COMMON IMPLEMENTATION STRATEGY FOR THE WATER FRAMEWORK DIRECTIVE AND THE FLOODS DIRECTIVE

Voluntary Groundwater Watch List

V. 3.1

(June 2019)

Based on the final draft of the "Voluntary Groundwater Watch List Concept & Methodology 12.3"

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1. Introduction

The "Voluntary Groundwater Watch List" is an intermediate result of the Voluntary Groundwater Watch List Process described in the Groundwater Watch List Concept & Methodology.

The Voluntary Groundwater Watch List Process was initiated by the European Commission in 2014 as an outcome of the first review of the Groundwater Directive (GWD). In Recital 4 of the revised GWD the European Commission expressed the need to obtain information on additional substances posing a potential risk for groundwater. To support this, the European Commission established a watch list for pollutants in groundwater. The Groundwater Watch List (GWWL) will facilitate the identification of substances, including emerging pollutants, for which groundwater quality standards or threshold values should be set. The "Voluntary Groundwater Watch List Concept & Methodology" describes how to identify substances that shall be put on the Groundwater Watch List (chapter 3.7 and annex 1.6). Substances assessed will be ranked according to their leaching potential, hazard potential and – so far available – already available monitoring data. The Groundwater Watch List Process leads to a ranked list of substances (Integrated Groundwater Score, List IV, chapter 3.6). Those substances from List IV which are not selected for the List facilitating Annex I & II review process (chapter 3.8) or deselected from the Groundwater Watch List Process (chapter 3.9) potentially are candidate substances for the Groundwater Watch List (GWWL). The GWWL is a list of substances MS/AC are recommended to monitor to build a solid decision (data) base. As agreed by the CIS Working group Groundwater (WG GW), the number of substances on the GWWL should be limited to about 30 substances making it necessary to select a limited number of substances. How this is to be done is not yet described in detail in the Groundwater Watch List Process Concept. The selection will be based on the "Integrated Groundwater Score" (List IV), the outcome of the full assessment process. It is agreed that the final selection of substances for the Groundwater Watch List will be partly based on expert judgment. The GWWL will elaborate proposals which will finally be discussed and endorsed by WG GW. **WG Groundwater has endorsed this version, the Strategic Coordination Group (SCG) members took note of it on 15 May 2019, and EU Water Directors acknowledged it on 14 June in Constanta, Romania.**

While constructing the first assessment and preparing a list of substances for the GWWL, certain questions arose. They are discussed below and possible solutions described.

2. Selection of substances for the Voluntary Groundwater Watch List

2.1 Number of substances selected for the first Groundwater Watch List (GWWL)

As agreed in the Working Group Groundwater (WG GW) a maximum of about 30 substances should be selected for the GWWL. After discussion in the Watch List group it was agreed to select fewer than 30 substances to leave space for substances from additional chemical groups (i.e., PFAS and pharmaceuticals) selected in the future. An exact number was not fixed to be able to design a robust transparent procedure for the selection and that the result remains manageable for the MS.

2.2 Slight Modification of the Watch List assessment process

The selection of substances for the Groundwater Watch List is based on List IV of the Watch List Process. Here the groundwater leaching potential score (i.e., detection of chemicals in GW), the theoretical groundwater leaching potential score and the toxicological or ecotoxicological hazard score are combined. A critical analysis of the results of Watch List assessment carried out with all available data for pharmaceuticals and PFAS revealed a weakness in data assessment when the number of sites analysed for a substance is less than 10. Substances analysed and detected for example at only one site are highly ranked in Column I and thus overestimated. Therefore the Watch List group suggested to score substances analysed at less than 10 sites with a score of 0 in column I. This modification was presented at the Bucharest meeting in April 2019 and endorsed by WG WG.

Based on the modified scoring the 30 top ranked substances include 12 PFAS und 18 Pharmaceuticals. The 15 top ranked substances include 6 PFAS and 9 Pharmaceuticals (Tab. 1).

