1	1	-	-	-	-	3	1	-	1	4
Sweden	7	3	-	-	-	1	-	1	2	3	3	-	1
UK (England)	29	-	-	28	-	-	-	-	1	5	14	4	6
UK (N.Ireland)	3	-	-	3	-	-	-	-	-	-	3	-	-
UK (Scotland)	6	-	-	5	-	-	-	1	-	-	6	-	-
UK (Wales)	1	1	-	-	-	-	-	-	-	-	-	-	1
UK (unspecified)	6	-	-	6	-	-	-	-	-	3	2	1	-
No. Outbreaks	86	9	3	46	2	8	1	5	12	32	32	6	16
Cases	72546	16222	531	7772	232	11408	2500	2511	31370*	43571	23047*	906	5022

* One outbreak did not report case numbers.

According to the Microrisk project levels of endemic waterborne disease are probably low in most MS. However, public supplies serve very many consumers and as such contamination, even if causing illness in a small proportion of consumers, can pose a significant threat to public health. Although private water supplies serve a smaller population, they are frequently prone to faecal contamination and probably pose a greater risk to people reliant on them for their primary drinking water source. Heavy rainfall and livestock activity are frequent contributory factors involved in the occurrence of outbreaks. Although the probability of occurrence is less, the magnitude of effect is greater for distribution system incidents. Increased awareness of the public health hazard associated with illegal cross-connections and source water contamination could ameliorate these issues. The detection and investigation of outbreaks is important for the protection of public health, yet detection and reporting varies from one European Member State to another making comparison across Europe difficult.

C.3.7.1 Case of the Nordic countries Denmark, Sweden, Norway and Finland

From 1998 to 2012 a total of 175 waterborne outbreaks affecting 85,995 individuals (see table A.E. 7) were notified to the national outbreak surveillance systems in Denmark, Finland, Norway and Sweden (SE 1998 to 2011). Between 4 and 18 outbreaks were reported each year during this period. Outbreaks occurred throughout the countries in all seasons, but were most common between June and August. Viruses belonging to the ***Caliciviridae*** family and ***Campylobacter*** were the pathogens most frequently involved, comprising 41% and 29% of all 123 outbreaks with known aetiology respectively. Although only a few outbreaks were caused by the parasites Giardia and/or ***Cryptosporidium***, they accounted for the largest outbreaks reported during the study period, affecting up to 53,000 persons. Most outbreaks, 124 (=76%) of those with a known water source were linked to groundwater.

A large proportion of the outbreaks (76%) affected a small number of people (less than 100 per outbreak) and were linked to single-household water supplies. However, in 11 (6%) of the outbreaks, more than 1,000 people became ill. Although outbreaks of this size are rare, they highlight the need for increased awareness, particularly of parasites, correct water treatment

[5] Intestinal illness through drinking water in Europe December 2005 Microrisk.

regimens, and vigilant management and maintenance of the water supply and distribution systems. In the period concerned there does not seem to be a trend in the number of outbreaks reported.

Table A.E.7 Waterborne outbreaks in the Nordic countries between 1998 and 2012 (2011) (in brackets number of people affected)

TABLE 3

Waterborne outbreaks by microorganism involved and year, Denmark, Finland, Norway and Sweden, 1998–2012[a] (n = 175)

Year	Number of outbreaks (number of patients involved) by microorganism											
	Caliciviridae	Campylobacter	Cryptosporidium	*Escherichia coli* (pathogenic)	Giardia	Rotavirus	Salmonella	Shigella	Francisella tularensis	Multiple microorganisms	Unknown	Total
1998	2 (2,500)	2 (2,216)	–	1 (unknown)[b]	1 (3)	–	–	–	–	–	1 (13)	7 (4,732)
1999	4 (238)	2 (14)	–	–	–	–	1 (55)	–	–	–	7 (664)	14 (971)
2000	5 (5,944)	4 (1,063)	–	–	1 (37)	–	–	–	–	1 (300)	5 (167)	16 (7,511)
2001	3 (698)	4 (1,069)	–	–	–	–	1 (3)	–	–	–	2 (37)	10 (1,807)
2002	5 (746)	4 (114)	–	–	–	–	–	–	1 (11)	1 (50)	5 (520)	16 (1,441)
2003	7 (291)	1 (3)	–	1 (8)	–	1 (140)	–	–	–	–	3 (101)	13 (543)
2004	3 (259)	3 (13)	–	–	1 (6,000)	–	–	–	–	–	4 (32)	11 (6,304)
2005	1 (45)	2 (300)	–	1 (16)	–	–	–	–	1 (2)	–	5 (144)	10 (525)
2006	1 (150)	2 (45)	–	1 (10)	–	–	–	1 (18)	1 (5)	2 (35)	4 (38)	12 (283)
2007	3 (90)	3 (1,613)	1 (28)	–	1 (13)	–	–	–	3 (27)	2 (6,513)	5 (2,431)	18 (10,715)
2008	1(2,000)	2 (20)[b]	–	1 (20)	1 (2)	–	–	–	–	–	4 (110)	9 (2,152)
2009	4 (436)	2 (210)	–	1 (4)	–	–	–	–	–	–	3 (67)	10 (717)
2010	5 (401)[b]	2 (275)	2 (27,000)[b]	–	–	–	–	–	–	1 (40)	2 (30)	12 (27,746)
2011	5 (57)[b]	3 (56)	1 (20,000)	1 (8)	–	–	–	–	–	1 (27)	2 (15)	13 (20,163)
2012	2 (170)	–	–	1 (15)	–	–	–	–	–	1 (200)	–	4 (385)
Total	**51 (14,025)**	**36 (7,011)**	**4 (47,028)**	**8 (81)**	**5 (6,055)**	**1 (140)**	**2 (58)**	**1 (18)**	**6 (45)**	**9 (7,165)**	**52 (4,369)**	**175 (85,995)**

Dashes indicate that there were no such outbreaks.

[a] For Sweden, 1998 to 2011.

[b] There was an outbreak with an unknown number of people involved. There were five such outbreaks in total

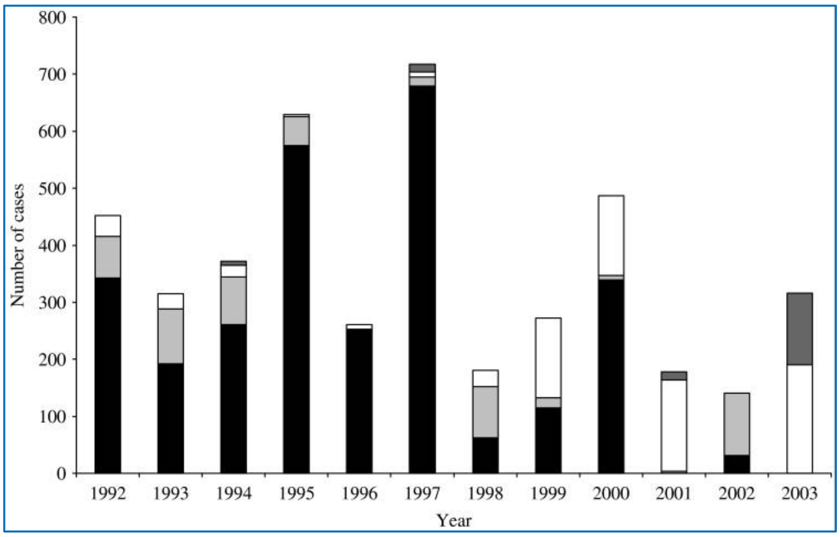
C.3.7.2 Case of England and Wales

The Communicable Disease Surveillance Centre (CDSC) and local health authorities in England and Wales have conducted structured surveillance of outbreaks of infectious intestinal disease (IID) since 1992. They reviewed the epidemiological and microbiological features of the subset of outbreaks of IID in which water was the reported vehicle of transmission in England and Wales in the period 1992–2003 utilizing the CDSC classification system for categorizing the strength of association with water.

Between 1 January 1992 and 31 December 2003, CDSC received 89 waterborne IID outbreak reports affecting 4321 people. Public water supplies were implicated in 24 outbreaks (27%), private water supplies in 25 (28%), swimming pools in 35 (39%), and other sources in five outbreaks (6%), three involving recreational river use and two involving fountains. There was an average of 119 case patients per public water outbreak and 22 cases per private water outbreak (Figure A.E.7).

Cryptosporidium was implicated in 69% of outbreaks, *Campylobacter* sp. in 14%, *Giardia* in 2%, *E. coli* O157 in 3% and *Astrovirus* in 1%. From 2000, there was a consistent decline in the number of outbreaks of waterborne disease associated with public water supplies. The incidence rate of outbreaks in recipients of private water supplies may be as high as 35 times the rate in those receiving public water supplies (1830 *vs.* 53 per million population). Private water suppliers need to be aware of the importance of adequate treatment and the prevention of faecal contamination of storage water.

