World Health Organization
Meetings on the Guidelines for Drinking-water Quality

Chemical Aspects Working Group Meeting
Chemical Aspects and Microbial Aspects Working Group Meeting
on Cross-cutting Issues
Microbial Aspects Working Group Meeting
and
Chemical Mixtures Meeting

2–5 December 2013
Geneva, Switzerland

Geneva, 2014
World Health Organization Meetings on the Guidelines for Drinking-water Quality

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## ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>ADI</td>
<td>acceptable daily intake</td>
</tr>
<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
</tr>
<tr>
<td>ARfD</td>
<td>acute reference dose</td>
</tr>
<tr>
<td>BDCM</td>
<td>bromodichloromethane</td>
</tr>
<tr>
<td>BMDL&lt;sub&gt;0.5&lt;/sub&gt;</td>
<td>lower 95% confidence limit on the benchmark dose for a 0.5% response</td>
</tr>
<tr>
<td>BMDL&lt;sub&gt;5&lt;/sub&gt;</td>
<td>lower 95% confidence limit on the benchmark dose for a 5% response</td>
</tr>
<tr>
<td>BMDL&lt;sub&gt;50&lt;/sub&gt;</td>
<td>lower 95% confidence limit on the benchmark dose for a 50% response</td>
</tr>
<tr>
<td>BTEX</td>
<td>benzene, toluene, ethylbenzene and xylenes</td>
</tr>
<tr>
<td>bw</td>
<td>body weight</td>
</tr>
<tr>
<td>CAS</td>
<td>Chemical Abstracts Service</td>
</tr>
<tr>
<td>CCL</td>
<td>Contaminant Candidate List (USA)</td>
</tr>
<tr>
<td>CICAD</td>
<td>Concise International Chemical Assessment Document (WHO)</td>
</tr>
<tr>
<td>CT</td>
<td>disinfectant concentration × contact time</td>
</tr>
<tr>
<td>DALY</td>
<td>disability-adjusted life year</td>
</tr>
<tr>
<td>DBP</td>
<td>disinfection by-product</td>
</tr>
<tr>
<td>DDT</td>
<td>dichlorodiphenyltrichloroethane</td>
</tr>
<tr>
<td>EFSA</td>
<td>European Food Safety Authority</td>
</tr>
<tr>
<td>EHC</td>
<td>Environmental Health Criteria monograph (WHO)</td>
</tr>
<tr>
<td>EU</td>
<td>European Union</td>
</tr>
<tr>
<td>FAO</td>
<td>Food and Agriculture Organization of the United Nations</td>
</tr>
<tr>
<td>GDWQ</td>
<td>Guidelines for Drinking-water Quality</td>
</tr>
<tr>
<td>GRADE</td>
<td>Grading of Recommendation Assessment, Development and Evaluation</td>
</tr>
<tr>
<td>GRG</td>
<td>Guidelines Review Committee (WHO)</td>
</tr>
<tr>
<td>GV</td>
<td>guideline value</td>
</tr>
<tr>
<td>HBV</td>
<td>health-based value</td>
</tr>
<tr>
<td>HWT</td>
<td>household water treatment</td>
</tr>
<tr>
<td>IEDI</td>
<td>international estimated daily intake</td>
</tr>
<tr>
<td>IEH</td>
<td>Institute of Environment and Health (Cranfield University)</td>
</tr>
<tr>
<td>INFOSAN</td>
<td>International Food Safety Authorities Network</td>
</tr>
<tr>
<td>IOM</td>
<td>Institute of Medicine (USA)</td>
</tr>
<tr>
<td>IPCS</td>
<td>International Programme on Chemical Safety (WHO)</td>
</tr>
<tr>
<td>IQ</td>
<td>intelligence quotient</td>
</tr>
<tr>
<td>IRIS</td>
<td>Integrated Risk Information System (USEPA)</td>
</tr>
<tr>
<td>ISO</td>
<td>International Organization for Standardization</td>
</tr>
<tr>
<td>IUPAC</td>
<td>International Union of Pure and Applied Chemistry</td>
</tr>
<tr>
<td>JECFA</td>
<td>Joint FAO/WHO Expert Committee on Food Additives</td>
</tr>
<tr>
<td>JMPR</td>
<td>Joint FAO/WHO Meeting on Pesticide Residues</td>
</tr>
<tr>
<td>KWR</td>
<td>Kiwa Water Research</td>
</tr>
<tr>
<td>LOAEL</td>
<td>lowest-observed-adverse-effect level</td>
</tr>
<tr>
<td>LRV</td>
<td>log&lt;sub&gt;10&lt;/sub&gt; reduction value</td>
</tr>
<tr>
<td>MCPA</td>
<td>2-methyl-4-chlorophenoxyacetic acid</td>
</tr>
<tr>
<td>MCR</td>
<td>maximum cumulative ratio</td>
</tr>
<tr>
<td>MRL</td>
<td>maximum residue level</td>
</tr>
<tr>
<td>NaDCC</td>
<td>sodium dichloroisocyanurate</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
</tr>
<tr>
<td>----------</td>
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</tr>
<tr>
<td>NDMA</td>
<td>N-nitrosodimethylamine</td>
</tr>
<tr>
<td>NOAEL</td>
<td>no-observed-adverse-effect level</td>
</tr>
<tr>
<td>NSF</td>
<td>NSF International</td>
</tr>
<tr>
<td>NTP</td>
<td>National Toxicology Program (USA)</td>
</tr>
<tr>
<td>NTU</td>
<td>nephelometric turbidity unit</td>
</tr>
<tr>
<td>OECD</td>
<td>Organisation for Economic Co-operation and Development</td>
</tr>
<tr>
<td>P&amp;C</td>
<td>prevention and control</td>
</tr>
<tr>
<td>P&amp;P</td>
<td>policies and procedures</td>
</tr>
<tr>
<td>PBPK</td>
<td>physiologically based pharmacokinetic</td>
</tr>
<tr>
<td>PCP</td>
<td>personal care product</td>
</tr>
<tr>
<td>PFOA</td>
<td>perfluorooctanoate</td>
</tr>
<tr>
<td>PFOS</td>
<td>perfluorooctane sulfonate</td>
</tr>
<tr>
<td>PHE</td>
<td>Department of Public Health, Environmental and Social Determinants of Health (WHO)</td>
</tr>
<tr>
<td>PICO</td>
<td>population, intervention, comparator, outcome</td>
</tr>
<tr>
<td>PMTDI</td>
<td>provisional maximum tolerable daily intake</td>
</tr>
<tr>
<td>POP</td>
<td>persistent organic pollutant</td>
</tr>
<tr>
<td>PTWI</td>
<td>provisional tolerable weekly intake</td>
</tr>
<tr>
<td>PUB</td>
<td>Public Utilities Board (Singapore)</td>
</tr>
<tr>
<td>QMRA</td>
<td>quantitative microbial risk assessment</td>
</tr>
<tr>
<td>RCT</td>
<td>randomized controlled trial</td>
</tr>
<tr>
<td>TDI</td>
<td>tolerable daily intake</td>
</tr>
<tr>
<td>THM</td>
<td>trihalomethane</td>
</tr>
<tr>
<td>TTC</td>
<td>threshold of toxicological concern</td>
</tr>
<tr>
<td>USEPA</td>
<td>United States Environmental Protection Agency</td>
</tr>
<tr>
<td>VOC</td>
<td>volatile organic carbon</td>
</tr>
<tr>
<td>WASH</td>
<td>water, sanitation and health</td>
</tr>
<tr>
<td>WG</td>
<td>working group</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
</tr>
<tr>
<td>WHOPES</td>
<td>World Health Organization Pesticides Evaluation Scheme</td>
</tr>
<tr>
<td>WSH</td>
<td>Water, Sanitation, Hygiene &amp; Health Programme (WHO)</td>
</tr>
<tr>
<td>WSP</td>
<td>water safety plan</td>
</tr>
<tr>
<td>YOPI</td>
<td>young, old, pregnant, immunodeficient</td>
</tr>
</tbody>
</table>
1. CHEMICAL ASPECTS WORKING GROUP MEETING

A World Health Organization (WHO) meeting of the Chemical Aspects Working Group on the Guidelines for Drinking-water Quality (GDWQ) was held in Geneva, Switzerland, from 2 to 4 December 2013. The Water, Sanitation, Hygiene & Health (WSH) Programme of WHO headquarters organized the meeting.

1.1 Background

A WHO Joint Expert Meeting on Water Quality and Health was held in Dübendorf, Switzerland, from 18 to 22 March 2013. Participants included WHO staff, representatives of the WHO regional offices and representatives of the expert groups responsible for preparing the WHO guidelines related to drinking-water, recreational water environments and the safe use of wastewater, excreta and greywater in agriculture and aquaculture.

The key purpose of the Dübendorf meeting was to promote the harmonization of the drinking-water guidelines, the recreational water guidelines and the wastewater guidelines and to develop a workplan leading to the publication of the three revised guidelines by 2020. The experts recognized the importance of harmonized water quality regulations based on health (i.e. health-based targets) and the concept of preventive health risk assessment and risk management (i.e. water safety plans [WSPs]). The key outputs of the Dübendorf meeting are being used as a guide to the future work on each of the WHO water quality guidelines.

This meeting will build on the outcomes of the Dübendorf meeting by bringing together experts to progress the workplan for the GDWQ. Technical discussion will progress the post–fourth edition workplan that was refined at the Dübendorf meeting, leading to the publication of the first addendum to the fourth edition of the GDWQ.

1.2 Objectives of the meeting

The objectives of the meeting were to:

- Review progress to date on post–fourth edition activities of the GDWQ, with a particular focus on updates needed for the first addendum of the fourth edition related to chemical aspects; and
- Determine next steps in developing the first addendum of the fourth edition of the GDWQ related to chemical aspects.

1.3 Participants

Sixteen participants attended the meeting, including staff from WHO headquarters and experts on chemical aspects related to drinking-water quality (hereafter referred to as the Chemical WG). A list of participants is given in Annex 1.
1.4 Organization of the meeting

The meeting consisted of a series of plenary sessions together with a few presentations. David Cunliffe chaired the meeting, and Marla Sheffer acted as rapporteur. The meeting was organized according to general themes, and the order of items presented in the agenda, attached as Annex 2, does not necessarily represent the order of items presented in this meeting report.

1.5 Opening session

Maria Neira, Director of the Department of Public Health, Environmental and Social Determinants of Health (PHE), of which the WSH unit is a part, welcomed participants to the meeting. Dr Neira recognizes that the GDWQ are one of the most important publications of WHO. Through the credibility of the GDWQ, WHO has been able to provide advice to national authorities. The ability to keep the GDWQ up to date and complete through addenda and new editions is also important. The GDWQ are part of the big picture in which it is important to address both social and environmental aspects of health. Health is not just treating diseases that have already occurred. Rather, we need to address public health by preventive risk assessment and risk management, to which this group’s contribution is fundamental. The capacity to convene a group consisting of the best experts from around the world to contribute to the GDWQ is also important. The group is not just providing advice to national authorities; it is also giving the message that access to clean water and sanitation is critical to ensuring a healthy population. Dr Neira is very pleased and grateful to have the meeting participants in Geneva. The group’s work will support changing of legislation, help to ensure that investments go in the right direction and improve the capacity of nations to contribute to public health. She concluded by noting that the experiences of this group will be useful for work on updating and adapting the WHO air quality guidelines, and she wished participants a successful meeting.

Bruce Gordon gave a brief history of the GDWQ, a flagship normative publication of WHO. The aim of the GDWQ is to protect public health. The target audience is primarily regulators, as well as water suppliers and practitioners. The approach to developing the GDWQ involves using the best available evidence (both scientific and practical); a risk–benefit philosophy; local adaptations to priorities for health gain in a social, cultural, economic and environmental context; the use of multiple barriers; and incremental improvement. The core recommendations are to establish national water quality standards on relevant waterborne hazards (health-based targets); undertake site-specific local risk assessment and management from catchment to consumer (WSPs); and verify water safety through independent tests and audits (independent surveillance). A key message is to shift the focus away from reacting to water quality test results or illness and towards preventing contamination (monitor control/production processes).

The chemical guideline values (GVs) constitute the clearest guidance to Member States and have a substantive influence on national drinking-water standards (over 100 countries have adopted the WHO GVs). However, there is a significant public perception issue, in that chapters 8 and 12 make up about half of the GDWQ. This could lead to the wrong impression about the importance of chemical compared with microbial issues, although it is
important to maintain the priority for chemicals causing large-scale effects through drinking-water exposure, such as arsenic and fluoride. Many chemical risk assessments date back 10 or 20 years, and there is a need to update the chemical aspects guidance with the latest scientific evidence and prevent the guidance from being misinterpreted. At the same time, there is a need to optimize our processes and prioritize this updating. Reducing the burden of (non-communicable) disease from waterborne chemicals such as arsenic and fluoride is within our reach and means.