Tab. 1: Ranking of **PFAS** and **Pharmaceutical** substances based on the outcome of List IV, including modifications mentioned under 2.2 (Integrated Groundwater Score)
LF = List Facilitating Annex I/II review; n.d. =no data

Ranking (Integrated GW Score) <10 sites = 0 in C Ib	Substance Name	Acronym	Scoring Column Ia - MS/PC	Scoring Column Ib - sites	Leaching score (CI)	Column II score (C II = leaching potential)	Combinded Leaching Score (List III)	Hazard score	Integrated GW Score (List IV)
LF	Perfluorobutane Sulfonate	PFBS	1	0,8	**0,90**	**1,00**	0,95	n.d	0,950
LF	Perfluorooctanoic Acid	PFOA	1	0,7	**0,85**	**0,80**	0,825	1	0,913
LF	Perfluorobutanoic Acid	PFBA	1	0,8	**0,90**	n.d	0,9	n.d	0,900
LF	Perfluorooctane Sulfonate	PFOS	1	0,8	**0,90**	**0,65**	0,775	1	0,888
LF	Perfluorohexane Sulfonate	PFHxS	1	0,8	**0,90**	**0,80**	0,85	n.d	0,850
LF	Perfluoropentanoic Acid	PFPeA	1	0,8	**0,90**	**0,80**	0,85	n.d	0,850
LF	Perfluorohexanoic Acid	PFHxA	1	0,8	**0,90**	**0,80**	0,85	n.d	0,850
1	4:2 Fluortelomerphosphatemonoester	4:2 monoPAP	n.d.	n.d.		**0,75**	0,75	n.d	0,750
LF	Perfluoroheptanoic Acid	PFHpA	1	0,7	**0,85**	**0,65**	0,75	n.d	0,750
LF	Perfluorodecanoic Acid	PFDA	1	0,5	**0,75**	**0,65**	0,7	n.d	0,700
LF	Perfluorononanoic Acid	PFNA	1	0,5	**0,75**	**0,65**	0,7	n.d	0,700
2	Perfluorodecyl Phosphonic Acid	PFDPA	n.d.	n.d.		**0,65**	0,65	n.d	0,650
3	Perfluorooctyl Phosphonic Acid	PFOPA	n.d	n.d		**0,65**	0,65	n.d	0,650
4	Caffeine		0,4	0,9	**0,65**	n.d	0,65	n.d	0,650
LF	Sulfamethoxazole		1	0,6	**0,80**	1,00	0,9	0,38	0,638
5	Clopidol		0,2	1	**0,60**	n.d	0,6	n.d	0,600
6	Crotamiton		0,2	1	**0,60**	n.d	0,6	n.d	0,600
7	Ranitidine		0,2	0,2	**0,20**	1,00	0,6	n.d	0,600
8	Amidotrizoic acid		0,6	0,6	**0,60**	n.d	0,6	n.d	0,600
9	Sulfadiazine		1	0,3	**0,65**	1,00	0,825	0,38	0,600

Ranking (Integrated GW Score) <10 sites = 0 in C Ib	Substance Name	Acronym	Scoring Column Ia - MS/PC	Scoring Column Ib - sites	Leaching score (CI)	Column II score (C II = leaching potential)	Combinded Leaching Score (List III)	Hazard score	Integrated GW Score (List IV)
10	Perfluoroundecanoic Acid	PFUnA	1	0,4	**0,70**	**0,50**	0,6	n.d	0,600
11	Perfluorododecanoic Acid	PFDoA	1	0,4	**0,70**	**0,50**	0,6	n.d	0,600
12	Primidone		0,6	0,6	**0,60**	1,00	0,8	0,38	0,588
LF	Carbamazepine		1	0,6	**0,80**	0,65	0,725	0,42	0,571
13	Sotalol		0,8	0,4	**0,60**	1,00	0,8	0,33	0,567
14	6:2 Fluortelomerphosphatemonoester	6:2 monoPap	n.d	n.d		**0,55**	0,55	n.d	0,550
15	ethyleendiaminetetra-azijnzuur (EDTA)		0,2	0,9	**0,55**	n.d	0,55	n.d	0,550
16	Perfluorohexadecanoic Acid	PFHxDA	0,2	0,4	**0,30**	**0,80**	0,55	n.d	0,550
17	Ofloxacin		0,2	0,2	**0,20**	1,00	0,6	0,50	0,550
18	Atenolol		0,6	0,3	**0,45**	1,00	0,725	0,38	0,550
19	Paracetemol		0,8	0,6	**0,70**	1,00	0,85	0,22	0,533
20	Phenazone		0,6	0,5	**0,55**	1,00	0,775	0,29	0,533
21	Ciprofloxacin		0,2	0,3	**0,25**	1,00	0,625	0,42	0,521
22	Perfluorethylethanol 4:2	4:2 FTOH	n.d	n.d		**0,50**	0,5	n.d	0,500
23	Pentadecafluorooctanoic Acid Ammonium Salt (Ammonium Pentadecafluorooctanoate)	APFO	n.d	n.d		**0,50**	0,5	n.d	0,500
24	Perfluoropentadecanoic Acid	PFPeDA	n.d	n.d		**0,50**	0,5	n.d	0,500
25	Perfluoropentane Sulfonic acid	PFPeS	n.d	n.d		**0,50**	0,5	n.d	0,500
26	Polytetrafluoroethylene (Teflon)	PTFE	n.d	n.d		**0,50**	0,5	n.d	0,500
27	Ifosfamide		n.d	n.d	**0,00**	1,00	0,5	0,50	0,500
28	Cyclophosphamide		n.d	n.d	**0,00**	1,00	0,5	0,50	0,500
29	Sulfamethazine		0,6	0,4	**0,50**	n.d	0,5	n.d	0,500