Figure A.E.7 Total number of case patients associated with waterborne outbreaks of infectious intestinal disease. ▩, Other water supplies; □, swimming pools; ▢, private water supplies; ■, public water supplies



A number of common themes emerged as possible contributory factors to the outbreaks reported. These included an inadequate or a transient failure of water treatment measures, overloading of the treatment process through gross contamination of the water source, contamination of water source with animal or human faeces.

There was a consistent decline in the number of outbreaks of waterborne disease associated with public water supplies, particularly noticeable since 2000. Private water supplies, on the other hand, are an ongoing concern. The microbiological quality of many private water supplies is poor. Outbreaks of waterborne disease associated with private water supplies increased in number during the period of the study. If a large private water supply becomes contaminated it can pose a substantial risk to public health. The regulatory framework for private water supplies needs to be strengthened and that this should include an obligation on suppliers to inform recipients that they are consuming water from a private supply.

C.3.7.3 Case the success story of Ireland (personnel communication Darragh Page Ireland regulator)

In Ireland the majority of drinking water comes from surface water supplies for several reasons. In addition to the large amount of surface water available, groundwater resources are not as suitable for use as most other MS as Ireland has large areas of karst geology as well as a fractured pattern of geology around the country. This means that many of our groundwater resources are heavily influenced by surface water. As a result most of our raw waters contain E. coli as it is ubiquitous in surface waters everywhere. This means considerable treatment for drinking water supplies has to be put in place, as disinfection alone will not be sufficient in many of our groundwater sources. This is the reason for historically having high levels of non-compliance with E. coli compared to other MS which have better quality groundwater resources.

In summary, since the Directive came into force in 2004:

- The number of incidents of E. coli contamination of water supplies in Ireland has reduced by around 90% in public water supplies and private group water schemes (see figure A.E.8 and A.E.10). For example in 2004 there were 91 public water supplies where E. coli was detected at least once during the year compared to 10 in 2013 (figure A.E.9). Similarly in private group water schemes the numbers of schemes contaminated with E. coli dropped from 282 in 2004 to

32 in 2013. Data for 2014 (which is currently being analysed) shows a further drop in the number of public water supplies and private group water schemes contaminated with E. coli. This data will be published in November;

- The real improvements in public water supplies took place after 2007. This is because in 2007 the EPA was given enforcement powers over the public water supplies and took several initiatives to reduce the number of incidents (e.g. setting minimum standards for disinfection systems including mandatory process alarms) and started to take enforcement action (including prosecutions) where action was not being taken. The Irish government also published a Remedial Action List which is a list of supplies are in need of improved operation/management, replacement or upgrading. This has focussed investment on supplies that need it most. Thus, while the DWD set the standards improvements only occurred due to active enforcement of the DWD. This is a very important point to note. Darragh Page suspects other MS where there is active direct enforcement (e.g. Portugal and the UK) will also show improvements;
- In relation to the private group water schemes (which are community run local water supplies), a massive programme of improvement took place to reduce the number of incidents. Many of these plants had no treatment in 2004. The majority of these have now been upgraded or amalgamated with nearby schemes. This has resulted in a significant drop in the number of such schemes (698 were monitored in 2004 reducing to 417 in 2013). The quality of remaining schemes has also improved dramatically (only 78% of samples analysed in 2004 complied with the E. coli standard improving to 97.6% in 2013).

Figure A.E.7 Percentage of public water supplies fully compliant with the *E. coli* standard (DWD) Ireland source D. Page (2015)

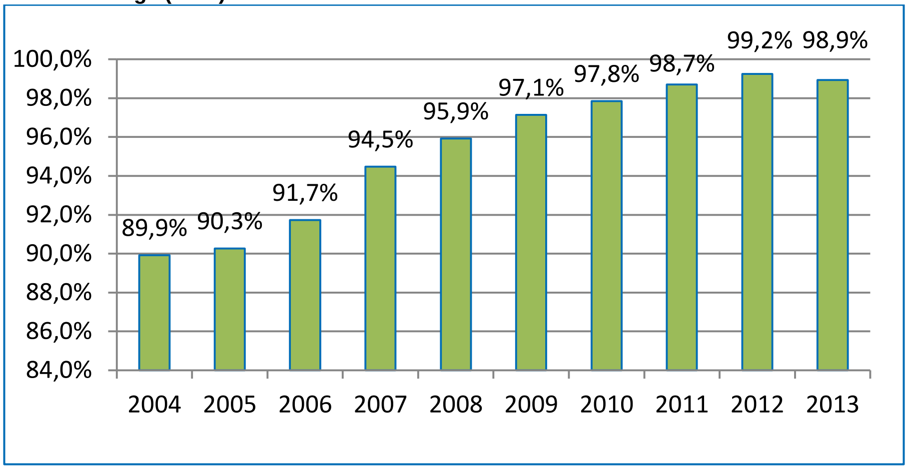


Figure A.E.8 Number of public water supplies with detected *E. coli* Ireland source D. Page (2015)

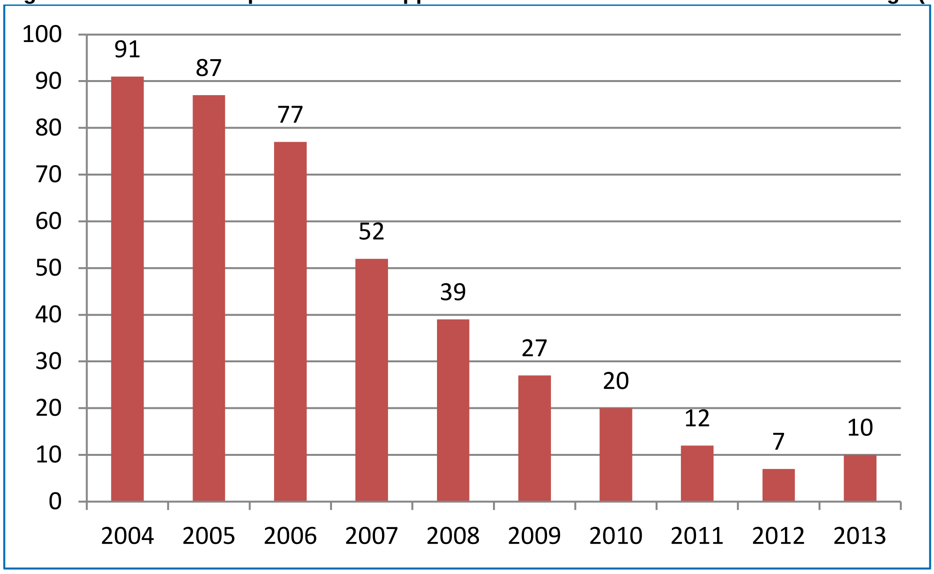
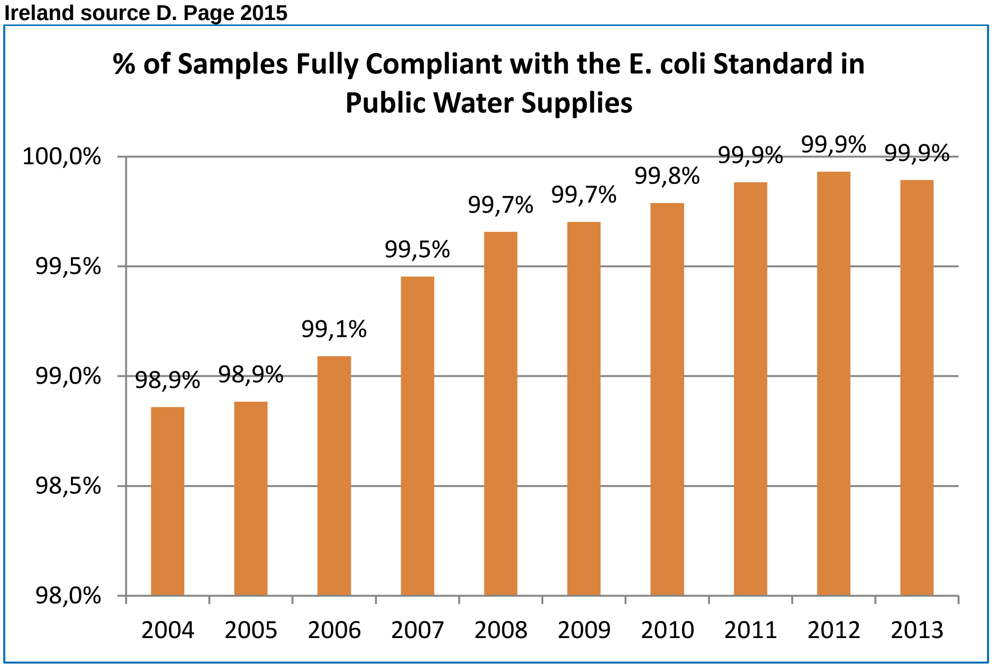


Figure A.E. 9 Percentage of samples fully compliant with the *E. coli* standard in public water supplies in Ireland source D. Page 2015



C.3.8 Impact of DWD and other related legislation on microbial outbreaks

With respect to epidemiological data on the potential microbiological parameters that are discussed a number of conclusions can be drawn.