Jennifer De France explained that the Dübendorf Water Quality and Health meeting on drinking-water, wastewater and recreational water included a lot of experts and covered a great deal of topics, leaving little time for detailed discussions on GDWQ-related issues. A GDWQ workplan was developed at the Dübendorf meeting, and we need to progress that workplan at this meeting. The meeting objective is to review progress to date and identify next steps on high-priority items post-fourth edition that are related to chemicals. This requires an evaluation of the latest scientific evidence, application of the Guidelines (e.g. it is not appropriate to set standards for all chemicals, and there is a need to help countries select priorities for monitoring), reflections on past work (e.g. is the template for background documents still appropriate for all chemicals?) and changes to the Policies and Procedures (P&P) Manual (changes to it have been initiated, and discussions at this meeting will require further updates to the manual). For each technical agenda item, we need to determine next steps, capturing what needs to be done, who is going to do it and within what time frame the work is to be carried out.

Expected outcomes of this meeting include an updated workplan on the GDWQ and recommendations to WHO on a way forward for background documents on pesticides and other chemicals, how to promote better understanding of GVs and health-based values (HBVs) by Member States and a list of priority contaminants to be reviewed.

In terms of the next steps for the overall GDWQ, a Guidelines Review Committee (GRC) planning proposal is to be submitted and a WHO Guideline Steering Group, Guideline Development Group (which is to replace the Drinking-water Quality Committee) and External Review Group will be established in 2014. The P&P manual will be updated to incorporate the development of the drinking-water, wastewater and recreational water guidelines and will be finalized in 2014, although input from the GRC will be needed before finalization. There will be a meeting with experts on microbial aspects of drinking-water quality (hereafter referred to as the Microbial WG) in June 2014 to coincide with Singapore International Water Week. The first addendum to the fourth edition will be published in 2015 (Q4), the second addendum to the fourth edition in 2017 (Q4) and the fifth edition in 2020 (Q4).

1.6 Declarations of interests

All experts participating in the meeting completed the WHO standard form for declaration of interests prior to the meeting. At the start of the meeting, all participants were asked to confirm their interests and to provide any additional information relevant to the subject matter of the meeting.
The following participant declared current or recent (within the past year) financial interests related to commercial organizations:

- **Joe Cotruvo**
  Personal consulting services to Coca Cola, Water Security Corporation, American Chemistry Council and Halosource, to the combined value of > US$ 10 000 per annum.

On the basis of these declared interests, no significant conflict was registered in relation to the objectives of the meeting considering the types of issues that were addressed.

### 1.7 Update on WHO activities

#### 1.7.1 Update from JMPR

**Philippe Verger** explained that the Codex Alimentarius Commission (hereafter referred to as Codex) establishes a list of priority pesticides from Member States. Codex then establishes a workplan for the Joint FAO/WHO Meeting on Pesticide Residues (JMPR) to evaluate the compounds on its priority list: both a toxicological evaluation (by WHO) and a residues evaluation (by the Food and Agriculture Organization of the United Nations [FAO]). These generally consist of new chemicals (8–10 per meeting); chemicals (2–4/meeting) for periodic re-evaluation (every 25 years or so), consisting of chemicals off patent either supported by the original manufacturer or not supported by the original manufacturer but supported by at least one Member State; and follow-up evaluations (> 20 per meeting), which are requests for new maximum residue levels (MRLs) in crops.

JMPR evaluates the toxicological data, including the significance of metabolites and degradates, establishes health-based guidance values, which are acceptable daily intakes (ADIs) and acute reference doses (ARfDs) for chronic and acute exposures, respectively, estimates chronic and acute dietary exposures and proposes MRLs, ensuring that dietary exposure is below the health-based guidance values. These MRLs are later formally adopted by Codex.

International estimated daily intakes (IEDIs) are assessed for each pesticide, expressed as a percentage of the ADI and calculated based on mean daily per capita consumption and median residues in crops (from residue trials, i.e. median concentration where pesticide is actually used).

Each JMPR meeting results in three publications: the JMPR report, the residue monographs (FAO) and the toxicological monographs (WHO). To date, Codex has adopted 3552 MRLs for 170 pesticide residues. The JMPR database of pesticides was launched this year ([http://apps.who.int/pesticide-residues-jmpr-database](http://apps.who.int/pesticide-residues-jmpr-database)), which makes it very easy to locate information on pesticides if they have been evaluated by JMPR. In the future, it would be useful to include GDWQ GVs (or HBVs) in the database, as well as the JMPR dietary exposure values.

Dr Verger provided the tentative list of priority pesticides for consideration at future meetings (2014 and 2015). The final list is known 9 months in advance of the meeting. A
A compound can be included on the priority list as a result of 1) a need from a country for trade issues (MRLs are recognized by the World Trade Organization) or 2) some other concern. The Chemical WG could propose the addition of compounds to the priority list of JMPR, through Dr Verger, if there is a health concern.

Companies do not pay for the evaluations by JMPR, as WHO cannot involve the private sector in standard setting. Instead, JMPR is supported by Member States. Companies send their dossiers, perform the toxicological studies and collect the residue data. JMPR receives the dossier, assigns a monographer and reviewer for each compound, drafts the monograph and establishes a tentative ADI and ARfD. The monograph is then sent to the company, excluding the ADI and ARfD, for its review of the data.

Dr Verger announced that he had provided the dietary exposure assessments for bentazone and diquat from this year’s JMPR to Jennifer De France.

1.7.2 Update from WHO Chemical Safety Team (including chromium)

Richard Brown explained that the PHE Chemical Safety Team at WHO provides advice in response to chemical emergencies and is involved in the harmonization of chemical risk assessment methodologies and the preparation of pesticide classification documents, International Chemical Safety Cards and chemical risk assessment documents (including Concise International Chemical Assessment Documents [CICADs] and Environmental Health Criteria monographs [EHCs]).

A CICAD on chromium(VI) compounds (CICAD 78) was originally prepared in 2007, and it was intended that the CICAD would provide information to the Chemical WG on the oral intake of chromium(VI). However, the document was not finalized because the CICAD expert group requested updates to take account of new studies being undertaken around that time, in particular relating to carcinogenicity via the oral route (including United States National Toxicology Program [NTP] studies). Owing to the combination of a recruitment freeze at WHO and controversy over the carcinogenic risk of chromium(VI) via the oral route (which led to a number of additional studies being commissioned), the document remained unfinished. Dr Brown convened a consultative group meeting in late 2010, at which it was recognized that work on the oral carcinogenicity of chromium(VI) was still ongoing and the controversy was unlikely to be resolved in the short term. As the purpose of CICADs is to summarize existing national or regional evaluations and no up-to-date product existed addressing the oral carcinogenicity of chromium(VI), the decision was taken not attempt to address the new material in the CICAD. A literature review cut-off date of 2009 was maintained, and the CICAD was finalized. Although the key occupational risk of chromium(VI) compounds (via inhalation) was addressed, the CICAD was not useful to the Chemical WG in terms of oral intake of chromium(VI). This unsatisfactory outcome (with respect to drinking-water quality) could be addressed by a future update of the CICAD when the ongoing studies have been completed and a scientific consensus is achieved on the risk of cancer via the oral route. However, this would depend on funding being made available for this purpose, as no CICAD work is currently being undertaken.
Other work being carried out by the PHE Chemical Safety Team includes an ongoing brief to look at dichlorodiphenyltrichloroethane (DDT) on behalf of the Stockholm Convention on Persistent Organic Pollutants (POPs) and work on mercury and chrysotile asbestos. In relation to the Chemical WG, activities on harmonized chemical risk assessment methodologies, chemical mixtures, evaluating and communicating uncertainty in hazard and exposure assessment, risk assessment terminology and identifying important life stages for risk assessment are areas of recent interest.

Dr Brown noted that if the Chemical WG wants an international assessment to be done on a specific chemical, then this could potentially be accommodated (if the need was identified as a priority), subject to resources being made available.

The WHO Chemical Risk Assessment Network was launched in 2013, with a goal to improve chemical risk assessment globally through facilitating interaction between institutions on chemical risk assessment issues and activities. The Network is initially focusing on activities in capacity building and training, risk assessment methodology and identification of research priorities. The WHO Secretariat is currently accepting applications from institutions wanting to become Network participants. Involvement can be at different levels, ranging from joining a roster of expertise available for peer review to joining a steering group for developing risk assessment methodologies.

In terms of the work on chemical mixtures in drinking-water and source water, the WHO/International Programme on Chemical Safety (IPCS) framework for risk assessment of combined exposures to multiple chemicals is the starting point for the work of the chemical mixtures group, which will be meeting later in the week; there is also an overlap in membership between the two groups. The framework includes some case-studies, and ongoing work is developing more case-studies to illustrate the use of and to refine the framework. The best way to publish those case-studies is currently under discussion. The Organisation for Economic Co-operation and Development (OECD) has been involved in the development and promotion of the framework (it co-sponsored the initial workshop with WHO), and several case-studies have been developed through OECD.

Jennifer De France will make Dr Brown’s slide presentation available to the Chemical WG.

1.7.3 Update from JECFA (including inorganic mercury)

On behalf of Angelika Tritscher, Philippe Verger explained that the areas of work of the Joint FAO/WHO Expert Committee on Food Additives (JECFA) include the safety evaluation of food additives, processing aids, flavouring agents, contaminants, natural toxins and residues of veterinary drugs, through three Codex committees (Codex Committee on Contaminants in Foods, Codex Committee on Food Additives and Codex Committee on Residues of Veterinary Drugs in Foods). As with JMPR, work is done jointly with FAO, which develops specifications and analytical methods, provides residue definitions and establishes MRLs for veterinary drug residues and maximum limits for food additives.

Outputs of each JECFA meeting include a meeting report, FAO specifications monographs and WHO toxicological monographs. A searchable JECFA database is now available.
JECFA work feeds into the Codex standard-setting process, national food legislation, capacity-building programmes, the International Food Safety Authorities Network (INFOSAN) for rapid risk assessment, as well as the WHO drinking-water guidelines, the WHO Pesticides Evaluation Scheme (WHOPES) and Children’s Environmental Health.

JECFA assessments that may be of interest to the Chemical WG include those on several heavy metals (arsenic in 2011, cadmium in 2010, lead in 2011, methylmercury in 2007 and inorganic mercury in 2011), as well as acrylamide (2011), polycyclic aromatic hydrocarbons (2006), nitrate and nitrite (2002), acidified sodium chlorite (2007) and cyanide (2011). Dietary exposure assessments are done for JECFA, as for JMPR, but in a less systematic way, as they depend on data submissions.

A substantial JECFA task for the future is non-dioxin-like polychlorinated biphenyls (for 2015).

It is very important to maintain the link between the Chemical WG and JECFA, even though the Chemical WG may not in all cases agree with the conclusions of JECFA.

1.8 Plan of work

Each agenda item was discussed in detail, and a summary of the discussions as well as next steps were recorded for each. The agenda items have been numbered consecutively in this meeting report; the numbers do not bear any relation to the numbers of agenda items in previous meeting reports on the GDWQ.


Background: The document Policies and procedures used in updating the WHO Guidelines for Drinking-water Quality describes the process through which the GDWQ are developed and revised. The purpose of both the process and document is to maintain the relevance, quality, credibility and integrity of the GDWQ, while ensuring their continuing development in response to new, or newly appreciated, information and challenges. The manual should provide more detailed guidance than the outline of processes and procedures contained in the GDWQ. The manual will undergo continuous revision and updating to reflect current protocols.

Suggested changes to the P&P manual:

- The new template for the pesticide background documents needs to be included. It should be explained that the new format will be used whenever pesticides are being re-evaluated or new pesticides are being assessed.
- HBVs need to be defined and differentiated clearly from GVs, and it should be explained why HBVs are being derived for pesticides instead of GVs. This will include a clear rationale for withdrawing GVs for pesticides from the GDWQ. This will also necessitate a change to the criteria for deriving GVs, and taking into consideration recommendations for the POPs.
• It should be noted that HBVs, rather than formal GVs, are derived for non-pesticide chemicals for a variety of reasons: for example, if the HBV far exceeds concentrations that will in most cases give rise to acceptability problems (as for monochlorobenzene), if the HBV is lower than the limit for practical analytical achievability or treatment performance, resulting in the establishment of a provisional GV (as for bromate), if the HBV exceeds levels desirable for treatment performance reasons (as for aluminium) or if the chemical is unlikely to occur in drinking-water at levels of health concern (as for cyanogen chloride).

• When deriving a GV or a HBV based on the upper bound of a JECFA or JMPR ADI, the GV or HBV should actually be derived based on the unrounded no-observed-adverse-effect level (NOAEL) or lowest-observed-adverse-effect level (LOAEL) on which that ADI was based (in other words, the upper bound of the ADI will change from 0.2, for example, when derived from a NOAEL of 15 using an uncertainty factor of 100, to 0.15 for the purposes of calculating the GV or HBV). The GV or HBV for the GDWQ will be rounded at the final step only. This will need to be clearly explained in the guideline derivation section.