Ranking (Integrated GW Score) <10 sites = 0 in C Ib	Substance Name	Acronym	Scoring Column Ia - MS/PC	Scoring Column Ib - sites	Leaching score (CI)	Column II score (C II = leaching potential)	Combinded Leaching Score (List III)	Hazard score	Integrated GW Score (List IV)
30	Iomeprol		0,6	0,4	**0,50**	1,00	0,75	0,25	0,500
31	Perfluoroheptane Sulfonate	PFHpS	0,4	0,6	**0,50**	**0,50**	0,50	n.d	0,500
32	Clotrimazole		0,2	0,1	**0,15**	n.d	0,15	0,83	0,492
33	Clofibric acid		1	0,4	**0,70**	0,65	0,675	0,30	0,488
34	Diclofenac		1	0,4	**0,70**	0,50	0,6	0,38	0,488
35	Mestranol		0	0	**0,00**	0,50	0,25	0,71	0,479
36	Metformine		0,4	0,6	**0,50**	1,00	0,75	0,21	0,479
37	Furosemide		0,2	0,3	**0,25**	0,65	0,45	0,51	0,479
38	Trimethoprime		0,4	0,1	**0,25**	1,00	0,625	0,33	0,479
39	Diazepam		0,4	0,4	**0,40**	0,65	0,525	0,42	0,471
40	Sulfadimidine		0,6	0,5	**0,55**	0,65	0,6	0,33	0,467
41	Norfloxacine		0,2	0,2	**0,20**	1,00	0,6	0,33	0,467
42	Sulfapyridine		0,2	0,3	**0,25**	1,00	0,625	0,29	0,458
43	Ibuprofen		1	0,5	**0,75**	0,50	0,625	0,29	0,458
44	Ethynil Estradiol		0	0	**0,00**	0,50	0,25	0,67	0,458
45	Chlorotetracycline		0,2	0,1	**0,15**	1,00	0,575	0,33	0,454
46	Enrofloxacin		0,2	0,1	**0,15**	1,00	0,575	0,33	0,454
47	Iohexol		0,4	0,2	**0,30**	1,00	0,65	0,25	0,450
48	Erythromycin		0,4	0,4	**0,40**	0,50	0,45	n.d	0,450
49	Propyphenazone		0,4	0,4	**0,40**	0,80	0,6	0,29	0,446
50	Lidocaine		0,4	0,5	**0,45**	0,65	0,55	0,33	0,442

3. Additional data and information to take into account

Examination of the data used for calculating the Integrated Groundwater Score (List IV) exhibits several gaps. For 8 of the top ranked 50 substances (according to their Integrated Groundwater Score) data for only two criteria (leaching score = Column I, potential leaching score = Column II or hazard score) are available. In addition for 16 of the top ranked 50 substances, data for only one criterion (leaching score = Column I, potential leaching score = Column II or hazard score) are available.