- The micro-organisms that can cause outbreaks through water are not directly included in the DWD as the Directive only includes two indicator parameters;
- In most cases outbreaks can be caused by a number of sources besides drinking water and it is often not possible to relate outbreaks to (drinking) water;
- The epidemiological data on these micro-organism indicate an increased number of outbreaks for pathogenic E. coli STEC/VTEC between 2008 and 2012, no significant changes in the outbreaks related to Shigella and Giardia. Cases related to Campylobacter increased in the period 2007-2011 but showed a slight decrease in 2012. Cryptosporidium related cases showed an increase in 2012;

- The only micro-organism that most certainly related to (drinking) water Legionella showed significant increase from the start of monitoring the cases of Legionnaires' disease in 1987 till 2012. The significant increase in travel related cases within Europe almost certainly reflects increased ascertainment of cases through improved national surveillance schemes and can also be attributed to improved collaboration and reporting by participating countries;
- The epidemiological data are, however, presumably only the tip of the iceberg as water related disease surveillance systems are not necessarily capable to detect waterborne outbreaks due to methodological problems. Comparisons over time are this not very meaningful in terms of assessing an impact of the DWD unless there is convincing evidence that the disease was water borne and reduced due to remedial actions taken because of the DWD.

Annex D Comparison between EU legislation and legislation in other countries

Introduction

This Annex forms part of the Study reporting the revision of the EU DWD. Its objective is determine the similarities and differences between the DWD and drinking water legislation in other regions and countries with the aim to identify good practices that can be introduced at European level.

The Annex is based primarily on literature review of relevant legislative documents, guidelines, reports and technical standards related to drinking water of the following countries: United States of America (USA), Canada, Australia and New Zealand. The desk research have been complemented by an interview with representative of World Health Organization (WHO) on effectiveness of the drinking water legislation in other countries.

D.1 Drinking water legislation in the USA

D.1.1 General information

The Safe Drinking Water Act (SDWA) is the main federal law regulating the quality of the drinking water in the USA. SDWA sets standards for drinking water quality and requirements as well as provisions for control on the implementation of the SDWA by the United States Environmental Protection Agency (US EPA), states, localities, and water suppliers who implement the standards.

SDWA was originally passed by the Congress in 1974 to protect public health by regulating public drinking water supply. The law was amended in 1986 and in 1996. Until 1996 the SDWA focused primarily on treatment as the means of providing safe drinking water at the tap. With the amendments in 1996 provisions were introduced recognizing source water protection, operator training, funding for water system improvements, and public information as important components of safe drinking water. Sound science and risk-based standard setting, small water supply system flexibility and technical assistance, community-empowered source water assessment and protection, and water system infrastructure assistance through a multi-billion-dollar state revolving loan fund were introduced.

SDWA applies to every public water system in the United States. Public water systems are defined as systems that have at least 15 service connections or serve at least 25 people per day for 60 days of the year. The public water systems may be publicly or privately owned. There are currently more than 170,000 public water systems. SDWA does not regulate private wells (these serve less than 25 individuals). Drinking water standards apply to water systems differently based on their type and size. The following water supply systems are distinguished:

- Community Water System (approximately 54,000) - A public water system that serves the same people year -round. Most residences including homes, apartments, and condominiums in cities, small towns, and mobile home parks are served by Community Water Systems;
- Non-Transient Non-Community Water System (approximately 20,000) - serves the same people more than six months per year, but not year -round, for example, a school with its own water supply is considered a non-transient system;

- Transient non-community water system (there are approximately 89,000) - serves the public but not the same individuals for more than six months, for example, a rest area or campground may be considered a transient water system.

In addition to the SWDA, National Primary Drinking Water Regulations set maximum contaminant levels for particular contaminants in drinking water and treatment technologies to remove contaminants. National Primary Drinking Water Regulations are legally enforceable standards that apply to public water systems. Each standard also includes requirements to test for contaminants in the water to make sure standards are achieved.

National Secondary Drinking Water Regulations are non-enforceable guidelines regulating contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or colour) in drinking water. EPA recommends secondary standards to water systems but does not require systems to comply. However, states may choose to adopt them as enforceable standards.

The responsibility for application of the SDWA is divided among US EPA, states, tribes, water systems, and the public. SDWA provides a framework in which these parties work together. US EPA provides guidance, assistance, and public information about drinking water, collects drinking water data, and oversees state drinking water programs.

States can apply to US EPA for “primacy,” the authority to implement SDWA within their jurisdictions, if they can show that they will adopt standards at least as stringent as US EPA’s and make sure water systems meet these standards. All states and territories, except Wyoming and the District of Columbia, have received primacy. While no Indian tribe has yet applied for and received primacy.

Both US EPA and states can take enforcement actions against water systems not meeting safety standards. US EPA and states may issue administrative orders, take legal actions, or fine utilities.

D.1.2 Main provisions of the legislation

Drinking water standards: US EPA sets primary drinking water standards trough the National Primary Drinking Water Regulations. Two type of contaminants levels are defined:

- Maximum Contaminant Level Goal (MCLG) - The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety and are non-enforceable public health goals;
- Maximum Contaminant Level (MCL) - The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to MCLGs as feasible using the best available treatment technology and taking cost into consideration. MCLs are enforceable standards.

When it is not economically or technically feasible to set a maximum level, or when there is no reliable or economic method to detect contaminants in the water, US EPA instead sets a required Treatment Technique which specifies a way to treat the water to remove contaminants. US EPA performs a cost-benefit analysis and obtains input from interested parties when setting standards.

The primary drinking water standards are determined by EPA through a three-step process:

- US EPA identifies contaminants that may adversely affect public health and occur in drinking water with a frequency and at levels that pose a threat to public health. US EPA identifies these contaminants for further study, and determines contaminants to potentially regulate;
- US EPA determines a maximum contaminant level goal for contaminants it decides to regulate;

- US EPA specifies a maximum contaminant level which is enforceable standard or required Treatment Technique.

The List of Contaminants and their Maximum Contaminant Level Goal and Maximum Contaminant Level are available at: http://water.epa.gov/drink/contaminants/#Primary.

There are activities undertaken to strengthen protection for microbial contaminants, including Cryptosporidium, while strengthening control over the by-products of chemical disinfection. The Stage 1 Disinfectants and Disinfection By-products Rule and the Interim Enhanced Surface Water Treatment Rule together address these risks. Defined are the following criteria:
- Maximum Residual Disinfectant Level Goal - The level of a drinking water disinfectant below which there is no known or expected risk to health. MRDLGs do not reflect the benefits of the use of disinfectants to control microbial contaminants.);
- Maximum Residual Disinfectant Level - The highest level of a disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.

Contaminant candidate list (CCL): Contaminants that are currently not subject to any proposed or promulgated national primary drinking water regulations, but are known or anticipated to occur in public water systems are also monitored and listed in CCL. Contaminants listed on the CCL may become part of future regulation under the SDWA. Water systems must monitor certain contaminants from the CCL. These monitoring data are used to help determine which contaminants should be regulated by new standards, and the levels of those standards. SDWA requires EPA to publish the CCL every five years. EPA also solicit public nominations for the CCL.

US EPA must conduct a thorough cost-benefit analysis for every new standard to determine whether the benefits of a drinking water standard justify the costs.

EPA's surface water treatment rules require systems using surface water or groundwater under the direct influence of surface water to:
- disinfect their water; and
- filter their water; or
- meet criteria for avoiding filtration so that the selected contaminants (Cryptosporidium, Giardia lamblia, Viruses, Legionella, Turbidity, Heterotrophic Plate Count,) are controlled at certain levels.

The following rules specifically apply for surface water treatment:
- Long Term 1 Enhanced Surface Water Treatment: Surface water systems or groundwater under the direct influence systems serving fewer than 10,000 people must comply with the applicable Long Term 1 Enhanced Surface Water Treatment Rule provisions (such as turbidity standards, individual filter monitoring, Cryptosporidium removal requirements, updated watershed control requirements for unfiltered systems);
- Long Term 2 Enhanced Surface Water Treatment Rule: This rule applies to all surface water systems or groundwater systems under the direct influence of surface water. The rule targets additional Cryptosporidium treatment requirements for higher risk systems and includes provisions to reduce risks from uncovered finished water storage facilities and to ensure that the systems maintain microbial protection as they take steps to reduce the formation of disinfection byproducts;
- The Filter Backwash Recycling Rule requires systems that recycle to return specific recycle flows through all processes of the system's existing conventional or direct filtration system or at an alternate location approved by the state.