• When using default allocation factors, it is important to provide supporting information on dietary exposure, when available. For pesticides, the IEDI is provided as a percentage of the upper bound of the ADI, and this should be included in each short pesticide background document (with reference to the JMPR report, as this information is included only in the JMPR report, not in the JMPR toxicological monograph).

• The JMPR database (http://apps.who.int/pesticide-residues-jmpr-database) can be referenced in each short pesticide background document, as it will link the reader to the appropriate toxicological monograph.

• When preparing background documents, a statement needs to be added that the literature was searched up to a specific cut-off date.

• Background documents based on JMPR or JECFA evaluations can be shorter than is normally the case, with references including the original JMPR or JECFA evaluation as well as the sources of any information that is not derived from the original evaluation. High-quality peer-reviewed national reviews can also be used as the basis for short-form background documents, with appropriate referencing.

• The various types of documents now being produced should be clearly explained: summary statements or fact sheets in chapter 12 of the GDWQ, short background documents for pesticides (based on JMPR evaluations), and longer background documents for other chemicals (unless based on a JECFA evaluation, in which case these can be shorter as well).

• The revised template for the chemical background documents should be included in the manual.

• There is a need to be internally consistent with respect to the allocation factors applied when deriving GVs or HBVs for POPs (generally 1% was used, but there are some inconsistencies). The Chemical WG will need to come to a decision on this in order to ensure consistency in the GDWQ. In addition, the need to derive GVs (rather than HBVs) for chemicals listed on the Stockholm Convention or the Rotterdam Convention needs to be confirmed. Changes to the P&P manual will be needed once decisions on these issues have been made.
• In most circumstances, allocation factors will range from 20% to 80% (default allocation factors are 20% for chemicals for which drinking-water is not the main exposure route and 80% for chemicals for which drinking-water is the main exposure route).
• There is a need to incorporate text in the P&P manual on deriving GVs based on acute effects (e.g. nickel, copper).

Next steps:
• **Phil Callan** will revise the P&P manual according to the above suggestions.

#2. Pesticide background documents

**Background:** The usual process of preparing large background documents is becoming an onerous task. As JMPR evaluations are used for preparing background documents on pesticides, there is little point in duplicating that process. Rather than preparing a full background document and evaluation, a shorter background document could be developed instead, which includes the derivation of an HBV (not a formal GV). In this way, pesticides could be dealt with more quickly, and the list could be added to when needed.

**Summary of discussion:**
• The Chemical WG agreed to the new format of short pesticide background documents with the derivation of HBVs. The template for these documents is discussed under agenda item #4.
• These short background documents (not to be called “fact sheets”, to avoid confusion with the fact sheets in chapter 12 of the GDWQ) are to replace the current longer technical background documents that are posted on the WHO website.
• These short background documents will be summarized even further for the fact sheets (also called “summary statements”) in chapter 12 of the GDWQ.
• In chapter 12 of the GDWQ, the summary statements or fact sheets on pesticides could be grouped together and preceded by a few paragraphs of explanation (similar to what was done for pesticides used for vector control in drinking-water), explaining what HBVs mean and how they are to be used, emphasizing that HBVs should never be used as a target to pollute, but concentrations should be kept as low as is reasonably practicable, etc.
• The new format of documents needs to be formalized in the P&P manual.

**Next steps:**
• The **Chemical WG** will prepare short background documents for pesticides as each pesticide evaluation is revised based on a JMPR evaluation.
• **Phil Callan** will formalize the new format of documents in the P&P manual.

#3. Withdrawal of guideline values, including for pesticides

**Background:** GVs, HBVs and “aesthetic” or “acceptability” values have been misunderstood by some Member States. Withdrawing GVs for pesticides may help to alleviate some of the confusion around GVs and HBVs, if it is well explained. The underlying issue for the Member States is the massive number of chemicals they have to deal with. There is a need to move away from the current approach, or it will not be possible to provide the appropriate level
of advice. The way to move forward is to improve the way in which chemical guidelines are presented to Member States and to help them determine how to select what goes into their standards, emphasizing the need to monitor and enforce the appropriate standards for their particular situation or jurisdiction. It makes sense to take all pesticides out of the list of GVs and identify HBVs for them instead. Member States would then need to select only those pesticides of relevance to them.

Summary of discussion:

- The terminology being used is very confusing, with guideline values, health-based values, “aesthetic” or “acceptability” values (this terminology is not actually used, but it is inferred in chapter 10 of the GDWQ) and guidance levels (for radiation) in the GDWQ, as well as guidance values (e.g. GV) and health-based guidance values (e.g. ADI) from EHC 240.
- Most countries do not understand the difference between GVs and HBVs. The Chemical WG assumed that formal GVs would be more apt to be incorporated into national standards, but this is not necessarily the case.
- There is a need for very clear language in the GDWQ as to why there are different types of values and how national authorities should apply them.
- Perhaps the GDWQ should go even farther and focus only on those pervasive chemicals for which there is a concern about drinking-water in a number of locations (e.g. arsenic, fluoride, nitrate, uranium); for all other chemicals, HBVs could be derived, and the individual Member States would have the responsibility to follow up on chemicals of particular concern to them.
- The Chemical WG recommended that GVs should be withdrawn for all pesticides, taking into consideration recommendations for the POPs. Decisions on withdrawal of GVs for other chemicals should be made on a case-by-case basis.
- It should be remembered that this withdrawal of GVs for pesticides will need to be reflected in text changes throughout the GDWQ for the fifth edition.
- It is noted that the term HBV may also be used for other reasons, such as when the GV needs to be technically or analytically achievable (i.e. the GV is higher than the HBV).
- A smaller working group needs to be convened to discuss broader issues, including the following:
  - whether these shorter background documents with HBVs should be used for all chemicals, not just pesticides (except for those for which drinking-water exposure is a significant risk factor, such as arsenic, fluoride, nitrate, uranium);
  - whether any of these pesticides actually belong to the group in Table 8.11 (Chemicals from agricultural activities excluded from guideline value derivation) because they are unlikely to occur in drinking-water and hence should be dropped from the GDWQ altogether;
  - what to do with the treatment and analytical method annexes for the fifth edition (e.g. it may be better to move away from chemical-specific information, as it gets out of date quickly, and give information on standard analytical methods or types of treatment that can be used for specific chemical groups or classes);
  - is the right information being communicated? (feedback from the WHO regional offices and other users is needed to answer this question);
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- the need to include more remarks about the application of the Guidelines for those people who use only the tables (perhaps section 8.5.3 on chemicals from agricultural activities could be expanded with guidance on how to deal with pesticides in drinking-water);
- terminology to be used for various types of values (and how to make sure they are not misinterpreted);
- the need to identify further research needs to provide support for grant applications by researchers.

Various options need to be developed and presented to the WHO regional offices so that they can circulate them to Member States for feedback. The Chemical WG will then be able to make final decisions on some of these issues.

Next steps:
- The Secretariat in consultation with others will develop a way forward and circulate it to the Chemical WG for comment.

#4. Overview of updated template for pesticide background documents

Background: A proposed template for the new short pesticide background documents was prepared for review by the Chemical WG.

Summary of discussion:
- Sufficient information on the occurrence of a pesticide in water is needed to determine whether the pesticide occurs at levels that are close to or above the HBV. However, many occurrence data are unpublished, which makes them difficult to find.
- Analytical methods given in the current longer background documents are sometimes poor, old, non-robust methods. In addition, many Member States do not have up-to-date analytical capabilities. The analytical section should be scrapped, or it should refer to standardized methods only (and provide the source of the methods).
- It is not useful to give precise values for analytical or treatment achievability, as what is achievable this year may be exceeded next year as technologies improve.
- A treatment table containing qualitative information about the appropriate types of technologies to be used for certain types of chemicals would be useful.
- It is important to include some information on treatment and analysis even for pesticides with HBVs, because Member States may wish to incorporate the HBVs into their national standards and will need access to such information.
- It is important to remember that the criteria for developing a GV (as outlined in section 8.2 of the GDWQ) are 1) credible evidence for occurrence in drinking-water combined with evidence of potential or actual toxicity, 2) of significant international concern (e.g. listed on Stockholm Convention on POPs) or 3) included (or considered for inclusion) in the WHOPES list of pesticides for public health, including those applied directly to drinking-water to control insect vectors of disease.
- It is important to include acute values (i.e. HBVs based on the ARfDs from the JMPR evaluations) for use in spill situations (if such ARfDs are available).
- It is important to include metabolites (where applicable), as they are sometimes more toxic than the parent compound.
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- Sub-bullets should be added to the template for the short pesticide background documents to explain what sorts of information should be included in each section.

**Suggested changes:**

- International Organization for Standardization (ISO) and International Union of Pure and Applied Chemistry (IUPAC) names and the Chemical Abstracts Service (CAS) registry number should be provided.
- The “Environmental fate” and “Occurrence in water and food” sections should be combined into a new section entitled “Potential for occurrence in water”, which will include pathways that may lead to the pesticide’s entry into water, formation of transformation products, quantitative information on half-lives, etc., if available, a statement regarding how likely it is that the pesticide will enter water and a general statement about the pesticide’s occurrence in water, as occurrence can vary widely globally (typical and maximum concentrations from broad studies in several countries can be given, if available).
- The “Toxicity” section should include information on metabolites, if applicable; a very short summary of the JMPR ADI, including the end-point on which it is based, with reference to the JMPR toxicological monograph, plus a short statement on the availability of an ARfD (if applicable) for use in spill situations (or a statement that JMPR did not find it necessary to derive an ARfD).
- The “Derivation of the health-based value” (not “guidance value”) section is to include a derivation of the HBV, together with the assumptions used, including a discussion of the allocation factor chosen and a note about how much dietary exposure contributes to the ADI from the JMPR report; a clear explanation is needed in the case of deviation from the default allocation factor of 20% for pesticides. The default allocation factor of 20% should be used when there is insufficient information on exposure from other environmental media (e.g. air, soil).
- The “Analysis in water” section is to include a general statement as to whether it is or is not possible to analyse the pesticide down to the level of the HBV using a standardized method (e.g. a United States Environmental Protection Agency [USEPA] method or Standard Methods for the Examination of Water and Wastewater from the American Water Works Association/American Public Works Association/Water Environment Federation).
- The “Treatment” section is to include by-products produced by treatment, if relevant, and a statement that it is or is not possible to reduce the pesticide concentration to the HBV by treatment processes, with an indication of the type of process that may be used (e.g. biological, oxidation, carbon).
- A new “Considerations in applying the health-based value” section should be added. It will include source control and seasonal variation (if applicable), advice regarding monitoring (e.g. monitor only if the pesticide is used, there is no need to monitor volatiles in surface water), what to do in case of short-term exceedance, guidance on when it is appropriate to include values in national standards, etc.
- All information is to be referenced (the toxicity section will reference the JMPR toxicological monograph, available through the JMPR database), as this will be the only referenced background document.
Next steps:
- The Chemical WG will use the revised template for the new short pesticide background documents (see Annex 3 for the final template).

#5. MCPA

Background: The background document on 2-methyl-4-chlorophenoxyacetic acid (MCPA) from 2003 (which used a 10% allocation factor) was revised by Health Canada in 2011, but it was never finalized or published, as JMPR evaluated MCPA in 2012 and established an ADI (of 0–0.1 mg/kg body weight [bw]) that would change the HBV for MCPA. It was suggested that MCPA should be added to the list of pesticides, based on JMPR evaluations, for which short background documents will be provided.

Summary of discussion:
- The “Environmental fate” information in the new “Potential for occurrence in water” section could be condensed.
- The dietary exposure assessment from JMPR should be used to determine the margin between exposure from food and the ADI. This can provide reassurance that the default allocation factor used for drinking-water is reasonable. For MCPA, up to 1% of the upper bound of the ADI comes from food.
- There was some discussion as to whether the low dietary exposure meant that an 80% allocation to drinking-water could be allowed. However, drinking-water should not be the major source of exposure to pesticides used for agricultural purposes, and the HBV is not permission to pollute to that value. Furthermore, the default value should be 20%, because there is not enough information to alter it (as information on all other potential sources of exposure is lacking).
- Occurrence data from several countries are preferred to single occurrence data, but these data should be referenced. A large gap between occurrence levels and the HBV is reassuring. The phrase “significant minority” needs to be changed.
- The short background document needs to be thoroughly referenced, as it is to replace the longer background document.
- The background document should state that an ARfD of 0.6 mg/kg bw has been established, which might be useful in the event of a spill (the reader can refer back to the JMPR toxicological monograph, for which a link will be provided in the background document, for more information).
- A statement should be added that the pesticide seems to have a high potential to end up in drinking-water, but occurrence data seem to show otherwise.
- Information should be included on half-lives, which can be found in the Health Canada publication.
- It was suggested that a statement be added in the section “Considerations in applying the HBV” to the effect that if the pesticide is not being used in the region, it should not be monitored. This statement, of course, is a general one that applies to all chemicals and should be made in the GDWQ itself.
- It should be noted in the section “Considerations in applying the HBV” that the margin between occurrence levels and the HBV suggests that it is of little concern in drinking-water (“occurs in drinking water at levels well below those of health concern”).
• The “Analysis in water” section should note that analytical methods are available to quantify MCPA well below the HBV (and provide a standard method, e.g. the USEPA has a reporting limit of X mg/L using method Y). The draft background document prepared by Health Canada can be used as a starting point.