Therefore, it has been decided to apply additional criteria for the selection of substances for the Voluntary Groundwater Watch List.

a. Amount of substances released to the environment or sold in the EU

An additional parameter for selecting substances for the Watch List may be the amount of a substance released to the environment, for which information is seldom available. Comparable information could be the amount of a substance sold in EU – or in individual MS/PC. In general, substances sold in high quantities in the EU have a higher potential to reach groundwater than substances sold in low quantities if their leaching potential is similar. In this case substances sold in high quantities should be given higher priority on the Groundwater Watch List.

b. Substances representative for different classes/groups of substances

In the PFAS-Questionnaire substances were differentiated into 7 sub-groups. Substances from 2 of these sub-groups (Perfluoroalkyl Carboxylates / Perfluoroalkyl Carboxylic Acids [PFCAs] and Perfluoroalkyl Sulfonates / Perfluoroalkyl Sulfonic Acids [PFSAs]) are already present in the "List Facilitating". Tab. 2 shows the 15 top ranked PFAS substances (PFAS integrating the "List Facilitating" excluded)

Tab. 2: Top ranked PFAS except substances integrating the List facilitating Annex I/II review process of the GWD.

Ranking: Integrated GW Score	Substance Name	Acronym	Sub-group	Chain length
1	4:2 Fluortelomerphosphatemonoester	4:2 monoPAP	monoPAP	S
2	Perfluorodecyl Phosphonic Acid	PFDPA	PFPAs	L
3	Perfluorooctyl Phosphonic Acid	PFOPA	PFPAs	L
10	Perfluoroundecanoic Acid	PFUnA	PFCAs	L
11	Perfluorododecanoic Acid	PFDoA	PFCAs	L
14	6:2 Fluortelomerphosphatemonoester	6:2 monoPap	monoPAP	S
16	Perfluorohexadecanoic Acid	PFHxDA	PFSAs	?
22	Perfluorethylethanol 4:2	4:2 FTOH	FTOHs	S
23	Pentadecafluorooctanoic Acid Ammonium Salt (Ammonium Pentadecafluorooctanoate)	APFO	PFSAs	L

24	**Perfluoropentadecanoic Acid**	**PFPeDA**	?	
25	**Perfluoropentane Sulfonic acid**	**PFPeS**	PFSAs	S
26	**Polytetrafluoroethylene (Teflon)**	**PTFE**	?	?
31	**Perfluoroheptane Sulfonate**	**PFHpS**	PFSAs	L
57	**1H, 1H, 2H, 2H-Perfluorodecanesulfonic Acid**	**H4-PFDeS (8:2 FTS)**	FTSs	L
60	**10:2 Fluortelomerphosphatemonoester**	**10:2 monoPAP**	monoPAP	L

PFAS on the "List Facilitating Annex I/II review process" and the top ranked substances in Tab. 2 represent 6 of the 7 PFAS sub-groups most of which (8) are long chain substances. Substances from the sub-groups Perfluoroalkyl Phosphonic Acids [PFPAs] and Fluorotelomer Alcohols [FTOHs] were not analysed thus far. Several of the substances of these sub-groups have not been monitored as yet because reliable analytical methods are lacking. Nevertheless a high leaching potential (Column II) for some of these substances is calculated (see Tab. 3).

Tab. 3: Selected PFAS-substances sorted according to their leaching potential (Column II score)

Ranking: Integrated GW Score	Substance Name	Acronym	Sub-group	Monitoring data available	Leaching potential
16	**Perfluorohexadecanoic Acid (?)**	**PFHxDA**		**yes**	**0,8**
1	**4:2 Fluortelomerphosphatemonoester (S)**	**4:2 monoPAP**	**monoPAP**	**no**	**0,75**
2	**Perfluorodecyl Phosphonic Acid (L)**	**PFDPA**	**PFPAs**	**no**	**0,65**
3	**Perfluorooctyl Phosphonic Acid (L)**	**PFOPA**	**PFPAs**	**no**	**0,65**
14	**6:2 Fluortelomerphosphatemonoester (S)**	**6:2 monoPap**	**monoPAP**	**no**	**0,5**
22	**Perfluorethylethanol 4:2 (S)**	**4:2 FTOH**	**FTOHs**	**no**	**0,5**
23	**Pentadecafluorooctanoic Acid Ammonium Salt (Ammonium Pentadecafluorooctanoate) (L)**	**APFO**	**PFCAs**	**no**	**0,5**
11	**Perfluorododecanoic Acid (L)**	**PFDoA**	**PFCAs**	**yes**	**0,5**
10	**Perfluoroundecanoic Acid (L)**	**PFUnA**	**PFCAs**	**yes**	**0,5**