The groundwater treatment is regulated through the Ground Water Rule. The purpose of the rule is to provide for increased protection against microbial pathogens (through fecal contamination) in public water systems that use groundwater sources. The rule also applies to any system that mixes surface and groundwater if the groundwater is added directly to the distribution system and provided to consumers without treatment. SDWA also sets a framework for the Underground Injection Control program to control the injection of wastes into groundwater. The SDWA also provides for designation of aquifers which are the sole or principal drinking water source for an area, and which, if contaminated, would create a significant hazard to public health. After a Sole Source Aquifer is designated, no commitment for federal financial assistance may be provided for any project which the EPA determines may contaminate the aquifer through its recharge area so as to create a significant hazard to public health.

Source Water Assessment: Every state must conduct an assessment of its sources of drinking water (rivers, lakes, reservoirs, springs, and groundwater wells) to identify significant potential sources of contamination and to determine how susceptible the sources are to these threats. Protecting drinking water sources is implemented through combined efforts of many partners such as public water systems, communities, resource managers and the public. The 1996 amendments to the SDWA established EPA's Source Water Assessment and Protection Programs.

Monitoring water quality: Water systems are responsible for conducting monitoring of drinking water to ensure that it is meets all drinking water standards. To do this, water systems and States use analytical methods developed by government agencies, universities, and other organizations. EPA is responsible for evaluating analytical methods developed for drinking water and approves those methods that it determines meet Agency requirements for monitoring organic, inorganic, radionuclide and microbiological contaminants. States or US EPA certify the laboratories that conduct the analyses. Individual water systems submit samples for laboratory testing (monitoring) to verify that the water they provide to the public meets all federal and state standards. How often and where samples are taken varies from system to system and contaminant to contaminant. Requirements vary depending on the contaminant group, whether the water system uses groundwater or surface water, and the number of people served. Water systems serving large populations generally require more monitoring because of the greater potential impact of violations. Small water systems can receive variances or exemptions from monitoring in limited circumstances.

Risk assessment and management: The use of science in decision making is made-the best available, peer-reviewed science and supporting studies conducted in accordance with sound and objective scientific practices. The effect of the water on human health is studied and Drinking Water Standards and Health Advisories Tables are developed. Health Advisories provide information on contaminants that can cause human health effects and are guidance values based on non-cancer health effects for different durations of exposure (e.g., one-day, ten-day, and lifetime).

Operator Certification: Water system operators must be certified to ensure that systems are operated safely. US EPA issued guidelines in February 1999 specifying minimum standards for the certification and recertification of the operators of community and non-transient, noncommunity water systems. These guidelines apply to state Operator Certification Programs. All states are currently implementing EPA-approved operator certification programs.

Funding programmes and grants: US EPA provides grants to implement state drinking water programs, and to help each state set up a special fund to assist public water systems in financing the costs of improvements. The following financial mechanisms have been created:

- Drinking Water State Revolving Fund: States can use this fund to help water systems make infrastructure or management improvements or to help systems assess and protect their source water;
- Clean Water State Revolving Fund: available to a range of borrowers including municipalities, communities of all sizes, farmers, homeowners, small businesses, and nonprofit organizations; the interest rates are low (the interest rates average 1.7 percent, compared to market rates that average 3.7 percent); The fund partners with banks, nonprofits, local governments, and other federal and state agencies.

Small Water Systems: The small water systems are given special consideration. US EPA and states provide them with extra assistance (including training and funding) as well as allowing, on a case-by- case basis, alternate water treatments that are less expensive, but still protective of public health. EPA funds eight Technical Assistance Centers through earmark grants to provide on-site technical assistance, training, financial planning support and other services for small water systems. The TACs offer specialized technical assistance based on the needs of small systems in your area and provide management training that can improve system performance and efficiency.

Consumer information and consultation: It is required that the information is provided to the public about public health effects which is comprehensive, informative, and understandable. US EPA operates Safe Drinking Water Hotline. All community water systems must prepare and distribute annual reports about the water they provide, including information on detected contaminants, possible health effects, and the water's source. If a water system is not meeting the standards, it is the water supplier's responsibility to notify its customers. States and US EPA must prepare annual summary reports of water system compliance with drinking water safety standards and make these reports available to the public. In addition data on the numbers and types of public water supplies, populations served, source water, violations, enforcement actions are publicly available through EPA's public web sites, although the statistics are a bit outdated (2011 statistics available in August 2015). The public can be involved in developing source water assessment programs, state plans to use drinking water state revolving loan funds, state capacity development plans, and state operator certification programs.

Sources of information for the USA
- Safe Drinking Water Act
- Understanding the Safe Drinking Water Act (PDF)
- National Primary Drinking Water Regulations
- Secondary Drinking Water Regulations
- List of Contaminants and their Maximum Contaminant Level Goal and Maximum Contaminant Level
- Contaminant candidate list
- Drinking Water Standards and Health Advisories Tables
- Microbiological Risk Assessment (MRA) Tools, Methods, and Approaches for Water Media
- Variances and Exemptions in water monitoring
- Long Term 1 Enhanced Surface Water Treatment
- Long Term 2 Enhanced Surface Water Treatment Rule
- Ground Water Rule
- The Filter Backwash Recycling Rule
- Underground Injection Control
- Standards & Risk Management
- Ground Water Rule (GWR)
- Source Water Assessment and Protection Programs
- Underground Injection Control Program

- Sole Source Aquifer
- Drinking Water State Revolving Fund
- Clean Water State Revolving Fund
- Technical Assistance Centers
- Safe Drinking Water Hotline
- National Public Water Systems Report
- Drinking Water Monitoring, Compliance, and Enforcement

D.2 Drinking water legislation in Canada

D.2.1 General information

The main document regulating drinking water at national level in Canada is Guidelines for Canadian Drinking Water Quality (GCDWQ). GCDWQ are established by the Federal-Provincial-Territorial Committee on Drinking Water (CDW) and published by Health Canada. The GCDWQ set out the basic parameters that every water system should achieve in order to provide clean and safe drinking water. They are used by every jurisdiction in Canada as the basis for establishing their own requirements for drinking water. In some cases, a department or responsible authority may choose to meet more stringent objectives than those detailed in the GCDWQ. This decision is left to the discretion of each department or authority.

The drinking water systems in Canada are divided into the following categories:
- Large systems serve more than 5,000 people;
- Small systems serve between 501 and 5,000 people;
- Very small systems serve between 26 and 500 people;
- Micro-systems serve up to and including 25 people.

In addition to these categories unique facilities are recognised as those in remote locations. For the unique facilities, very small systems and micro-systems specific approaches are developed as it is recognised that they face proportionally higher costs, and have less access to sophisticated technologies and adequately trained staff.

Throughout much of Canada the water supply systems are operated by municipalities, however, an increasing number are being operated and in some cases owned by private companies. A few municipalities have delegated service provision to public companies owned by provinces.

The governing of drinking water in Canada falls under provincial/territorial jurisdiction. The provinces and territories are responsible for developing and enforcing all legislation pertaining to municipal and public water supplies including their construction and operation. Although drinking water quality is generally an area of provincial jurisdiction, the federal government has some responsibilities for drinking water quality, including on federal lands and in First Nations communities located south of 60° N latitude. North of 60° N, the territorial governments are responsible for ensuring safe drinking water in all communities in their territories, including First Nations and Inuit communities. In some instances (e.g., for federal employees), there are legislative obligations to ensure the safety of drinking water supplies. Federal departments have an obligation under the Canada Labour Code and its Occupational Health and Safety Regulations to provide potable water to their employees.

Interdepartmental Working Group on Drinking Water (IWGDW) was created in August 2002 to develop a federal drinking water program that would incorporate an intake-to-tap approach to drinking water quality in all areas of federal jurisdiction. The Mandate of the IWGDW is two-fold: (1)

to maintain the GCDWQ and update it as necessary; and (2) to be the principal interdepartmental forum for discussing and providing input to issues related to drinking water quality and the GCDWQ. The IWGDW consists of representatives of federal departments who have responsibilities for producing and/or providing clean, safe and reliable drinking water in areas of federal jurisdiction, as well as the Treasury Board of Canada Secretariat. Interdepartmental Water Quality Training Board is a sub-group of the IWGDW. The Training Board is developing and disseminating a range of training tools for very small systems in the federal domain. Its focus is systems serving only up to 25 people, as no tools are available to this vulnerable sub-set of drinking water systems. Health Canada provides the technical and scientific expertise to the IWGDW, through its role as technical secretariat.