• The section on “Source control” is to be moved into the “Considerations in applying the HBV” section.

• A “Treatment” section needs to be added, indicating that treatment methods are available to reduce the concentration of MCPA to below the HBV (giving examples of the types of methods that could be used).

• The statement on field studies in the third paragraph of the “Environmental fate” section needs to be deleted, as it conflicts with the conclusion on mobility.

• **Peter Marsden and Michèle Giddings** revised the draft background document to incorporate all of the above comments and to follow the revised template, for immediate feedback from the group. The new draft was circulated to Chemical WG members for their comments, which included the following:
  - The 0–1% contribution to the upper bound of the ADI from dietary exposure needs to be added.
  - Types of treatment processes that can remove MCPA from water need to be added.
  - A concluding statement (to be moved from the “Derivation” section) needs to be added.
  - The ADI text from the JMPR toxicological monograph needs to be reduced.
  - A disclaimer about the cut-off date for the literature search should be added (a decision on whether this is necessary should be made on a case-by-case basis).
  - The original background document and the draft document prepared by Health Canada should be reviewed to determine the original references. John Fawell could also be contacted, as he prepared the background document reviewed at the meeting.

**Expected product(s):** Revised background document and summary statement (first addendum)

**Next steps (Chemical WG):**

• **Peter Marsden** will revise the short background document on MCPA, taking the above comments into consideration, by the end of December 2013.

• The revised background document will be sent to **Phil Callan** and **Jennifer De France**, who will send it to the Chemical WG for comments.

• Following incorporation of Chemical WG comments, the document will be posted on the web for public review.

• A summary statement will be prepared from the final background document. The format of the summary statement still needs to be determined.

**#6. Bentazone**

**Background:** The current background document (and summary statement) for bentazone needs to be updated according to a recent JMPR evaluation and changed to the new shorter background document format.
Summary of discussion:
- The term “detection limit” should be used, even if the practical quantification limit is more important, as it is less confusing to the reader.
- The same approach used to revise the MCPA document (see agenda item #5) should be used.
- In the new “Potential for occurrence in water” section, it should be stated that the pesticide has a high propensity to reach water, but occurrence data appear to suggest otherwise.
- Quantitative data (e.g. half-lives in soil) are preferable to qualitative information, but they should be summarized.
- The “Toxicity” section should be reduced to include only the most recent JMPR evaluation.
- In the “Treatment” section, it should be stated that bentazone is difficult to remove by activated carbon. It could be added that laboratory studies have shown oxidative processes to be effective. It is just as important to state what is unknown as what is known, in terms of treatment processes.
- The JMPR report states that dietary exposure (IEDI) contributes 0% to the upper bound of the ADI.
- A statement that JMPR considered that an ARfD was not necessary should be added.

Expected product(s): Revised background document and summary statement (first addendum)

Next steps (Chemical WG):
- Detailed comments on the background document should be sent to Yoshihiko Matsui, copied to Phil Callan and Jennifer De France.
- Yoshihiko Matsui will revise the background document to incorporate the above comments (and any additional comments received) by the end of December 2013.
- The revised background document will be sent to Phil Callan and Jennifer De France, who will send it to the Chemical WG for comments.
- Following incorporation of Chemical WG comments, the next stage will be posting on the web for public review.
- A summary statement will be prepared from the final background document. The format of the summary statement still needs to be determined.

#7. Diquat

Background: The current background document (and summary statement) for diquat needs to be updated according to a recent JMPR evaluation and changed to the new shorter background document format.

Summary of discussion:
- The ISO and IUPAC names, but not the CAS name, should be given (as in the JMPR toxicological evaluation), as well as the CAS registry number.
It is important to know whether average occurrence levels include only detected values. The statement “Limited data suggest that concentrations in water are low” can be used in the absence of additional information.

The “Toxicity” section needs to be reduced, and the ADI of 0–0.006 mg diquat ion/kg bw should be referred to as established (not re-established).

A statement to the effect that “An ARfD of 0.8 mg/kg bw is available in case of a spill” should be added.

The “Analysis in water” section needs to be amended to note that analytical methods are available to quantify diquat well below the HBV (and to give referenced standard method examples).

The contribution of dietary exposure to the upper bound of the ADI is 0–4% (from the JMPR report). This needs to be added to the “Derivation of the HBV” section.

For treatment, a statement regarding the availability of treatment processes to remove diquat to the HBV needs to be added. If no information is available (as no treatment information was included in previous background documents), a statement to this effect should be made.

Expected product(s): Revised background document and summary statement (first addendum)

Next steps (Chemical WG):

- Yoshihiko Matsui will revise the background document to incorporate the above comments by the end of December 2013.
- The document will be sent to Phil Callan and Jennifer De France, who will send it to the Chemical WG for comments.
- Following incorporation of Chemical WG comments, the next stage will be posting on the web for public review.
- A summary statement will be prepared from the final background document. The format of the summary statement still needs to be determined.

#8. Dicofol

Background: A short background document on dicofol was prepared for the second addendum to the third edition. Review comments received required a substantial effort to address, and the background document was never completed. Dicofol was added to the list of shorter background documents for pesticides to be prepared based on a recent (2011) JMPR evaluation.

Summary of discussion:

- The allocation factor needs to be changed from 10% to the new default allocation factor of 20%.
- Dietary exposure to dicofol contributes 1–30% of the upper bound of the ADI of 0–0.002 mg/kg bw (from the JMPR report).
- Similar changes to those suggested above for the other pesticide documents (e.g. reducing the detail provided in the “Toxicity” section) should be made to this background document.
• In the “Derivation of the HBV” section, the statement “Health-based values should never be used as a target to pollute to, but concentrations should be kept as low as is reasonably practical” should be removed, as this is a general statement that should be added to the appropriate section of the GDWQ.

• It is noted that dicofol is proposed for listing on the Stockholm Convention on POPs. If it is accepted for listing, the Chemical WG may need to reconsider the default factor used and derive a GV instead of an HBV, according to the P&P manual.

Expected product(s): New background document and summary statement (first addendum)

Next steps (Chemical WG):
• **Peter Marsden** will revise the background document to incorporate the above comments by the end of December 2013.
• The document will be sent to **Phil Callan** and **Jennifer De France**, who will send it to the Chemical WG for comments.
• Following incorporation of Chemical WG comments, the next stage will be posting on the web for public review.
• A summary statement will be prepared from the final background document. The format of the summary statement still needs to be determined.

#9. Dichlorvos

Background: A short background document on dichlorvos was prepared for the second addendum to the third edition. Review comments received required a substantial effort to address, and the background document was not completed. Dichlorvos was added to the list of shorter background documents for pesticides to be prepared based on a recent JMPR evaluation.

Summary of discussion:
• It is important to consider inhalation, as dichlorvos is a volatile compound used in domestic settings.
• There is a European Union (EU) standard analytical method.
• The contribution to the upper bound of the ADI (of 0–0.004 mg/kg bw) from dietary exposure is 5–30%.
• A concentration of 0.8 g/L in drinking-water has been measured in Japan.

Expected product(s): New background document and summary statement (first addendum)

Next steps (Chemical WG):
• **Shane Snyder** will revise the background document based on the above comments.
• The document will be sent to **Phil Callan** and **Jennifer De France**, who will circulate it to the Chemical WG for comments.
• Following incorporation of Chemical WG comments, the next stage will be posting on the web for public review.
• A summary statement will be prepared from the final background document. The format of the summary statement still needs to be determined.
#10. Prioritizing existing GDWQ pesticides for review, including aldrin, dieldrin and DDT

**Background:** It has been suggested that aldrin, dieldrin and DDT need to be removed from the list of pesticides in the GDWQ since they have very low solubility, they are used for other purposes and there is a significant decline in their use. Their GVs have a 1% allocation to drinking-water, which seems quite excessive due to decreasing exposure.

**Summary of discussion:**
- These three pesticides are listed under the Stockholm Convention on POPs. According to the P&P manual, GVs need to be derived for chemicals listed under the Stockholm Convention (see criteria for developing a GV on p. 158 of the GDWQ, one of which is “of significant international concern”).
- These pesticides are banned in most countries but are still being used in some countries and are still being detected, as they are very persistent in the environment.
- Allocation factors of 1% are used for aldrin and dieldrin and DDT, and it is stated that these are very conservative allocation factors due to the reduction in levels in food.
- The Chemical WG agreed to keep GVs for aldrin/dieldrin and DDT, given that they are still being used and because of their persistence.
- The Chemical WG agreed to leave the background documents and summary statements for these pesticides as they are for now. In the future, however, the background documents may be revised to give more emphasis to the fact that these pesticides are POPs and to explain that the allocation factor is 1% because they are POPs and that, according to the Convention, either they should not be used (aldrin and dieldrin) or the limited permitted use should not lead to contamination of drinking-water (use of DDT in indoor residual spraying for disease vector control). Alternatively, the Chemical WG may consider increasing the allocation factor from 1% to 10%, but not to 20%, because of their persistence and the potential for bioaccumulation.

**Expected product(s):** No change (for now) to background documents and summary statements for aldrin/dieldrin and DDT

**Next steps (Chemical WG):**
- The Chemical WG needs to look at all pesticides that are POPs or likely to be POPs and reconsider the allocation factors given to them, as a priority. At present, the GDWQ are internally inconsistent; for example, lindane uses a 1% allocation factor, but endrin uses an allocation factor of 10%.
- The Secretariat needs to develop a way forward on this issue, as the Chemical WG did not come to a conclusion during the meeting on this priority item.
- If the background document on DDT is revised in future, EHC 241 (“DDT in Indoor Residual Spraying: Human Health Aspects”) should be taken into consideration.

#11. Japanese priority pesticides

**Background:** The capability of testing for pesticides in developing countries is limited. There is a need to ask Member States what pesticides are being used (along with field data on concentrations in water sources) and if there is a need for HBVs for certain pesticides. It would also be useful to develop an occurrence database for pesticides. As 500 pesticides are
used on rice paddies in Japan, it was decided to match the list of the top 100 pesticides used on rice paddies (prioritized in terms of amounts used, information that is not available for all developing countries) with JMPR evaluations and to prepare short background documents with HBVs for those pesticides identified in this manner.

Summary of discussion:

- Of the pesticides listed in Table 8.13 in the GDWQ (Guideline values for chemicals from agricultural activities that are of health significance in drinking-water) and of significance to Japan, bentazon, dicofol and diquat have already been discussed at this meeting. The criteria for prioritizing additional pesticides were as follows: the JMPR review includes an ADI, widespread use, high frequency of detection (monitoring data) or predicted high frequency of detection (risk ranking).
- Carbofuran was last assessed in 1998, and JMPR reviewed it in 2008 and established a different ADI. There is therefore a need to revise the WHO background document. In Japan, carbofuran is not a popular pesticide, but it has a high frequency of detection.
- Fipronil has no background document or GV, but there is a JMPR evaluation (2000) with an ADI of 0–0.0002 mg/kg bw. This pesticide has the third highest frequency of detection in Japan (with a maximum concentration of 0.15 μg/L). It should be included in the next revision of the GDWQ, as its frequency of detection is very high worldwide.
- Fenitrothion has an HBV of 8 μg/L using an allocation factor of 5%. Its sales are ranked 7th in Japan, with a high frequency of detection (1.6% out of total samples) and a maximum concentration of 33 μg/L. A 2007 JMPR evaluation is available, which provides an ADI of 0–0.006 mg/kg bw.
- Bromobutide and molinate have the 1st and 2nd highest frequencies of detection in Japan; there is no JMPR evaluation for either one of them, and there is no GV for bromobutide, but a GV for molinate does exist (using a 10% allocation factor).
- In 2013, the Japanese government published a procedure for selecting pesticides for inclusion in its drinking-water quality guidelines.
- Phil Callan has put together a table listing all chemicals in the GDWQ, including the pesticides, with background documents and the most recent publications cited in those background documents.
- Short-term priorities are the Japanese pesticides and POPs; longer term, the Chemical WG can look at pesticides with different allocation factors and consider revising them as necessary.
- Those Japanese pesticides with JMPR reports could be updated relatively easily (especially those already in the GDWQ).