Discussions should continue on the availability of suitable analytical techniques. As soon as suitable analytical methods are available some of these substances might be placed on the Groundwater Watch List.

c. Substances referring to already available monitoring data

For 327 substances, monitoring data are already available; of these 285 substances are monitored at 10 or more sites. The number of MS/PC where a substance was found already indicates whether the substance might be a local problem or a European wide problem. The number of sites where a substance was detected provides similar information. The data available after the first data collection cover only a part of European Groundwater

resources. Substances analysed and frequently found in few countries are likely also to be found in other countries not yet tested. Table 4 shows the 62 most frequently found PFAS and Pharmaceutical substances according to monitoring data reported by MS/PC up to now.

Tab. 4: Frequently found **PFAS** and **Pharmaceuticals** sorted according to the number of MS/PC and number of sites with findings. LF = List Facilitating Annex I/II review

Ranking	Substance Name	Acronym	No of sites with findings	MS/PC with findings	Integrated GW Score (List IV)
LF	Carbamazepine		471	12	0,571
LF	Perfluorooctanoic Acid	PFOA	1553	11	0,913
LF	Perfluorooctane Sulfonate	PFOS	1435	11	0,888
LF	Sulfamethoxazole		114	10	0,638
LF	Perfluorohexanoic Acid	PFHxA	1175	8	0,850
LF	Perfluoroheptanoic Acid	PFHpA	817	8	0,750
LF	Perfluorohexane Sulfonate	PFHxS	873	7	0,850
LF	Perfluoropentanoic Acid	PFPeA	701	7	0,850
1	Ibuprofen		50	7	0,458
LF	Perfluorobutane Sulfonate	PFBS	577	6	0,950
LF	Perfluorononanoic Acid	PFNA	195	6	0,700
LF	Perfluorodecanoic Acid	PFDA	173	6	0,700
2	Perfluorododecanoic Acid	PFDoA	62	6	0,600
3	Perfluoroundecanoic Acid	PFUnA	39	6	0,600
LF	Perfluorobutanoic Acid	PFBA	552	5	0,900
4	Clofibric acid		46	5	0,488
5	Diclofenac		34	5	0,488
6	Perfluorooctane Sulfonamide	PFOSA	22	5	0,375
7	Sulfadiazine		11	5	0,600
8	Paracetemol		251	4	0,533
9	Tramadol		61	4	0,371
10	Sotalol		27	4	0,567
11	Clarithromycin		12	4	0,442
12	Amidotrizoic acid		64	3	0,600
13	Phenazone		40	3	0,533
14	Iomeprol		38	3	0,500
15	Primidone		32	3	0,588
16	Sulfamethazine		14	3	0,500
17	Atenolol		12	3	0,550
Ranking	Substance Name	Acronym	No of sites with findings	MS/PC with findings	Integrated GW Score (List IV)

18	Sulfadimidine		8	3	0,467
19	Caffeine		237	2	0,650
20	Perfluoroheptane Sulfonate	PFHpS	77	2	0,50
21	Metformine		56	2	0,479
22	Erythromycin		25	2	0,450
23	Gabapentin		19	2	0,292
24	Lidocaine		14	2	0,442
25	Hydrochlorothiazide		12	2	0,367
26	Propyphenazone		11	2	0,446
27	Acide fenofibrique		11	2	0,400
28	Diazepam		10	2	0,471
29	Ketoprofen		8	2	0,400
30	Oxolinic acid		8	2	0,304
31	Oxcarbazepine		6	2	0,400
32	Perfluorotetradecanoic Acid	PFTeDA	4	2	0,350
33	Lincomycin		4	2	0,300
34	Benzotriazole		4	2	0,288
35	Trimethoprime		3	2	0,479
37	Bezafibrate		3	2	0,408
36	Metoprolol		3	2	0,408
38	Perfluorodecane Sulfonate	PFDS	3	2	0,400
39	Iothalamic acid		3	2	0,350
40	Progesterone		3	2	0,350
41	Fluoxetine		3	2	0,325
42	Cocaine		3	2	0,321
43	Iohexol		2	2	0,450
44	Propranolol		2	2	0,354
45	Gemfibrozil		2	2	0,267
46	ethyleendiaminetetra-azijnzuur (EDTA)		61	1	0,550
47	1H, 1H, 2H, 2H-Perfluorooctanesulfonic Acid	H4-PFOS (6:2 FTS)	31	1	0,250
48	Oxazepam		29	1	0,429
49	Crotamiton		27	1	0,600
50	Pentobarbital		27	1	0,425