The Canadian Council of Ministers of the Environment also has some role in drinking water management as far as it concerns water sources protective and pollution prevention measures.

D.2.2 Main provisions of the legislation

The Guidelines for Canadian Drinking Water Quality regulate:

- Microbiological parameters;
- Chemical and physical parameters;
- Radiological parameters.

Each guideline was established based on current, published scientific research related to health effects, aesthetic effects, and operational considerations. For each parameter the guidelines establish treatment goal, maximum acceptable concentration or operational guidance values. Health-based guidelines are established on the basis of comprehensive review of the known health effects associated with each contaminant, on exposure levels and on the availability of treatment and analytical technologies. Aesthetic effects (e.g., taste, odour) are taken into account when these play a role in determining whether consumers will consider the water drinkable. Operational considerations are factored in when the presence of a substance may interfere with or impair a treatment process or technology (e.g., turbidity interfering with chlorination or UV disinfection) or adversely affect drinking water infrastructure (e.g., corrosion of pipes). Technical documents for each parameter are developed.

The guidelines are reviewed in order to assess the need to update them. In the tables, guidelines that have been reaffirmed include both the original approval and reaffirmation year indicated after the name of the parameter.

Science-based documents published as part of the Guidelines for Canadian Drinking Water Quality are developed through literature review, internal and external peer-reviews, public consultations and Federal-Provincial-Territorial approval processes.

Multi-barrier approach to safe drinking water is set as fundamental approach for managing Canadian drinking water in line with the integrated water management approach. The approach comprises an integrated system of procedures, processes and tools that collectively prevent or reduce the contamination of drinking water, from source to tap. It also includes stakeholder commitments to develop legislative and/or policy frameworks; guidelines, standards and objectives; research, science and technology solutions; and consumer awareness and involvement. The application of the multi-barrier approach at the federal level varies from department to department and from site to site. As part of the multi-barrier approach a sanitary survey is undertaken. The survey is on-site review, from intake to tap, of the specific raw water quality, facilities, equipment, operations, and maintenance records for the purpose of evaluating the system's ability to adequately treat source water in order to produce and deliver safe drinking water. The sanitary survey varies depending upon the type and complexity of the system.

Due diligence: In addition to meeting regulatory requirements, federal departments, drinking water system operators, and other responsible authorities are expected to be able to demonstrate due diligence in carrying out their duties (whether these duties are regulated or not). Demonstrating due diligence means taking every precaution reasonable in the given circumstances to avoid harm and having mechanisms in place to deal with non-compliance and for holding employees accountable for their decisions and actions.

Operator Certification: In 1974, the Canadian group adopted a set of guidelines for operator certification programs. Today Certified Operators are required in 5 of the 10 provinces. The 3 territories have no requirements for operator Certification.

Water quality monitoring: The monitoring program for all federal drinking water systems should be developed based on a sanitary survey in combination with a vulnerabilities assessment and a baseline chemical analysis. At minimum, an initial sanitary survey, vulnerabilities assessment, and baseline chemical analysis should be conducted within five years for an existing system and before a new system is put into service. They should continue to be conducted every five years, or when there are significant changes to the treatment system, land use, or other conditions which may adversely affect water quality.

For departments and other responsible authorities who produce/treat their own drinking water, the recommended monitoring frequency for microbiological parameters depends on a number of factors, including the size of the population served, the monitoring history, type and quality of the source water, and the presence and type of treatment used. For all systems serving up to and including 5,000 people, bacteriological samples should be collected at a minimum four times per month at regular intervals. It is recommended that monitoring programs for identified chemical contaminants include, at minimum, annual monitoring for surface water sources, and monitoring every two years for groundwater sources, unless otherwise specified in the GCDWQ.

There is case-specific guidance for monitoring of groundwater supplies and municipally supplied systems. Monitoring at the tap is still required for some contaminants originating in plumbing systems (e.g., lead).

The water monitoring is divided into operational monitoring and compliance monitoring.

Operational monitoring practices focus on critical control points in the drinking water system to ensure the system is being operated as required. This type of monitoring allows the operator to detect changes in water quality and adjust the treatment process accordingly. In addition, increased monitoring is provided during extreme conditions to collect information on the ability of the system to cope with the pressures. Where feasible, continuous monitoring at plants is recommended for some parameters (e.g., chlorine residual, turbidity). Tests for operational monitoring do not need to go to an accredited laboratory. Operational monitoring strategies are system-specific and foster due diligence.

Compliance monitoring ensures drinking water reaching consumers meets established requirements. Every facility will need to develop its monitoring program based on the results of the vulnerabilities assessment, sanitary survey and baseline chemical analysis. In addition, many federal departments and First Nations communities have their own documents and/or directives that provide guidance on monitoring frequency and related monitoring issues.

It is provided that the results of water testing within the building should be compared with the results of testing at the treatment plant or in the distribution system (municipal or federal), conducted during the same time period, in order to identify any discrepancies. All discrepancies should be investigated and remedial actions taken as appropriate.

Disinfection by-products: Disinfection by products are monitored from point of view of ensuring the minimum concentration of choline in order to control bacterial regrowth and not from point of view of reducing the unnecessary levels of residual chlorine in the system. In the provinces and territories, specific requirements for chlorine residual concentrations are set by the regulatory authority and may vary between jurisdictions. Any chemicals (additives) used in drinking water treatment processes and/or the distribution system must meet the NSF/ANSI Standard 60 (NSF, 2012).

Materials that come into contact with drinking water are divided into the following three categories:
- treatment devices (such as filters and reverse osmosis systems and their components);
- treatment additives (such as alum and chlorine); and
- system components (such as pipes and faucets).

There are no recommended specific brands of drinking water treatment devices, but it is recommended that consumers look for a mark or label indicating that the device has been certified by an accredited certification body as meeting the appropriate NSF International (NSF)/American National Standards Institute (ANSI) health-based performance standards. Plumbing systems (internal building distribution systems) within federal buildings and in First Nations communities must be designed and constructed to meet the National Plumbing Code of Canada.

Incident and emergency response plans are developed by the federal suppliers of drinking water and Chief and Council in the Nations communities. To address cases of a suspected/confirmed event of contamination, the plan should include the possibility that water advisory are issued (boil water advisory, drinking water avoidance advisory). Drinking water advisories are public announcements to advise the public of an identified or expected risk to their water supply. Incident response protocols are established. Web-based alert and reporting system for drinking water advisories is available for use by agencies across Canada.

Consumer information: The consumer information provided by the national authorities is scares. There are no national-wide requirements for provision of information and reporting. This is regulated at provinces based on their legislation. For example all municipalities in Ontario are required to produce an annual report on drinking water systems.

Sources of information for Canada
- Guidelines for Canadian Drinking Water Quality;
- Health Canada;
- Canadian Council of Ministers of the Environment;
- From Source to Tap: Guidance on the Multi-Barrier Approach to Safe Drinking Water;
- Canadian Water and Waste Water Association;
- Guidance for Providing Safe Drinking Water in Areas of Federal Jurisdiction;
- Technical documents;
- Drinking Water System Annual and Summary Reports in Ontario.

D.3 Drinking water legislation in Australia

D.3.1 General information

Australian Drinking Water Guidelines (ADWG) is the main national-wide document that sets requirement related to drinking water. The Guidelines provide a framework for good management of drinking water supplies and contain information about management of drinking water systems, monitoring and the contaminants that may be present in drinking water. The ADWG are not mandatory standards. The Australian states are given the right to determine requirements to the drinking water quality considering the regional or local factors, and taking into account economic, political and cultural issues, including customer expectations and willingness and ability to pay.

The development and enforcement of the drinking water legislation is under the jurisdiction of the Australian states. A comprehensive list of the responsible institutions and legislation is available at the site of the Australian Water Association. The institutional arrangements for service provision vary among States and Territories. For example in Western Australia, drinking water quality management is a shared responsibility between the Water and Rivers Commission and the Water Corporation of Western Australia. The Water and Rivers Commission is responsible for administration of catchment and source protection legislation and the Water Corporation of Western Australia is the major licensed drinking water supplier responsible for the collection, treatment and distribution of drinking water to consumers. Other key agencies in the supply of drinking water are the regulators, including the health authority (National Health and Medical Regulation Council), which provides interpretation and guidance on potential health impacts of drinking water quality.

The Australian Government Department on the Environment is responsible for water policies at the federal level.

D.3.2 Main provisions of the legislation

The ADWG provide guidance on the following categories of contaminants in drinking water:

- Physical;
- Microbial;
- Chemical, including:
  - inorganic chemicals;
  - organic compounds;
  - pesticides.
- Radiological.