Expected product(s): Revised background documents and summary statements for carbofuran and fenitrothion (possibly first addendum); new background documents for fipronil and possibly bromobutide and molinate (time frame unknown)

Next steps (Chemical WG):

- Jennifer De France will ask Philippe Verger to consider adding bromobutide and molinate to the JMPR priority list, although this could take a long time to accomplish.
- The current background documents (and summary statements) for carbofuran and fenitrothion could easily be updated according to recent JMPR evaluations and changed
to the new shorter background document format. If these pesticides are identified as a priority by the Chemical WG, authors for these revisions will be identified.

- **Phil Callan** will send an updated list of pesticides (and other chemicals) with background documents and the most recent publications cited in those background documents, together with the availability of recent JMPR or JECFA evaluations, to the Chemical WG. The Chemical WG will prioritize all chemicals on this list for evaluation. If the Japanese pesticides are given a high priority by the Chemical WG, a way forward will be determined. Fipronil should be included on this list for prioritization, although it is not currently in the GDWQ, as a JMPR document is available.

- Post-meeting note: Philippe Verger informed Jennifer De France that Dr Matsui or another focal point should go through the Codex contact point in Japan to push the Japanese priorities. The two pesticides bromobutide and molinate are not currently in the Codex system, so public health and/or toxicological arguments and not only occurrence arguments are needed for them to be added to the priority list of Codex.

#12. Allocation factors, including for pesticides

**Background:** The use of allocation factors for deriving GVs for pesticides (and other chemicals) in the GDWQ has been inconsistent in the past. A paper in support of the range of allocation factors typically used in the GDWQ has recently been published.

**Summary of discussion:**

- A paper by Krishnan and Carrier (2013) supports default allocation factors with a range from 20% to 80% (e.g. for disinfection by-products [DBPs]).
- Several participants expressed their agreement with the range proposed in this paper and the rationale behind the range.
- Allocation factors add another safety factor to something that already has a safety factor built in, and there is no real strong scientific basis to support this.
- The Chemical WG agreed to continue to adopt the 20–80% range. If this range is varied, there needs to be a clear explanation for why this was done, and there need to be robust data to support this action.
- The GDWQ actually states that the default allocation factor can be as low as 1%, but there is a difference between rationalizing our own allocation factors and giving advice to Member countries about allocation factors that they can use (this is a crossover between risk assessment and risk management).
- Yoshihiko Matsui has published a paper on allocation factors for chloroform (inhalation and ingestion), which might be helpful in our discussions.
- If the Chemical WG decides to use 1% for POPs (which is not done consistently at present), the sentence on p. 164 of the GDWQ will need to be revised. In addition, there are chemicals that are POPs and not pesticides, which will also need to be taken into consideration.
- The criteria for the Chemical WG to follow for the progressive change from the old default allocation factor of 10% to the newer default value of 20% need to be outlined (e.g. whenever a recent JMPR assessment is available, the background document will be revised and the allocation factor will be changed).
Expected product(s): Revised text for the allocation factors section of the GDWQ (first addendum)

Next steps (Chemical WG):
- The Chemical WG did not make any final decisions on what allocation factor to use for POPs. The Secretariat needs to determine a way forward so that the allocation factor text can be revised for the first addendum.
- The final decision on allocation factors for POPs will need to be reflected in the P&P manual (Phil Callan).
- A reference to the Krishnan and Carter (2013) paper for the allocation factor range of 20–80% should be added to the GDWQ by the fifth edition.

#13. Data gaps in the GDWQ

Background: In order to derive a GV to protect human health, it is necessary to select the most suitable study or studies. Data from well conducted studies, where a clear dose–response relationship has been demonstrated, are preferred. Where the database is incomplete and there is a high degree of uncertainty in the toxicological and health data, provisional GVs have been established. In other cases, where there are inadequate or insufficient data, it has not been possible to derive GVs at all.

Many of the GDWQ background documents were developed in 2003 or earlier, so recent toxicological data have not been considered. In addition, occurrence data are lacking for many chemicals. Finally, speciation effects on the bioavailability of essential elements are a concern. As WHO wants to review these issues more systematically, it commissioned WCA Environment Ltd to perform a systematic literature review of a select group of 29 chemicals from the GDWQ.

Presentation by Owen Green (WCA Environment Ltd):
The scope of this project was to perform a preliminary assessment of the gaps in the evidence base to support the potential derivation or update of guidelines for 29 substances: some with provisional GVs (1,2-dibromoethane, dichloroacetonitrile, 1,2-dichloropropane, epichlorohydrin, pentachlorophenol, trichloroethene and uranium), some with no established GVs (bromochloroacetate, bromochloroacetonitrile, 2-chlorophenol, chloropicrin, dibromoacetate, 1,1-dichloroacetone, 1,3-dichloroacetone, dichloramine, 1,3-dichlorobenzene, 1,1-dichloroethene, 2,4-dichlorophenol, 1,3-dichloropropane, monobromoacetate, trichloramine and trichloroacetonitrile), some that are essential elements (selenium, iron, molybdenum, copper and manganese), as well as arsenic and fluoride. The terms of reference were split into two stages. The first stage was to conduct a literature review to identify relevant articles that need to be reviewed to determine gaps related to the 29 chemicals. Only about 40% of stage 1 has been completed, due to time and budgetary constraints. The second stage related to the review of the relevant articles identified in the literature search, providing comments on the overall quality of the evidence used to derive GVs and identifying major gaps in the research or evidence base that would prevent the establishment of GVs or reduce the quality of existing GVs.
To date, a complete literature search and identification of relevant references (screening) for 12 chemicals have been done; for 12 more, the literature search has been completed (results downloaded and formatted in Excel spreadsheets), but the references have not yet been screened; and for 5 chemicals (copper, manganese, iron, arsenic, fluoride), the literature search has been done, but the database is so large that the search needs to be modified before it can be completed. For stage 1, WCA conducted literature searches (on mammalian and human toxicity and occurrence), screened the results to identify potentially relevant studies, confirmed which studies needed to be reviewed, and conducted a preliminary assessment on whether significant new data are available that would justify revisiting the guidelines. The literature search was conducted on references published 1 year before the last publication reviewed in the reports to ensure that intervening studies were captured (unless a more recent toxicological review from a reputable organization was available).

Databases searched included Toxline, PubMed and Thomson Innovation (which goes back only 10 years). The literature search strategy was to use the CAS name, common name or synonyms: if there were more than 1000 hits, detailed search strings were added to reduce the number; if there were fewer than 1000 hits, the screening process was initiated. Some problems were encountered; for example, some searches resulted in hits above the download limit of the database; and the use of synonyms in search terms sometimes generated too many additional hits. If the number of hits was too high, searches were split by years, and terms in strings were divided to make two shorter strings.

Results have been downloaded and formatted into Excel spreadsheets. Results for each database were combined, and all results for all databases were combined and the duplicates removed. The combined results were screened to identify relevant studies using the following relevance criteria: for toxicology – relevant test species, human studies, relevant route of administration, relevant test design and relevant in vitro studies; and for exposure – occurrence in water and infant formula, bioavailability, solubility and availability in food. There were a relatively small number of references related to exposure.

The stage 1 output on a chemical-by-chemical basis was shown, together with a WCA preliminary rating as to whether, based on the number of abstracts with relevant titles, there are sufficient published reviews to progress to the next stage of evaluating the evidence for each identified substance; however, for the first 12 substances, 357 references would need to be obtained (which is very costly), and the current contract has since ended.

**Summary of discussion:**

- Essential elements were included in the terms of reference as a result of discussions at the Dübendorf meeting.
- Fluoride was included because of high public interest, and the USA is currently considering an HBV for fluoride. There are many new studies on dental and skeletal fluorosis, intelligence quotient (IQ), etc., that need to be evaluated, but some of the studies are of poor quality.
- Arsenic is of high public health concern. JECFA withdrew the provisional tolerable weekly intake (PTWI) for arsenic because the existing PTWI was very close to the lower 95% confidence limit on the benchmark dose for a 0.5% response (BMDL0.5) calculated from
epidemiological studies and was therefore no longer appropriate. There is an Integrated Risk Information System (IRIS) assessment due out in the USA in 2014, and Health Canada has conducted a biomonitoring study. The arsenic HBV was based on cancer, but the GV is provisional, as it is treatment based. Even if the HBV ends up being based on some other end-point (e.g. cardiovascular effects), it will not affect the GV, which will still be based on feasibility.

- Health Canada has recently reviewed selenium, so selenium was dropped from the WCA list of chemicals.
- Health Canada and the USEPA are both doing work on manganese.
- The USEPA conducts reviews of existing drinking-water standards every 6 years. This process is called “Six-year review”. The literature search for the last review of 70 chemicals was conducted up to about 2008, and some of the chemicals are the same as the ones on the WCA list. This is a screening-level, not an exhaustive, review. All of the chemicals designated as “provisional” on the WCA list are included in the USEPA review. The last review was completed in 2010, and the next cycle is expected in the 2016 timeframe. The USEPA evaluates unregulated chemicals every 5 years and announces the prioritization findings in the Contaminant Candidate List (CCL). The CCL3 was announced in 2009. The USEPA chooses five chemicals from the CCL for decisions on whether to regulate. Some work is ongoing on PFOS/PFOA, molybdenum, NDMA and bromide (from hydrofracturing). The manganese standard is also being revisited, and IQ changes are being looked at more closely.
- Every 3–4 years, for all chemicals that have a guideline (aesthetic or health based), as well as contaminants of emerging concern or that have been identified by stakeholders (i.e. provinces and territories) as being of possible concern, Health Canada hires a consultant to review and identify major new toxicological studies as well as what other jurisdictions are doing in order to identify the top 20 chemicals for guideline/guidance development. The top 10 priorities identified also get a treatment achievability review. The top 20 are ranked, and Health Canada does a full assessment on 5–7 chemicals per year, depending on the availability of staff. Some of the chemicals planned for evaluation include manganese, arsenic, chromium(VI) and trihalomethanes (THMs); the evaluation of selenium has been completed, and the evaluation of benzo(a)pyrene is in the public consultation phase.
- In the United Kingdom, there is no national rolling programme of review of standards. Instead, standards are established by the EU and reviewed every 5 years. These standards can be more politically than science based. In 2011, the EU decided not to change any of the existing standards, as it considered that they are based on best available knowledge or the precautionary principle. However, the EU continues to scrutinize the latest scientific and technical developments and will act where necessary. In addition, the EU is reviewing the provisions that relate to monitoring and performance methods. Most national standards in the United Kingdom are based on aesthetics, and guidance is issued on an ad hoc basis (e.g. N-nitrosodimethylamine [NDMA], perfluorooctane sulfonate [PFOS]/perfluorooctanoate [PFOA]). The United Kingdom is also looking at nitrogenous DBPs, manganese solubility, chromium(VI) in drinking-water, perchlorate and molybdenum. The WHO Regional Office for Europe is closely involved in the EU deliberations on the Drinking Water Directive and the introduction of the WSP approach.
• In Australia, chemicals are reviewed on submission. The National Health and Medical Research Council coordinates the reviews in a rolling revision, but the actual work is done by volunteers. The focus has been risk management plans and operational monitoring, moving away from verification (end-point) monitoring. There has been very little exceedance of existing guidelines for surface waters and some exceedances in groundwaters for arsenic, fluoride, nitrates/nitrites and uranium. There is a review of the science of DBPs, based on THMs, but there is a mismatch between likely health effects (bladder cancer) and THMs, as THMs do not cause bladder cancer, and they may not even indicate DBPs that do cause bladder cancer. Australia has developed a framework for emerging chemicals (as part of the potable reuse guidelines). There is a low level of concern that some of the Australian drinking-water guidelines are old, but they are based heavily on the WHO guidelines. Australia produced fact sheets on more than 100 pesticides, but this raised concern that utilities had to measure them, distracting them from the main focus of microbiological quality.

• Japan has a rolling revision process for its drinking-water guidelines and has some candidate chemicals to be reviewed for standards. There is no general process for toxicity evaluation, although any toxicology evaluations conducted by the Japan Food Safety Commission are considered, so it is important to get toxicological information from other national authorities, such as Health Canada or the USEPA. Fluoride is one of the chemicals under consideration.

• Some of the chemicals can be removed from the list because they do not persist in water, are not found at relevant concentrations in water or are managed operationally. There is a need to go through this list to see whether any of them can be removed from the GDWQ entirely.

• There was considerable discussion as to whether there was a need to further consider some of the chemicals on the WCA list (provided above). For example, it was suggested that there was no need to further consider epichlorohydrin (as it is used in a coagulation polymer, and concentrations in drinking-water are controlled by limiting the epichlorohydrin content of the polyamine flocculant or the dose used, or both), dichloramine and trichloramine (both of which are unstable), 1,3-dichlorobenzene, 2-chlorophenol and 2,4-dichlorophenol (which have low taste and odour thresholds), copper (as the GV is based on acute effects, and the issue is generally due to corrosion) and uranium (as it was recently revised in the fourth edition, and it is unlikely that there will be new data to consider). Others suggested that there was no need to further consider occurrence data for uranium, trichloroethene, selenium and epichlorohydrin, but that toxicological data on these compounds could be looked at.