Note that substances not monitored cannot be highly ranked in Table 4. For example substances with an elevated leaching potential (Column II) and/or elevated hazard score have to be taken into account separately. These substances will be assigned a higher rank according to their Integrated Groundwater Score (Table 3). Consequently both information – Integrated Groundwater Score and frequency of findings – must be taken into account in selecting substances for the GW Watch List. In the following chapter how the combination of this information could be put into practice and support the selection of substances for the Groundwater Watch List is discussed.

4. Final Selection of Substances for the "First Voluntary Groundwater Watch List"

Starting point for the selection of substances for the Voluntary Groundwater Watch List is List IV of the Watch List Concept. The sorting of list IV was modified to avoid overestimation of substances monitored at a few sites (Tab. 1). To select a limited number of substances (e.g. 15) further expert judgement is necessary. To support expert judgement, criteria mentioned above are taken into account combining the modified List IV with these criteria.

a. Selection of PFAS for the First Voluntary Groundwater Watch List

Top ranked PFAS according to the modified List IV are presented in Table 5 and substances frequently found in Groundwater are shown in Table 6.

Tab. 5: Top ranked PFAS in modified List IV. Chain length in brackets
(Substances common in Table 5 and 6 are marked in yellow)

List IV	Substance Name	Acronym	Monitoring data available	Integrated GW Score
1	**4:2 Fluortelomerphosphatemonoester (S)**	**4:2 monoPAP**	**no**	0,750
2	**Perfluorodecyl Phosphonic Acid (L)**	**PFDPA**	**no**	0,650
3	**Perfluorooctyl Phosphonic Acid (L)**	**PFOPA**	**no**	0,650
10	**Perfluoroundecanoic Acid (L)**	**PFUnA**	**yes**	0,600
11	**Perfluorododecanoic Acid (L)**	**PFDoA**	**yes**	0,600
14	**6:2 Fluortelomerphosphatemonoester (S)**	**6:2 monoPap**	**no**	0,550
16	**Perfluorohexadecanoic Acid (?)**	**PFHxDA**	**yes**	0,550
22	**Perfluorethylethanol 4:2 (S)**	**4:2 FTOH**	**no**	0,500
23	**Pentadecafluorooctanoic Acid Ammonium Salt (Ammonium Pentadecafluorooctanoate) (L)**	**APFO**	**no**	0,500
24	Perfluoropentadecanoic Acid (?)	PFPeDA	no	0,500
25	Perfluoropentane Sulfonic Acid (S)	PFPeS	no	0,500

Tab. 6: PFAS frequently found in Groundwater
(Substances common in Table 5 and 6 are marked in yellow)

Ranking: Findings	Substance Name	Acronym	No of sites with findings	MS/PC with findings	Integrated GW Score
2	**Perfluorododecanoic Acid**	**PFDoA**	**62**	**6**	**0,600**
3	**Perfluoroundecanoic Acid**	**PFUnA**	**39**	**6**	**0,600**
6	**Perfluorooctane Sulfonamide**	**PFOSA**	**22**	**5**	**0,375**
20	**Perfluoroheptane Sulfonate**	**PFHpS**	**77**	**2**	**0,475**
32	**Perfluorotetradecanoic Acid**	**PFTeDA**	**4**	**2**	**0,350**
38	**Perfluorodecane Sulfonate**	**PFDS**	**3**	**2**	**0,400**
47	**1H, 1H, 2H, 2H-Perfluorooctanesulfonic Acid**	**H4-PFOS (6:2 FTS)**	**31**	**1**	**0,250**

PFDoA and PFUnA are highly ranked in Table 5 due to their high Integrated Groundwater Score and high ranked in Table 6 because they are detected in 6 MS/PC.