The ADWG include two different types of guideline value:

- a health-related guideline value, which is the concentration or measure of a water quality characteristic that, based on present knowledge, does not result in any significant risk to the health of the consumer over a lifetime of consumption;
- an aesthetic guideline value, which is the concentration or measure of a water quality characteristic that is associated with acceptability of water to the consumer; for example, appearance, taste and odour.

Preventive management approach that encompasses all steps in water production from catchment to consumer is applied. Preventive risk management approach includes elements of HACCP, ISO 9001 and AS/NZS 4360:2004, but applies them in a drinking water supply context to support consistent and comprehensive implementation by suppliers. Multiple barriers approach and critical points approach are also applied.

Hazard identification and risk assessment requires to:

- Define the approach and methodology to be used for hazard identification and risk assessment;
- Identify and document hazards, sources and hazardous events for each component of the water supply system;
- Estimate the level of risk for each identified hazard or hazardous event;
- Evaluate the major sources of uncertainty associated with each hazard and hazardous event and consider actions to reduce uncertainty;
- Determine significant risks and document priorities for risk management;
- Periodically review and update the hazard identification and risk assessment to incorporate any changes.

Continuous review of the reports and monitoring data is required and as a result development of Water quality management improvement plans.

Materials and chemicals in contact with water

Chemicals added to water include disinfectants, oxidants, coagulants, flocculants, algicides, antioxidants and chemicals for softening, pH adjustment, fluoridation and scale prevention. It is provided that all chemicals used should be evaluated for potential contamination. General considerations include data on impurities, chemical and physical properties, maximum dosages, behaviour in water, migration and concentration build-up. In addition, the potential impact of water treatment chemicals on materials used in treatment plants is considered. Materials used should comply with Australian Standard AS/NZS 4020 Products for use in contact with drinking water. The products used in water systems should be subjected to an audited system of quality control.

Water quality monitoring is divided into

- operational monitoring in the source/catchment, through the treatment process, and in the distribution system, to ensure that processes and activities are functioning optimally to achieve safe drinking water;
- verification of drinking water quality, which consists of:
  - drinking water quality monitoring in the distribution system to verify the quality of treated water as supplied to the consumer; and
  - consumer satisfaction monitoring to assess consumer comments and complaints;
- investigative studies and research monitoring (including baseline monitoring where new water sources are going to be used to supply drinking water) to identify and characterise hazards, and increase understanding of a water supply system;
- validation monitoring of new operational processes and barriers, to assure effective operation and control; and
- incident and emergency response monitoring, undertaken in response to incidents or emergencies.

It is envisaged that the monitoring is planned and directed at significant characteristics among which characteristics that might have potential impact on human health and aesthetic characteristics. Critical control points approach is used in operational monitoring.

Sampling locations depend on the water quality characteristic being examined. Sampling at the treatment plant or at the head of the distribution system may be sufficient for characteristics where concentrations do not change during delivery; however, for those that can change during distribution, it is provided that the sampling is undertaken throughout the distribution system, including the point of supply to the consumer.

Frequency of testing for individual characteristics depend on variability, and whether the characteristics are of aesthetic or health significance. Sampling and analysis are required most frequently for microbial constituents, and less often for organic and inorganic compounds. Once parameters and sampling locations have been identified, these are documented in a consolidated monitoring plan. Procedures for sampling and testing are also documented.

Disinfection by-products
To be acceptable, the chemical must have a practical application (e.g. clarify dirty water, destroy or inactivate harmful microorganisms). The chemical must achieve its purpose and must not be toxic when ingested at concentrations present in treated water. Only the chemical approved by national Health and Medical Research Council to the Government of Australia can be used for water treatment. There are minimum standards established by the relevant state or territory regulatory agency for the concentrations of the residuals of the chemicals used for treatment of drinking water.

The determination of contaminants in drinking water treatment chemicals is carried out by an independent laboratory accredited to undertake the necessary assays.

Consumer information and public consultations
Development of a comprehensive strategy for community consultation is recommended in the ADWG. The Guidelines also provide advice on how consumers to be involved in considering options for effective and acceptable monitoring and reporting on performance of their water supply, and on the frequency of such reporting. A consumer complaint and response program operated by appropriately trained personnel is recommended to be established. Complaints and responses should be recorded and, in the longer term, the types, patterns and changes in numbers of complaints received should be evaluated. Appropriate documentation and reporting of the incident or emergency id also required.

The water supplies produce reports to inform consumers about the water quality and the water supply systems they manage as for example the report of Sydney water.

Funding programmes: The National Water Security Plan for Cities and Towns is providing funding to cities and towns with fewer than 50,000 people to upgrade older water systems, install new infrastructure and support practical projects that save water or reduce water losses.

Sources of information for Australia
- Australian Drinking Water Guidelines;
- Australian Water Association;
- Australian Government Department on the Environment;
- Sydney water;
- National Water Security Plan for Cities and Towns.

D.4 Drinking water legislation in New Zealand

D.4.1 General information
The amended Health (Drinking Water) Act of 2007 is the New Zealand's main legislative document which deals with the protection of public health by improving the quality of drinking water provided to communities.

The Act only applies to drinking water supplies above a certain size as listed below:
- 25 or more people for 60 or more days per year; or

- if there are fewer than 25 people, but 6000 or more 'person/days' (that is the number of people multiplied by the number of days they receive water from the supply).

The main responsibilities which apply to the above listed suppliers include the obligations to:
- take all practicable steps to comply with the (previously voluntary) drinking water Standards;
- introduce and implement water safety plans for the water supply (if serving more than 500 people);

As of 1 July 2008 all drinking water suppliers will be required to apply to the Ministry of Health for registration on the drinking water register. Supplies that serve fewer people also need to apply to be included on the Register of Community Drinking water Supplies, however, this is free and involves no other obligations.

The Director-General of Health maintains the register of drinking water assessors. No agencies have been appointed as drinking water assessors so far, but a number of individuals have been appointed.

The Associate Minister of Health issues Drinking water Standards for New Zealand 2005 (Revised 2008). The Standards are applicable to water intended for drinking by the public irrespective of the water's source, treatment or distribution system, whether it is from a public or private supply, or where it is used. The exception is bottled water, which is subject to standards set under the Food Act 1981.

The Standards have been made after consultation with all interested persons who made submissions to the Ministry of Health. According to the Health Act of 2007 drinking water suppliers should comply with the Drinking water Standards for New Zealand until 31 December 2014. The Standards have been published since 1984, however until the amendment of the Health act in 2007 the Standards were applied on voluntary basis. It is provided that the Standards are used together with a Water safety plan.

The Guidelines for Drinking water Quality Management in New Zealand provide additional information about the:
- Contaminants listed in the Standards;
- Management of drinking water quality;
- Publications on which the Standards are based.

Organisations at three levels are responsible for the provision of safe and wholesome drinking water to any particular community in New Zealand - one at the local level, one regional and one at national level. The Ministry of Health, through the provision of Drinking water standards, guidelines and other tools, ensures at national level that an appropriate infrastructure is present in New Zealand to support the provision of clean and safe drinking water.

At the local level, usually the water supply is provided by a territorial local authority such as a district or city council. They extract the source water, run the treatment plant to remove risks or contaminants, and pipe the water to the consumer houses. Under the Drinking water Standards for New Zealand 2005, they are expected to test the water regularly to demonstrate that it is safe.

The Ministry of Health does not supervise the local authorities directly, but instead works at the regional level through the District Health Boards (DHBs). Each DHB is expected to oversee the territorial local authorities in its area and ensure (audit) that they maintain appropriate water quality. In a serious health risk situation, the DHB can, through the health district's Medical Officer of

Health, order a water supply to close. DHBs also report to the Ministry so that a national picture can be maintained of the state of all community drinking water supplies. Drinking water responsibilities of the DHBS are undertaken by the Drinking Water Assessors.

D.4.2 Main provisions of the legislation

The Drinking water Standards for New Zealand provide requirements for drinking water safety by specifying the:

- Maximum amounts of substances or organisms or contaminants or residues that may be present in drinking water. The maximum concentrations of chemicals of health significance (MAVs) in water are defined based on current knowledge. Wherever possible, the MAVs have been based on the latest WHO guideline values. The MAVs constitute no significant risk to the health of a person who consumes 2L of water a day over their lifetime (usually taken as 70 years). The Standards provide MAV of microbial, chemical and radiological substances in drinking water that are acceptable for public health;
- Criteria for demonstrating compliance with the Standards;
- Remedial action to be taken in the event of non-compliance with the different aspects of the Standards.

The Standards apply only to health significant contaminants. Guideline values for aesthetic characteristics are also provided, however they are not part of the water quality standards.