• It would be beneficial if the experts reviewed these lists in detail post-meeting and provided feedback on which chemicals required further consideration and the rationale behind each suggestion.

• WCA could look at occurrence data in the literature retrieved for the chemicals with provisional GVs on the list. Work on these could continue as toxicological reviews are completed by other nations (e.g. all chemicals with provisional GVs are included in the next 6-year review by the USEPA around 2016, and the USEPA has standards for all except dichloroacetonitrile). However, it is important to identify the priority chemicals before such work is carried out.
**Expected product(s):** A summary of relevant evidence/literature that needs to be considered during the development of the next background documents and HBVs/GVs for these chemicals

**Next steps (Chemical WG):**

- **Jennifer De France** will circulate the list of chemicals in Table A3.2 that have no GVs because of inadequate data as well as the chemicals with provisional GVs in Table A3.3 (see Annex 4) to WHO regional offices and ask them to get feedback from Member States on two questions: 1) Do these chemicals occur in drinking-water supplies in your country, and, if so, do you have any monitoring (occurrence) data? and 2) Have these chemicals been raised as a concern in your region? (It should be emphasized that WHO does not want the Member States to go out and get monitoring data to answer the first question.)
- At the same time, the **Chemical WG** can provide feedback on the list of chemicals and inform the Secretariat as to what chemicals their organizations are planning to review in the near future.
- Manganese will be added to the list of chemicals for which occurrence data will be requested from Member States (see Annex 4). The background document on manganese will be revised once the Health Canada evaluation has been completed (see agenda item #21).

## #14. Identifying background documents that need updating

**Background:** Phil Callan prepared a list of GDWQ background documents, including the latest date of the key references cited in those background documents. Seventy-five percent of the background documents are about 10 years old. This list should help in the identification of background documents that need updating.

**Expected product(s):** Priority list of chemicals for updating

**Summary of discussion:**

- The Chemical WG noted that consideration should be given to updating the background documents on mercury and cyanide based on the recent JECFA assessments (as mentioned in Philippe Verger’s presentation; see section 1.7.3).

**Next steps (Chemical WG):**

- **Phil Callan** will update the list of GDWQ background documents, to correct a few errors and to add recent WHO evaluations (e.g. JECFA, JMPR, IPCS), and send it to the Chemical WG electronically.
- The **Chemical WG** is asked to rank these chemicals (including the Japanese priority pesticides in agenda item #11 and the WCA chemicals in agenda item #13) to determine priorities for review. Experts should also indicate which chemicals are currently being looked at or will be looked at by their respective organizations in the near future.
#15. Review of background document structure and content

Background: Under what circumstances should full background documents be developed? Should the current structure of the background documents be updated? There is a need to provide guidance on identifying chemicals that are always important (e.g. nitrate/nitrite) compared with those at the other end of the spectrum. This is a very important exercise, as readily accessible information is needed.

Summary of discussion:

- Is it necessary to retain full-length background documents for non-pesticide chemicals, or should chemicals be treated the same way as pesticides, with reference to the review on which the WHO evaluation is based (whether JECFA or Health Canada or otherwise)?
- The same background document format is needed for all non-pesticide chemicals, regardless of the type of review on which the background document is based. In other words, the same headings in the template should be used for all documents, but the amount of information provided under those headings can vary according to the review document on which the WHO evaluation is based. If there is a single review on which the background document is based, the amount of information provided can be reduced, and the other document can be referred to for more detailed information.
- It is important to remember that the Chemical WG may use the point of departure from national reviews, but it does its own derivation of the GV, using its own assumptions (e.g. body weight, drinking-water consumption, allocation factor).
- If there are several reviews available, the Chemical WG needs to decide which review to use in developing the background document.
- The “Guideline value” heading is used when a GV is actually derived; where no GV is derived, the “Conclusions” heading is used.
- A new heading is “Assessment of the quality of evidence”, which reflects the GRC requirement to do a full assessment of the quality of the body of evidence (to be reported as very low, low, moderate or high). A session on grading the evidence will be held later in the meeting (see agenda item #34). It is probably not necessary to add such a heading to the template for the short pesticide background documents, as they are based on JMPR documents, which should already have assessed the quality of the evidence for the toxicological evaluation.
- Should gaps in research be included? This could be helpful to researchers in their grant applications.
- A “Mode of action” heading should be added to the template and included in the background document if applicable.

Expected product(s): Revised template for chemical background documents

Next steps (Chemical WG):

- Phil Callan will revise the template for background documents to reflect the suggestions made and recirculate it to the Chemical WG (see Annex 5).
#16. Barium

**Background:** The GV for barium (0.7 mg/L) is based on an epidemiological study in which no adverse effects were observed, although the study population was relatively small and the power of the study was limited. As a consequence, an uncertainty factor of 10 was applied to the level of barium in the drinking-water of the study population. However, the level at which effects would be seen may be significantly higher than this concentration, so the GV for barium may be highly conservative, and the margin of safety is likely to be high.

The USEPA (IRIS) evaluated barium in 2005 and derived a reference dose (tolerable daily intake [TDI]) based on a chronic study in mice and using an additional uncertainty factor of 3 to account for database limitations. The need to revise the WHO GV based on the chronic mouse study needs to be discussed.

**Summary of discussion:**
- The first issue is to decide which study to use: the epidemiological study or the mouse study.
- The second issue is to decide on the allocation factor.
- Based on a BMDL₀₅ (the lower 95% confidence limit on the benchmark dose for a 5% response) for the increased incidence of nephropathy in male mice chronically exposed to barium chloride, and application of a 300-fold uncertainty factor (10 for interspecies variation, 10 for intraspecies variability and 3 for database limitations), together with a 20% allocation factor, a proposed GV of 1.2 mg/L (rounded to 1) was recommended by the Chemical WG.

**Expected product(s):** Revised background document and summary statement (first addendum)

**Next steps (Chemical WG):**
- **Santhini Ramasamy** will revise the background document on barium (using the new template for chemical background documents) reflecting the above decisions by March 2014. **Marla Sheffer** will send Santhini Ramasamy a Word version of the current background document.
- The revised background document will then be circulated to the Chemical WG for comment.
- Following Chemical WG review, the background document will be sent out for peer review, then public review.
- A revised summary statement will be prepared based on the final background document.

#17. Nitrate/nitrite

**Background:** The Health Canada drinking-water guideline on nitrate/nitrite has been revised. The nitrate GV stays the same, but it is based on available studies in humans that show no adverse health effects (either methaemoglobinaemia or thyroid effects) in bottle-fed infants below the GV, rather than only on methaemoglobinaemia, as previously. The nitrite GV is still based on methaemoglobinaemia (there are inadequate data on the association between methaemoglobinaemia and infantile diarrhoea) in bottle-fed infants.
Current science suggests an association between cancer and exposure to nitrates in drinking-water when conditions result in nitrosation within the human body (i.e. endogenous formation). More epidemiological studies are needed, because people are being exposed to nitrite (and other chemicals) through diet, for example, but are not necessarily getting cancer as a result. There is a need to revise the WHO background document and corresponding summary statement based on the recent Health Canada evaluation.

**Summary of discussion:**

- Nitrosation in the gut is a minimal source of nitrosamines. It occurs in the bloodstream due to circulating nitric oxide. Endogenous formation of nitrosamines leads to a relative source allocation in which water is the smallest source of exposure. The explanation in the background document needs to be revised to reflect this.
- It is difficult to attribute thyroid risk to nitrate, as the risk is due to total exposure to anions. The bigger issue is trying to deal with these anions (e.g. nitrate, perchlorate, chlorate) in isolation.
- The GV conclusion is fine, but it should take into account the NOAEL for acute effects.
- Some mention of the formation of nitrite from nitrate with ultraviolet treatment should be made.
- The last statement under Additional considerations (“The occurrence of nitrite in the distribution system as a consequence of chloramine use will be intermittent, and average exposures over time should not exceed about 0.2 mg/L”) in the summary statement in chapter 12 needs to be considered for possible deletion, as there is no health basis for the statement.
- Health Canada does not have the personnel to update the treatment section in the WHO document, but this can be done by the Prevention and Control (P&C) WG based on the treatment sections in the Health Canada Guideline Technical Document.
- The major risk from nitrate exposure is to users of private water supplies, and advice for private water supplies should be provided in the revised background document.

**Expected product(s):** Revised background document and summary statement (first addendum)

**Next steps (Chemical WG & P&C WG):**

- **Joe Cotruvo** will provide his comments to the Health Canada group that is preparing the WHO background document.
- **Michèle Giddings** will send the treatment sections of the Health Canada evaluation to the P&C WG with a request for them to update the treatment section in the WHO background document using the new Health Canada information.
- Health Canada will revise the WHO background document by March/April 2014. **Marla Sheffer** will send a Word version of the current background document to **Michèle Giddings**.
- The background document will be sent out first for Chemical WG review and then for peer and public review.
- The **Secretariat** will ask for additional exposure data when the background document is circulated for comments.
- The summary statement will be revised based on the final background document.
#18. Organotins

**Background:** At present, there is a background document on dialkyltins, which states that no GV can be derived because there are insufficient data. A European Food Safety Authority (EFSA) assessment on organotins was completed in 2004, which established a group TDI for four organotins (dibutyltin, tributyltin, triphenyltin and di-n-octyltin), and a CICAD on monosubstituted and disubstituted methyltin, butyltin and octyltin compounds was published in 2006, which established medium-term exposure TDIs (because no reliable lifetime TDI values could be derived). The WHO background document on dialkyltins may need to be updated based on one or both of these assessments.

**Summary of discussion:**
- The first issue is to decide which organotins should be evaluated in the GDWQ.
- The second issue is to decide whether GVs are necessary or whether concentrations are so low (where the organotins are detected at all) that they are well below the levels that would be of health concern.
- Another issue to be discussed is whether the EFSA method of a group TDI is an appropriate approach.
- Dialkyltins in pipes leach into water for a period of months only, so this is not a chronic exposure issue.
- Leaching of dialkyltins from pipes is not an issue in Canada or the USA, as it is covered by the certification of pipe materials under NSF/ANSI Standard 61 of NSF International (NSF) and the American National Standards Institute (ANSI).
- There are not many occurrence data on organotins in drinking-water, and it would be useful to obtain any such data from Member States.
- As the background document currently states that there are not sufficient data to establish a GV, but there have been recent international toxicological evaluations (CICAD, EFSA), the background document needs to be revised accordingly.
- As monoalkyltins and dialkyltins occur in drinking-water at very low levels and evaluations are now available with which to derive HBVs, the background documents can conclude that levels in drinking-water are much lower than levels that are of health concern (i.e. HBVs).
- Tributyltin is found in surface water from its use in antifouling paints, but it is not expected to be found in drinking-water because it partitions to sediments and therefore is removed by the removal of particulate matter during drinking-water treatment. For tributyltins, if there are no occurrence data, the conclusion may be that there is no need to derive a GV.
- Do revised background documents need to be held back until publication of the first addendum (especially if the GV has changed), or can they be posted online in advance?

**Expected product(s):** Revised background document and summary statement (first addendum)

**Next steps (Chemical WG):**
- Jennifer De France will add organotins to the list of chemicals to go out to Member States for requests for occurrence data (see Annex 4).
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- Akihiko Hirose will revise the current background document to take the above comments into consideration. The document will be expanded to include all organotins (monoalkyltins, dialkyltins and trialkyltins). Both the CICAD and EFSA evaluations will need to be used, as only the EFSA group TDI includes tributyltins.
- Marla Sheffer will send a Word version of the current background document to Akihiko Hirose.
- Akihiko Hirose also needs to check the literature to see if there are any toxicological reviews published after the CICAD was published in 2006.
- The background document will be prepared by March/April 2014. It will be circulated first to the Chemical WG for comments, then for peer and public review.
- The summary statement will be revised based on the final background document.

#19. Nickel

**Background:** The GV of 0.07 mg/L was established for nickel based on a LOAEL of 12 μg/kg bw for cutaneous reactions to oral nickel exposure in fasted nickel-sensitive patients. No uncertainty factor was used to derive the TDI, and an allocation factor of 20% was applied to calculate the GV. In Japan, the Food Safety Commission established a TDI of 4 μg/kg bw using the same study but applying an uncertainty factor of 3. If the Japanese default allocation factor of 10% is applied to the new TDI, the drinking-water GV would be 0.01 mg/L, which may be too strict for risk management, especially for the management of nickel leaching from faucets. The Japanese Committee on Drinking Water Quality therefore established a GV of 0.02 mg/L, the current regulatory value used by most authorities in the EU and USA. Based on exposure patterns, it may be necessary to revisit the allocation factor used in the derivation of the WHO GV for nickel.