After discussion, two PFAS components were selected for the GWWL:

1. Perfluorododecanoic Acid (PFDoA)
2. Perfluoroundecanoic Acid (PFUnA)

These two substances were selected because they were the most frequently found in groundwater and are not yet on the List Annex I/II.

There are four other substances which need information on the volumes used by industry and the availability of suitable analytical methods before a decision about a possible inclusion in the GWWL may be decided:

1. 4:2 Fluortelomerphosphatemonoester (4:2 monoPAP)
2. Perfluorodecyl Phosphonic Acid (PFDPA)
3. Perfluorodecyl Phosphonic Acid (PFOPA)
4. 6:2 Fluortelomerphosphatemonoester (6:2 monoPAP)

On the list, there are both short (4:2 monoPAP, 6:2 monoPAP) and long chain substances. 6:2 monoPAP is interesting because it is a replacement of PFOS/PFOA and a precursor as well. Depending on the outcome of further research, the extra substances could be added to the GWWL.

b. Selection of Pharmaceuticals for the First Voluntary Groundwater Watch List

Table 7 shows the 21 top ranked pharmaceuticals sorted according to the modified Integrated Groundwater Score (List IV). Table 8 shows the 21 top ranked pharmaceuticals sorted according to the frequency of findings (number of MS/PC and sites with findings).

Tab. 7: Top ranked Pharmaceuticals in modified **List IV**
Substances common in Table 7 and 8 are marked in yellow

List IV	Substance Name	Integrated GW Score
4	**Caffeine**	0,650
5	**Clopidol**	0,600
6	**Crotamiton**	0,600
7	**Ranitidine**	0,600
8	**Amidotrizoic acid**	0,600
9	**Sulfadiazine**	0,600
12	**Primidone**	0,588
13	**Sotalol**	0,567
15	**Ethyleendiaminetetra-azijnzuur (EDTA)**	0,550
17	**Ofloxacin**	0,550
18	**Atenolol**	0,550
19	**Paracetemol**	0,533
20	**Phenazone**	0,533
21	**Ciprofloxacin**	0,521

27	**Ifosfamide**	0,500
28	**Cyclophosphamide**	0,500
29	**Sulfamethazine**	0,500
30	**Iomeprol**	0,500
31	**Clotrimazole**	0,492
32	**Clofibric acid**	0,488
33	**Diclofenac**	0,488

Tab. 8: Top ranked Pharmaceuticals according to the number of MS/PC and sites with findings
Substances common in Table 7 and 8 are marked in yellow

Frequency of findings	Substance Name	Sites with findings	MS/PC with findings	Combinded Leaching Score (List III)	Integrated GW Score
1	**Ibuprofen**	50	7	0,625	0,458
4	**Clofibric acid**	46	5	0,675	0,488
5	**Diclofenac**	34	5	0,6	0,488
7	**Sulfadiazine**	11	5	0,825	0,600
8	**Paracetemol**	251	4	0,85	0,533
9	**Tramadol**	61	4	0,575	0,371
10	**Sotalol**	27	4	0,8	0,567
11	**Clarithromycin**	12	4	0,55	0,442
12	**Amidotrizoic acid**	64	3	0,6	0,600
13	**Phenazone**	40	3	0,775	0,533
14	**Iomeprol**	38	3	0,75	0,500
15	**Primidone**	32	3	0,8	0,588
16	**Sulfamethazine**	14	3	0,5	0,500
17	**Atenolol**	12	3	0,725	0,550
18	**Sulfadimidine**	8	3	0,6	0,467
19	**Caffeine**	237	2	0,65	0,650
21	**Metformine**	56	2	0,75	0,479
22	**Erythromycin**	25	2	0,45	0,450
23	**Gabapentin**	19	2	0,5	0,292
24	**Lidocaine**	14	2	0,55	0,442
25	**Hydrochlorothiazide**	12	2	0,4	0,367

After discussion, nine pharmaceuticals were selected for the GWWL. Specific pharmaceuticals and not a whole group of pharmaceuticals were selected. The procedure was to start with the pharmaceuticals with the highest Integrated Groundwater Scores (Table 7).
From the eight top scored substances, two pharmaceuticals (Caffeine and Ranitidine) were removed from the list because:

- Caffeine poses a potential low risk and Caffeine is not only used in pharmaceutical products,

- Ranitidine is high ranked in table 7 because of its high leaching potential. But the substance was monitored in four countries and detected at 2 sites in one country only.