There are separate compliance requirements for small drinking water supplies (serving fewer than 500 people, tankered drinking water, and rural agricultural drinking water supplies.

Multiple barriers approach in drinking water management is applied. The barriers include:

- minimising the extent of contaminants in the source water that must be dealt with by the treatment process;
- removing undesirable soluble and particulate matter;
- disinfecting to inactivate any pathogenic organisms present;
- protecting the treated water from subsequent contamination.

Monitoring

To demonstrate compliance with the MAVs, water suppliers need to follow the relevant sampling and testing programmes detailed in the Standards. The contaminants of public health significance have been divided into four priority classes to minimise monitoring costs without compromising public health. To demonstrate compliance, only those relatively few contaminants that fall into the classes with highest potential risk, Priorities 1 and 2, must be monitored. Monitoring of contaminants in the lower potential risk categories, Priorities 3 and 4, is at the supplier's discretion, unless a Drinking Water Assessor requires it for public health reasons.

The sampling frequencies are chosen to give 95 percent confidence that the medium to large drinking water supplies comply with the Standards for at least 95 percent of the time. The larger supplies are required to monitor more frequently.

The Ministry of Health requires all testing of drinking water made as part of the monitoring process is to be performed by accredited laboratories The Register of recognised laboratories provides information about the laboratories that have been assessed by the New Zealand's main accreditation body (IANZ) and found to comply with either NZS/ISO/IEC 17025:1999 or the Ministry of Health Level 2 Criteria analytical laboratories. The Director General of Health maintains a register of Recognised Laboratories.

Water safety plans and risk management

Water safety plans for drinking water supplies were introduced in 2001. They are intended to ensure management procedures that reduce the likelihood of contaminants entering supplies in the first place. Water safety plans encourage the use of risk-management principles during treatment and distribution. To assist drinking water suppliers to develop water safety plans for their drinking water the Ministry of Health produced 39 water safety plan guides covering the system elements (filtration, disinfection, water storage, distribution etc.) that are most frequently found in drinking water supplies. All but the smallest community water supplies are required to prepare and implement a Water safety plan.

Contingency planning

The drinking water suppliers should develop contingency plans to be invoked in the eventuality that an emergency arises. These plans should consider:

- potential natural disasters (such as earthquakes, volcanic eruptions, algal blooms, droughts and floods);
- accidents (spills in the catchment or recharge area);
- areas with potential backflow problems (including ones with fluctuating or low pressures);
- damage to the electrical supply;
- damage to intakes, treatment plant and distribution systems;
- human actions (strikes, vandalism, and sabotage).

The contingency plan should include a communications plan to alert and inform users of the supply and plans for providing and distributing emergency supplies of water. The plans should be developed in liaison with civil defence personnel and should be updated.

Funding programmes

In 2005 the Government announced $150 million programme to assist small drinking water supplies in providing safe water to their communities. The programme will run for 10 years. The programme has two major components:

Technical Assistance Programme, trains and assists communities to improve their own supplies.

Capital Assistance Programme, will help fund improvements where TAP participation has shown that local resourcing is inadequate for a good solution.

Consumer information

The Drinking Water for New Zealand web portal is an information source for the consumers and those managing drinking water quality.

Annual Reports on Quality of Drinking Water in New Zealand and other publications as guidelines are publicly available at http://www.health.govt.nz/our-work/environmental-health/drinking water/drinking water-publications.

Sources of information for New Zealand

- Health (Drinking Water) Act;
- Drinking water register;
- Drinking water Standards;
- Guidelines for Drinking water Quality Management in New Zealand;
- The Register of recognised laboratories;
- Safety plan guides;
- Technical Assistance Programme;

- Capital Assistance Programme;
- Drinking Water for New Zealand;
- Annual Reports on Quality of Drinking Water.

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Annex F Interview list and overview of position papers

Group	Country	Sector	Institute
EU28	n.a.	Academics	Eureau
		Industry	CEIR
		Industry	CEFIC
		Industry	ECPA
		NGO	ANEC
		Utility	Aquapublica
Central	Germany	Industry	Hach
		Utility	Rheinisch-Westfalische Wasserwerksgesellschaft
		Utility	Berlin Wasser Betriebe
		Utility	AoW
		Utiltiy	Figawa
	Hungary	Regulator	Ministry of Health
	Poland	Regulator	Inspektorat Sanit
		Regulator	Water Health Security Comission
		Utility	Water&Sewer Blonie
	Slovakia	Regulator	Public Health Authority
		Regulator	Min. of Health
North	Finland	Regulator	Min. of Health
South	Italy	Utility	Matropolitana Milanese
		Utility	CapHolding
		Utility	Abbanoa
		Utility	Viveracqua
	Portugal	Regulator	Ersar
	Spain	Utility	Agbar
South - East	Bulgaria	Utility	Sofia Vodia
	Croatia	Regulator	Min. of Health
		Utility	City of Zagreb
West	Belgium	Other	Aquaflanders, dewatergroep, pidpa
		Regulator	VMM
		Utility	Pidpa
		Utility	VIVAQUA
	Fr / Be	Utility	Aquawal
	France	Utility	Veolia
		Utility	FNCCR
		Utility	Compagnie Intercommunale Liégeoise des eaux

Group	Country	Sector	Institute
	Ireland	Regulator	EPA
	NL	Advisor to regulating authority	RIVM
		Regulator	Ministry I&M
		Utility	VEWIN
		Utility (Advisor)	VEWIN
	UK	Academics	University of Exeter
		Academics	WHO

Position papers have been received from:

- CEIR (*Final position CEIR on DWD*)
- Europump (*Position paper)*
- ANEC (*ANEC regarding policy options, updated version)*
- Vewin (*IA Stakeholder workshop evaluation*)
- Swedish Department of Geohydrology (*Proposal improvements DWD)*
- Veolia (*DWD policy options*)
- CEEP (*Opinion on the review of the DWD*)
- Public health agency of Sweden (*Comments on policy options for a revised DWD*)
- National food agency of Sweden (*Comments and views on a revised DWD)*
- SUEZ (*Reaction to study supporting the revision of the EU DWD*)
- Eureau (*Position paper on policy options*)
- Veolia (*Contributions and comments on the DWD*)
- BDEW (*Remarks - policy options*)
- EHI (*EHI DWD position paper*)
- FSA/PlasticsEurope/Cefic (*DWD revision*)
- AquaFed (*DWD revision*)
- AoW (*Comment on the review of the DWD)*

Overview of comments on the (evaluation of) the DWD:

On parameters and monitoring:

EurEau “there should be a core list of parameters and also a risk -based list of parameters. EurEau welcomes the risk-based holistic approach covering catchment to tap, but would like also to raise the issue about who bears the responsibility to assess and manage the risks, since catchment areas and households’ installations are not under the control of drinking water operators.”
ANEC: “include emerging pollutants”
Veolia: “This means that the parametric values to be monitored should be updated while remaining at a reasonable level in terms of numbers, and should be aligned with global evolutions prescribed by the World Health Organization. We also believe that matters which prove to be of EU relevance, such as endocrine disrupting compounds, must be monitored”
National Food Agency of Sweden: “There is a need for a simplified legal procedure to quicker adapt Annex I in the DWD to newly discovered relevant risks”. “As many MS already introduced, or are likely to introduce in the near future RBA in different ways (WSP, HACCP), EU is opersently sitting in the back-seat”.
BDEW: “As till now – it should be up to the MS to decide whether they want to extend their monitoring and controlling mechanisms for the special protection of drinking water”. “WHO revision is good, but not extend the list of parameters to be monitored”.
Swedisch Deparment of Geohydrology: “trends should be monitored andn evaluated in order to establish a good base for the drinking water of tomorrow”.

Public health agency of Sweden: ”it would be valuable if new or emerging substances more easily than now could be added to the requirements. Dtection limits for methods must be within action limits for the substance”.
SUEZ: “River basin Authorities should select relevant parameters from the list to draw a shorter, tailor-fitted list at the local level following the RBA”. “RBA constitutes a moer cost-effective way of monitoring risks and avoiding threats to water quality. Defining minimum requirements on the establishment of the WSP, on its content and control, at EU level could be an interesting way forward”.
Dutch position on DWD: “there is no need for specific requirements for water quality and monitoring requirements in the food industry and these provisions now occurring in the DWD should be omitted”. “To our opinion a clear legal basis for RBA should be given in the DWD”.
National Farmers Union: “Parameter values should be set based on a scientific basis and not on the precautionary principle”. “EU limits for pesticides should be replaced by a RBA assessment, with individual values for each approved pesticide”.