**Summary of discussion:**
- WHO and the Japanese have used the same study to derive the TDI, but the Japanese used an uncertainty factor of 3, whereas WHO used no uncertainty factor. The justification for the use of no uncertainty factor was that patients were fasted, and absorption from drinking-water on an empty stomach is much higher than absorption from food.
- Another concern is that the WHO GV is based on a LOAEL for an acute effect. It was not considered necessary to include an uncertainty factor for the use of a LOAEL rather than a NOAEL because the LOAEL was based on a highly sensitive human population. Guidance on deriving GVs based on an acute effect is needed.
- Levels in drinking-water are much lower than levels in food, but absorption from food is low.
- It may be difficult to deviate from the default allocation factor given the many uncertainties in the existing exposure database.
- After consultation with John Fawell, it was agreed that there was a need to review the nickel background document to take into consideration the acute LOAEL (for a concentration-dependent effect) on which the GV is based, the allocation factor (based on exposure) and possibly the uncertainty factor used (normally an additional uncertainty factor is applied for use of a LOAEL instead of a NOAEL). A robust evaluation needs to be undertaken.
• There is a need to incorporate text in the P&P manual on deriving GVs based on acute effects (e.g. nickel, copper).

**Expected product(s):** Revised background document and summary statement (time frame unknown)

**Next steps (Chemical WG):**

- **Akihiko Hirose** in consultation with **John Fawell** will prepare a revised background document for review by the Chemical WG. **Marla Sheffer** will send a Word version of the current background document to **Akihiko Hirose**.
- **Shane Snyder** is to provide input on appropriate analytical methods.
- The next step will be peer review of the revised background document, followed by public review.
- A revised summary statement will be prepared based on the final background document.
- **Phil Callan** will incorporate text in the P&P manual on deriving GVs based on acute effects (e.g. nickel, copper).

**#20. Sodium**

**Background:** Sodium is included in the GDWQ, but no GV was established, as it is not of health concern at levels generally found in drinking-water. Sodium-based water softeners are increasingly being used, and a significant amount of sodium can be released from the water softeners at certain water hardnesses. The background document needs to be updated to reflect concern about sodium from water softeners (there is currently one sentence on water softeners in the background document), especially for people on private wells using these devices. There is also a need to develop a note to address blood pressure for high-risk populations (and to show that the contribution from drinking-water is not relevant). The Institute of Medicine (IOM) in the USA has recently (2013) examined the associations between sodium intake and direct health outcomes, finding that there is not sufficient evidence to support treating population subgroups (e.g. individuals with hypertension) differently from the general population in the USA. WHO also published a guideline on sodium intake for adults and children in 2012.

**Summary of discussion:**

- The summary statement states that concentrations of sodium in drinking-water are typically less than 20 mg/L. This “typical” value may no longer be appropriate (the USA and Australia have “typical” concentrations higher than this).
- Both the summary statement and the background document include statements on water softeners, and it is not clear what else is needed, if anything.
- There is a need to update the whole background document (and summary statement) to incorporate more occurrence data and the IOM- and WHO-recommended sodium intakes. The guideline statement “Not of health concern at levels found in drinking-water” will not change.
- It was suggested that the background document include a recommendation that those on sodium-restricted diets (e.g. patients with hypertension) should not use sodium-based water softeners. However, this needs to be reconciled with the IOM conclusion...
that there is not sufficient evidence to support treating population subgroups differently from the general population.

**Expected product(s): Revised background document and summary statement (time frame unknown)**

**Next steps (Chemical WG):**
- Sodium is included on the list of background documents (prepared by Phil Callan) that need to be updated. The priority of this activity is not high (i.e. not for first addendum). The Chemical WG will prioritize the entire group of chemicals, including sodium, on the list prepared by Phil Callan.
- When the sodium background document is to be revised, a lead author will be identified.

**#21. Manganese**

**Background:** The manganese GV was withdrawn in the fourth edition, and an HBV of 0.4 mg/L was established. There is confusion in some Member States as to why the GV was withdrawn and also about the difference between a GV and an HBV. Studies have come out indicating that manganese is a problem in drinking-water. Health Canada is funding a 3-year epidemiological study that follows up on the 2010–2011 study of manganese in groundwater in Quebec, which showed cognitive issues in school-aged children related to manganese intake.

**Summary of discussion:**
- There is a lot of concern from developing countries about WHO withdrawing its GV for manganese because it is present at high levels in solution in some community groundwater supplies.
- There is an internal inconsistency in the GDWQ: on p. 387, it states that a GV for manganese is not necessary because it is “Not of health concern at levels found in drinking-water”, whereas on p. 471, it states that manganese is “Not of health concern at levels causing acceptability problems in drinking-water”. The latter statement is more correct, especially considering the high levels of manganese that have been found in drinking-water sources.
- Some revisions to the text of the summary statement were suggested, but the Chemical WG decided to wait for the Health Canada study to be completed (by September 2014) before revising the manganese background document and summary statement.

**Expected product(s): Revised line of text on p. 387 (first addendum); revised background document and summary statement (second addendum)**

**Next steps (Chemical WG):**
- **Phil Callan** will ensure that the text on p. 387 is replaced with the text on p. 471 for the first addendum.
- The Chemical WG agreed to wait for the Health Canada study to be completed before revising the manganese background document.
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- Manganese has been added to the list of chemicals for which occurrence data from Member States are being requested (see Annex 4).
- In the meantime, if Member States express concern about manganese, WHO will explain that the scientific basis of the manganese HBV is under review and that the review is expected to be complete in time for the second addendum.

#22. BDCM

Background: Bromodichloromethane (BDCM) was considered to be a carcinogen in the fourth edition, although it was noted in the summary statement that a recent (2006) NTP study concluded that BDCM was not carcinogenic under the test conditions. The NTP study was not evaluated in the background document on THMs because it was not published until after the background document had been published (in 2005). Health Canada has withdrawn its BDCM guideline, which was based on carcinogenesis. There is a need to revise the background document and guideline for BDCM (as part of the THMs background document) and to consider whether a TDI for BDCM should be developed based on a non-carcinogenic end-point.

Summary of discussion:
- The background document should be updated based on the chronic NTP bioassay with a NOAEL that could be used as the basis for calculating a new GV, if it is decided to base the GV on a non-carcinogenic end-point.
- The whole THMs background document would need to be updated in order to revise the BDCM portion of it.
- There is no need to look at the other THMs at the moment, as Health Canada is still working on its THMs evaluation.
- BDCM is important, as brominated THMs are present in substantial amounts in some locations.
- There are other new studies (epidemiological, physiologically based pharmacokinetic [PBPK] modelling) available on BDCM, so it does not make sense to revise the BDCM document just to incorporate the recent NTP study. Changing the number based on the NTP study without reviewing the other studies would be open to criticism. A full review of all of the new studies would take a long time.
- The current summary statement is confusing and is causing problems, as it calculates a GV for BDCM on the basis of carcinogenesis but notes that a recent NTP study shows that BDCM is not carcinogenic. This sentence was added to the summary statement in an attempt to indicate that the GV may need to be changed in the future, because the background document was published long before the NTP study was published. However, THMs (including BDCM) have not been reassessed since publication of the first addendum to the third edition.
- It is noted that although an HBV of 21 μg/L is derived, the previous GV of 60 μg/L for BDCM was retained based on technical achievability (concentrations below 50 μg/L may be difficult to achieve without compromising the effectiveness of disinfection) and the fact that it was derived from the same study from which the HBV was derived, but using a different model and model assumptions.
- There seem to be some inconsistencies in the carcinogenicity classification of BDCM. The Health Canada panel concluded that the NTP (2006) study alone was not sufficient to
change the classification to “possibly” carcinogenic from “probably” carcinogenic in humans. In addition, the 12th edition of the Report on Carcinogens states that BDCM is “reasonably anticipated to be a human carcinogen based on sufficient evidence of carcinogenicity from studies in experimental animals” (http://ntp.niehs.nih.gov/ntp/roc/twelfth/profiles/Bromodichloromethane.pdf).

- The NTP (1987) study on which the BDCM GV was based should have been included in the Principal references list in the summary statement.
- The statement under Additional comments about the recent NTP study showing that BDCM is not carcinogenic needs to be replaced with a statement along the lines that “Recent studies have become available that have questioned the carcinogenic potential of BDCM. A thorough review of THMs, including BDCM, will be undertaken as a high priority in the near future.”
- The new review will probably be based on the Health Canada review, if it is finalized in time.

Expected product(s): Reworded statement under Additional comments and addition of NTP (1987) reference under Principal references in chapter 12 (first addendum); revised background document and summary statement (fifth edition)

Next steps (Chemical WG):

- As recommended by the Chemical WG, the Secretariat should consider including the statement “Recent studies have become available that have questioned the carcinogenicity of BDCM. A thorough review of THMs, including BDCM, will be undertaken as a high priority in the near future.” to the GDWQ workplan available on the WSH homepage.
- An abbreviated form of the NTP (1987) reference from the THMs background document will be added under Principal references in the summary statement in chapter 12: NTP (1987) Toxicology and carcinogenesis studies of bromodichloromethane. In addition, the complete reference will need to be added to p. 466 of Annex 2: NTP (1987) Toxicology and carcinogenesis studies of bromodichloromethane (CAS No. 75-27-4) in F344/N rats and B6C3F1 mice (gavage studies). Research Triangle Park, NC, United States Department of Health and Human Services, National Toxicology Program (NTP TR 321). Phil Callan will ensure that this is done for the first addendum.
- Once the Health Canada review on THMs is completed, the Chemical WG will assign a lead to undertake a full review on BDCM, taking into consideration new epidemiological studies and PBPK modelling, and update the current background document on the other THMs based on the Health Canada review. When a revised background document on THMs, including BDCM, is ready, it will be sent to the Chemical WG for review.

#23. Chlorite and chlorate

Background: There is a 2007 JECFA evaluation of chlorite and chlorate (as part of the acidified sodium chlorite evaluation), which derived an ADI for chlorite of 0–0.03 mg/kg bw (which is the same as the TDI used in the GDWQ) and an ADI for chlorate of 0–0.01 mg/kg bw. Concern has been expressed that the JECFA ADI for chlorate is much lower than the TDI used in the WHO background document, which would lead to a GV that is too low and
would affect hypochlorite use for disinfection. The chlorite and chlorate background document needs to be revised to reflect the new JECFA assessment.

**Summary of discussion:**

- Joe Cotruvo has made some revisions to the summary statement in chapter 12, putting more emphasis on chlorate (and changing the title to “Chlorate and chlorite”). These changes need to be made in the background document also.
- The JECFA ADI for chlorate of 0–0.01 mg/kg bw (with the use of an additional safety factor of 10 for deficiencies in the database) will reduce the GV too low and put extreme pressure on the use of hypochlorite for disinfection.
- The Chemical WG must not confuse risk assessment with risk management. The JECFA ADI can be used as a valid risk assessment, but a different GV can be set for risk management purposes.
- The GV for chlorate is currently 0.7 mg/L and designated as provisional because the use of chlorine dioxide as a disinfectant may result in the GV being exceeded, and difficulties in meeting the GV must never be a reason for compromising adequate disinfection. The JECFA ADI of 0–0.01 mg/kg bw will reduce the GV from 0.7 mg/L to 0.2 mg/L. The value of 0.2 mg/L becomes the HBV, and the provisional GV is retained as 0.7 mg/L on the basis of practical considerations. This needs to be explained clearly. A statement explaining the difference between the HBV and the provisional GV should be added under Additional considerations in the summary statement in chapter 12.
- The Chemical WG needs to make sure that statements about chlorine dioxide residual acting as a residual disinfectant during distribution and rapid hydrolysis of chlorine dioxide to chlorite are not contradictory.
- There do not appear to be any more recent studies published after the JECFA evaluation that need to be taken into consideration. A statement to this effect can be made in the background document in order to meet GRC requirements.

**Expected product(s):** Revised background document and summary statement (first addendum)

**Next steps (Chemical WG):**

- **Joe Cotruvo** will revise the background document (and summary statement) for March/April 2014 to incorporate the JECFA evaluation on both chlorate and chlorite and to use the JECFA ADIs for chlorate and chlorite (for chlorite, this is the same as the TDI currently used) to derive the HBV for chlorate (although it was recommended that the provisional GV should be retained) and the GV for chlorite. Changes made to the summary statement before the current meeting need to be reflected in changes to the background document.
- The revised background document will be circulated to the Chemical WG for review. Following Chemical WG review, the background document will go out for public review.
- **Marla Sheffer** will send a Word version of the current background document to Joe Cotruvo.
#24. Chlorine dioxide

**Background:** Text needs to be added to the GDWQ to highlight the decomposition issue and sources of chlorite/chlorate. On p. 336 in chapter 12, text needs to be added regarding the temperature dependence of the taste and odour threshold. The background document also needs to be updated.