Six pharmaceuticals remain: clopidol, crotamiton, amidotrizoic acid, sulfadiazine, primidone and sotalol.
In addition, three pharmaceuticals were selected from the top ranked pharmaceuticals, according to the number of MS/AC and sites with detections (Table 8). Ibuprofen was selected because it was found in most MS/AC (7). Clarithromycin and Erythromycin were selected because they are antibiotics and are part of the Surface Water Watch List. Attention to antibiotics is needed because antibiotic resistance is a threat to health and food security.

The final ranking of the nine selected pharmaceuticals is presented in Table 3.

Table 9: Pharmaceuticals selected for the GWWL

Pharmaceutical	**Top 10 ranked in modified Integrated Groundwater Score (list IV)**	**Top 25 ranked according to the number of MS/PC and sites with findings**	**Explanation IGS = Integrated Groundwater Score**
Clopidol	Yes	No	IGS = 0.6; most found pharmaceutical in recent studies in UK (behind carbamazepine)
Crotamiton	Yes	No	IGS = 0.6; analysed in only 1 MS, but found at all sites.
Amidotrizoic acid	Yes	Yes	IGS = 0.6; highly ranked on both lists
Sulfadiazine	Yes	Yes	IGS = 0.6; highly ranked on both lists
Primidone	Yes	Yes	IGS = 0.588; highly ranked on both lists
Sotalol	Yes	Yes	IGS = 0.567; highly ranked on both lists
Ibuprofen	No	Yes	IGS = 0.458; pharmaceutical found in most (7) MS/AC
Clarithromycin	No	Yes	IGS= 0.442; antibiotic mainly used for humans, found in 4 MS/AC. It is also part of the surface water WL.
Erythromycin	No	Yes	IGS= 0.450; antibiotic mainly used for animals, found in 2 MS/AC It is also part of the surface water WL.

c. Summary

Table 10 shows the 11 substances proposed for the first Voluntary Groundwater Watch List. MS/PC are asked to monitor these substances voluntarily and report the monitoring results to the Watch List group of the CIS Working Group Groundwater regularly using the agreed format. Monitoring results will be assessed, summarised and reported to MS/PC anonymised. The Watch List group will check which of these substances may be added to the List facilitating Annex I/II process of the GWD, will stay on the Watch List or be eliminated from the Watch List. As soon as sufficient information for the candidate substances in Table 10 are available, which substances are added to the Groundwater Watch List may be decided.

Tab. 10: List of substances proposed for the first Voluntary Groundwater Watch List

Substance Name	Group of substance	Acronym	Sub-group
Perfluorododecanoic Acid (L)	**PFAS**	**PFDoA**	**PFCAs**
Perfluoroundecanoic Acid (L)	**PFAS**	**PFUnA**	**PFCAs**
Clopidol	Pharmaceutical		
Crotamiton	Pharmaceutical		
Amidozoic Acid	Pharmaceutical		
Sulfadiazin	Pharmaceutical		
Primidone	Pharmaceutical		
Sotalol	Pharmaceutical		
Ibuprofen	Pharmaceutical		
Erythromycin	Pharmaceutical		
Clarithromycin	Pharmaceutical		
Further candidates			
4:2 Fluortelomerphosphatemonoester (S)	PFAS	**4:2 monoPAP**	**monoPAP**
Perfluorodecyl Phosphonic Acid (L)	PFAS	**PFDPA**	**PFPAs**
Perfluorooctyl Phosphonic Acid (L)	PFAS	**PFOPA**	**PFPAs**
6:2 Fluortelomerphosphatemonoester (S)	PFAS	**6:2 monoPap**	**monoPAP**