On materials in contact with drinking water:
EHI, European heating industry: Common European legislation should focus on essential requirements and requirements for materials and producst in contact with drinking water should be harmonized.
Plastics Europe / Cefic-FSA: “We do see the revision of the DWD as a placeholder for requesting the European Commission to develop pragmatic and workable EU harmonized Regulation on materials and articles in contact with drinking water following one unified and science-based approach that ensures an adequate consumer protection and a level playing field for industry”.
BDEW: We urge the European Commission to examine, whether the Member States could implement Art 10 together. In this context a proposal of the four Member States could be the basis.
Europump: We support a transformation of Article of the DWD into a new European regulation, where third party certification of materials, components and products can remain on a voluntary basis.
CEIR: “CEIR recommends that the issue of products in contact with drinking water is removed from the Drinking Water Directive 98/83/EC and transformed into a new, dedicated and comprehensive European Regulation”.

On providing information to the consumers (reporting):
CEIR: “Quality perception of drinking water has to be improved”.
NFU: “Information for professional users, having high detail, has benefits for third parties”.
AquaFed: Information and transparancy provided to consumers is currently lacking.

On other issues:
BDEW: The current scope and aim of the Directive are considered relevant and should be maintained.
National food agency of Sweden: The current scope of the Directive is relevant and should be maintained.
CEEP: The DWD text does not include a cross-reference to WFD, in particular Article 7 thereof, the GWD and the PSD.
AoW: The objective of the DWD should be only the quality of water for human consumption. Additionally, member os AoW find that the DWD is a well functioning legal instrument, which should be kept in palce.

Annex G Background of the parametric values in the DWD.

G.1 Three groups of parameters and the adverse effects of non-compliance on human health

The DWD distinguishes three groups of parameters: the microbiological parameters, the chemical and the indicator parameters. All three groups have a different background and different weighting. Standards for drinking water in the DWD are based on health aspects (this holds for both microbiological and chemical parameters) and on other aspects such as organoleptic or consumer perception aspects (odour, taste, colour), or operational aspects (pH and hardness of the water) or as indicator for possible pollutants(this holds for indicator parameters) .

The *microbiological parameters E. coli* and Enterococci for tap water (there are additional parameters for water in bottles), have been included in the DWD, not because they are dangerous for human health, but since they are an indication for the potential contamination of the water with faecal matter and thus the potential presence of pathogenic organisms. The values in the DWD are set based on the principle that these should be absent from drinking water. In the case either *E. coli* or Enterococci are detected this is an indication that something is wrong with the water supplied and urgent and immediate action is needed to find the source and take remedial action.

For the microbiological parameters the assessment of the impact on human health is not a straightforward exercise as we are only dealing with the monitoring data on indicator organisms and not on pathogenic organisms. Based on our knowledge the level of *E. coli* and Enterococci in water polluted with faecal matter a rough estimate of the potential presence of pathogenic organisms is possible. This can be used to try and estimate a potential adverse effect on human health through drinking water as described in the inception report.

The *Indicator parameters* have not be included in the DWD for their adverse effects on human health. These parameters are monitored to ascertain the proper functioning of the water production and the water supply. In the case of non-compliance or abnormal changes the water supplier needs to investigate the reason behind these changes and take action as and when required. Even though the parameters and their parametric values (if any) do not have a health-based background, they often are the first change noticed by consumers. Wholesomeness and cleanliness of the water (organoleptic issues) are key to the consumer's perception and confidence in the water supplied at the tap. Parametric values are often based on perception and are best judged by the local operators. Any changes as noticed by indicator parameters should be a signal for water suppliers to make sure the water supply is still safe.

The *chemical parameters* do have a health-related basis. In principle health-based quality standards for chemical substances in drinking water are based on toxicity for humans through oral exposure. For these parameters the level of non-compliance is assessed for their potential impact on human health using the uncertainty/safety factors used for the setting of threshold chemicals and the change in the level of risk used to set the non-threshold chemicals. Considering the low concentrations of such substances in drinking water and sources of drinking water, the risk of acute effects during normal operational circumstances is negligible. Health-based limit values are generally based on effects that might occur after life-long exposure such as chronic toxicity, hormone disruption and geno-toxic and carcinogenic effects. As data on long-lasting exposure of human beings is hardly ever available toxic effects of substances are determined through animal testing.

A distinction is made between substances with and without a threshold doses below which no adverse health effects are to be expected. The existence of a threshold depends on the mode of action of a substance. Threshold substances will only cause toxic effects above a certain doses - the No Observed Adverse Effect Level, NOAEL. The NOAEL, based on long lasting animal testing (or when available on the basis of effects on humans), is used to determine a doses judged to be safe for human beings – the Tolerable Daily Intake (TDI, usually expressed as mg/kg body weight/day). A safety factor or 'uncertainty factor' (UF) is applied. Uncertainty factors are used in the development of drinking water guidelines to account for uncertainties in the database, including extrapolations of toxicity from animal studies (intra species) and variability within humans (inter species), which result in some uncertainty about risk. The individual UFs are multiplied, to derive the overall UF. The application of uncertainty factors is entrenched in toxicological risk assessment worldwide, but is not applied consistently. The Tolerable Daily Intake is calculated as follows:

$$TDI = \frac{NOAEL}{UF}$$

The intake standards are health-based limit values, defined as the maximum amount of a substance that can be ingested on a daily basis during a life time without any adverse effects on human health. When effects of a substance only occur after life-long exposure and are based on the most sensitive effects after chronic exposure, short term and relatively slight exceedances of the intake standard will not immediately result in adverse health effects. Furthermore a safety margin has been applied in setting the intake standard through the use of a 'worst case' approach. In case a substance will already cause adverse health impacts during a single or short term exposure, exceedance of the limit value will result in a risk to human health. In such cases each event will have to be judged individually to assess impacts on human health.

In general drinking water is not the only route of exposure. To ensure the total exposure to a substance does not exceed the TDI, a percentage of the total exposure (ingestion, inhalation and skin contact) is allocated to drinking water in setting health-based standards. The exposure through drinking water is generally relatively small compared to other exposure routes.
In case the contribution of drinking water is unknown, the WHO applies a standard allocation of 20% since 2010, and 10% before 2010. Since most of the current health-based standards, were set before 2010, they used the 10% allocation. Furthermore its assumed that the average drinking water consumption is 2 litres per person per day and the body weight of an adult is 60 kg or 70 kg.
Health-based standard for drinking water = (TDI x body weight x drinking water allocation) / 2 litres
For non-threshold substances, mostly geno-toxic and or carcinogenic substances a different approach is used. For these substances it is not possible to decide on a no-effect doses as theoretically one molecule could result in uninhibited cell growth. In these case the effect of a substance is expressed as the risk of death caused by cancer. A mathematical model is used to calculate the concentration in drinking water that at life-long exposure results in one additional cancer case per 1.000.000 people. This is considered to be a negligible risk level. WHO uses one additional case in 100.000 people. As this specific risk calculation only concerns exposure through drinking water no allocation factor is applied. However it is sometimes not evident whether or not a substance has a threshold for exposure, below which no adverse effects occur. Also a substance can have two modes of action one with a threshold and a non-threshold action. In those case the non-threshold mode of action is often used for the setting of standards as the level is mostly lower than the threshold.

G.2 Pesticides a special case

The Drinking Water Directive 98/83/EC requires that water at the consumer tap does not exceed levels of individual pesticides of 0.1 µg/L and a total sum of 0.5 µg/L, which includes any relevant metabolites, degradation and reaction products, i.e. those that may have adverse effects on human health. It is for MS to decide which relevant metabolites, degradation and reaction products are pertinent for the implementation of the Directive. Only those pesticides that are likely to be present in a given supply need to be monitored.

During the negotiation process for the current DWD it soon became clear that there was no transparency of what ‘relevant’ meant with respect to metabolites, degradation and breakdown products. After many years there is now a guidance from the EC DG SANCO that distinguishes three groups of metabolites and guidance on how to define if a metabolite is relevant or non-relevant (DG SANCO/221/200-rev.10)

In a previous version of the guidance document on the assessment of the relevance of metabolites in groundwater of substances regulated under Council directive 91/414/EEC a distinction is made in

- Relevant metabolites
- Metabolite of no concern
- Non-relevant metabolites

And a step wise approach is described on how to determine the (non) relevance of metabolites. For non-relevant metabolites it recommends a careful evaluation on a case by case basis.

For each of the chemical parameters in the DWD the background is studied and (used by EC/WHO or the CSTE (Scientific Committee)) used in setting the value in the DWD. It is also tried to assess if the substances are threshold or non-threshold substances. This is important for the assessment of the potential impact on human health of exceedances reported by MS. In the case of threshold parameters the uncertainty factor is added, also called safety factor, that has been used. In the case of non-threshold parameters the additional level of risk through drinking water accepted by the EC will be added.

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