**Expected product(s):** Revised text in background document and summary statement (first addendum)

**Next steps (Chemical WG):**
- **Joe Cotruvo** is to make sure that the above issues are addressed in the revision of the background document and summary statement on chlorite and chlorate for March/April 2014.

#25. Bromate

**Background:** The current provisional GV for bromate is 10 μg/L because of limitations in available analytical and treatment methods. The HBV of 2 μg/L is based on low-dose extrapolation of the incidence of mesotheliomas, renal tumours and thyroid follicular tumours in male rats given potassium bromate in drinking-water. Recent studies have questioned whether bromate is a genotoxic carcinogen or acts by a non-genotoxic (threshold) mode of action. Health Canada is currently revising its guideline on bromate.

**Summary of discussion:**
- Health Canada’s updated technical guideline document on bromate will be available by late 2014. A PBPK model is being developed that should allow the default uncertainty factor for interspecies variation to be reduced from 10.
- An interpretive paper (Bull & Cotruvo, 2013) has just been published in the *Journal of the American Water Works Association* (provided to the Chemical WG) that concludes that the renal tumours in rats caused by bromate are not based on a mutagenic mode of action, and therefore it is not appropriate to perform a linear low-dose extrapolation. Other tumours (thyroid and testicular mesothelioma) appear to be secondary to testing conditions: the bromate produces bromide, which interferes with iodine transport to the thyroid, which in turn interferes with thyroid hormones.
- The potential outcome of this work is a conclusion that the mode of action for bromate should not be based on carcinogenicity, which would lead to a more traditional calculation of a GV.

**Expected product(s):** Additional comments added to summary statement (first addendum); revised background document and summary statement (second addendum or fifth edition)
Next steps (Chemical WG):

- Once the Health Canada review has been finalized and the Health Canada guideline has been published (late 2014), work on revising the background document on bromate will be initiated. The lead for this work has not yet been identified, but Michèle Giddings and/or Joe Cotruvo are possible focal points.

- For the first addendum, the Secretariat should consider adding an Additional comments row to the summary statement of chapter 12: “Further studies are available that question the mode of action of bromate, and these are currently under review.”, as recommended by the Chemical WG

PFOS/PFOA

Background: There is no current guideline for PFOS and PFOA in the GDWQ. Both are listed on the Stockholm Convention for POPs. Health Canada has hired a consultant to prepare a risk evaluation in order to derive a GV (late 2014), the USEPA has a document on PFOS/PFOA, which is expected to be peer reviewed in 2014, and the United Kingdom also has a risk assessment. A new background document needs to be developed.

Summary of discussion:

- Ruth Bevan has prepared a quick overview of toxicity and occurrence data for PFOS and PFOA.
- A tiered approach is used in the United Kingdom: around a trigger of 0.3 μg/L, routine monitoring is required; above 1 and 5 μg/L for PFOS and PFOA, respectively, further action needs to be taken.
- EFSA has done dietary exposure estimates and derived TDIs for both PFOS and PFOA (with liver toxicity being the most sensitive end-point).
- The use of PFOS and PFOA has been phased out, as they are very persistent in the environment, both being listed on the Stockholm Convention on POPs (Annex B, Restriction of production and use).
- Low concentrations of both PFOS and PFOA are found in drinking-water, but hot spots of exposure do occur where concentrations will be higher.
- Health Canada has done a toxicological review, and Michèle Giddings will provide the results to Ruth Bevan.
- The USEPA is planning to announce the availability of a draft health assessment of PFOS and PFOA for external peer review and public comment in a Federal Register notice in 2014, which Santhini Ramasamy will share with the group.
- PFOS and PFOA are very different compounds, so two separate background documents are needed.
- The USA is interested in other perfluorinated compounds, such as perfluorinated hexanoic and pentanoic acids. Ruth Bevan’s group at Cranfield University is looking at some of these as part of the Institute of Environment and Health’s (IEH) work for EFSA.

Expected product(s): New background document and summary statement (second addendum)
Next steps (Chemical WG):

- **Michèle Giddings** and **Santhini Ramasamy** will provide Ruth Bevan with the Health Canada and USEPA reviews, respectively.
- **Ruth Bevan** will prepare two background documents (using the Health Canada and USEPA reviews). Once the background documents have been completed, they will be sent to the Chemical WG (via Jennifer De France and Phil Callan) for comment.
- **Shane Snyder** will help with the analytical and treatment sections. Method 537 for the determination of selected perfluorinated alkyl acids in drinking-water by solid-phase extraction followed by liquid chromatography with tandem mass spectrometry was published in 2009 (http://www.epa.gov/nerlcwww/documents/Method%20537_FINAL_rev1.1.pdf).
- Both peer and public reviews will be needed following the Chemical WG review.
- Summary statements will be prepared based on the final background documents.

### #27. Perchlorate

**Background:** In 2006, an official request was made by Japan for WHO to develop guidance concerning perchlorate in drinking-water, as it had found surface water containing up to 25 µg/L in some areas, from manufacturers, fireworks and other sources, including possibly natural sources. JECFA evaluated perchlorate in 2011, and a new background document needs to be prepared based on this evaluation. Global occurrence data are needed.

**Presentation by Shane Snyder:**

- The JECFA evaluation is very thorough.
- Care should be taken in interpreting toxicological studies administering ammonium perchlorate, as the ammonium ion can be toxic.
- Perchlorate was used extensively as a pharmaceutical for treatment of the thyroid. It also is naturally produced in the atmosphere, and synthetic forms are used in the defence and space industries.
- Perchlorate is very stable in the environment.
- The food data from JECFA are extensive.
- Treatment is by reverse osmosis, nanofiltration, anion exchange and anaerobic bacteria.
- The point of departure (BMDL$_{50}$ of 0.11 mg/kg bw per day) is from the human study by Greer et al. (2002), in which volunteers were administered perchlorate in drinking-water. The target tissue was the thyroid, and the end-point used was 50% inhibition of iodide uptake to the thyroid. Others have also used this study to derive guidelines but have used different points of departure (e.g. LOAEL) and different end-points (e.g. change in thyroid hormone levels).
- In the JECFA evaluation, the provisional maximum tolerable daily intake (PMTDI) was rounded to 0.01 mg/kg bw (no uncertainty factor for interspecies variation was needed, as the point of departure was from a human study). With a 20% allocation factor, this gives a GV of 60 µg/L.

**Summary of discussion:**

- The USEPA has found that most intake of perchlorate is from food, with minor amounts from drinking-water.
The JECFA evaluation notes that whole populations are drinking water containing 100 μg/L perchlorate with no adverse effects.

JECFA used the BMDL_{50} (50% response) for radioactive iodide uptake inhibition from the Greer et al. (2002) paper, and this point of departure is greater than the NOAEL from the same study utilized for the USEPA reference dose that had 2% radioactive iodide uptake inhibition.

Iodide deficiency is an important consideration. It is better to give people iodide than to regulate perchlorate.

Perchlorate is one contributor to iodide uptake inhibition, but other anions are also responsible.

In 2008, the USEPA decided not to regulate perchlorate. This decision was reversed in 2011, but no proposed regulation has been issued to date.

The United States Food and Drug Administration published a biological modelling paper using hyperthyroxinaemia as the end-point in pregnant women exposed to perchlorate, and a similar modelling approach is being considered for other life stages to derive a maximum contaminant level goal (MCLG), which is a departure from the usual formula-driven approach.

Perchlorate can form in hypochlorite solutions, especially those held at elevated temperatures for long periods of time. To a lesser extent, on-site generation of hypochlorite also can lead to perchlorate formation.

Text from the JECFA evaluation can be used verbatim or summarized. It is recommended that the JECFA PMTDI and an allocation factor of 20% be used for the first draft of the background document.

The USA has extensive perchlorate occurrence data; however, global occurrence data for drinking-water need to be included.

Expected product(s): New background document and summary statement (first addendum)

Next steps (Chemical WG):

- Akihiko Hirose should send Shane Snyder Japanese occurrence data, and Peter Marsden should supply him with United Kingdom data. Shane Snyder will have data from the USA, and Michèle Giddings can provide Canadian data. If the Chemical WG is aware of occurrence data from elsewhere, the data should be forwarded to Shane.
- Shane Snyder will produce a background document for distribution to the Chemical WG by March 2014 at the latest.
- Following the Chemical WG review, the next step would be the peer review, followed by the public review process.
- A summary statement will be prepared based on the final background document.

#28. Molybdenum

Background: Molybdenum is an essential element. An HBV was derived for molybdenum in the fourth edition, replacing the GV, which was considered not necessary as molybdenum occurs in water at levels well below those of health concern. Data show low concentrations of molybdenum in drinking-water in Japan, the USA and the United Kingdom, but molybdenum seems to be concentrated in rice in Japan. Studies are needed to determine the source of molybdenum in rice.
Summary of discussion:

- The concentration of molybdenum in drinking-water is low, but the concentrations in rice are high, so the source of the molybdenum in the drinking-water is probably irrigation water contamination.
- Murray et al. (2013) of the Molybdenum Association of the United Kingdom have published a subchronic toxicity study, and a developmental toxicity study is under way. The USEPA is looking at these studies and has a health advisory document in progress. It would be interesting to compare the HBV that could be derived from these newer studies with the HBV derived in the GDWQ.
- Occurrence data from Member States are needed.

Expected product(s): None at this time

Next steps (Chemical WG):

- Jennifer De France will ask Member States for occurrence data on molybdenum in drinking-water (see Annex 4).
- Peter Marsden will provide occurrence data for the United Kingdom to Akihiko Hirose, who is leading this agenda item.
- Santhini Ramasamy will review the two new toxicological studies to determine if they would influence (i.e. lower) the HBV.

#29. Personal care products

Background: The Drinking Water Inspectorate of the United Kingdom is starting a project to look at personal care products (PCPs) and will keep the group updated on its progress. This is probably not a drinking-water problem, but it has implications for wastewater reuse.

Presentation by Pete Marsden:

- Desk-based work has been commissioned by the Drinking Water Inspectorate.
- PCPs are believed to be of low risk, but one of the aims of the project is to provide public reassurance, especially with regard to dermal exposure to PCPs.
- PCPs are considered separately from pharmaceuticals in the United Kingdom.
- A study on the risks of pharmaceuticals in drinking-water has already been published; the current project is to fill the gap and complement that study for England and Wales.
- The objectives of the study are to identify and review all relevant studies on PCPs (and cleaning products) in raw and treated water; review the types of PCPs (and cleaning products) used in the United Kingdom; identify the most important routes into water; estimate possible concentrations in drinking-water; compare estimated concentrations with occurrence data; estimate likely exposure from normal use; and suggest areas for further research.
- Difficulties have been encountered in obtaining usage data and modelling exposure routes.
- A draft report should be available soon.

Summary of discussion:

- It is recommended that WHO should not produce PCP guidelines, but rather should consider individual chemicals based on their occurrence and toxicology data.
Expected product(s): None at this time

Next steps (Chemical WG): None at this time

1.9 Closing session

Jennifer De France reminded the Chemical WG that Phil Callan’s list of chemicals included in the GDWQ is to be circulated over the next couple of weeks. Chemical WG members are asked to rank these chemicals according to their priority for updating. When the list is circulated, Chemical WG members are welcome to add new chemicals to the list, as long as they provide some justification for doing so.

Jennifer De France thanked Chemical WG members for their active contributions to the meeting, which led to satisfactory outcomes, including many decisions on a way forward. A number of high-priority items have been included in the workplan for the first addendum. As well, some items have been identified for the second addendum and fifth edition, and more work will go into these in the future.

Jennifer De France thanked David Cunliffe for chairing the meeting, Phil Callan for his work in preparing for the meeting and Marla Sheffer for rapporteuring the meeting. Finally, she thanked the governments of the United Kingdom, Japan, the United States and Australia for their support of the meeting.

The meeting of the Chemical WG was closed.

2. CHEMICAL ASPECTS AND MICROBIAL ASPECTS WORKING GROUP MEETING ON CROSS-CUTTING ISSUES

A WHO meeting of the Chemical and Microbial WGs on cross-cutting issues for the GDWQ was held in Geneva, Switzerland, on 4 December 2013. The WSH Programme of WHO headquarters organized the meeting.

2.1 Background

A WHO Joint Expert Meeting on Water Quality and Health was held in Dübendorf, Switzerland, from 18 to 22 March 2013. Participants included WHO staff, representatives of the WHO regional offices and representatives of the expert groups responsible for preparing the WHO guidelines related to drinking-water, recreational water environments and the safe use of wastewater, excreta and greywater in agriculture and aquaculture.

The key purpose of the Dübendorf meeting was to promote the harmonization of the drinking-water guidelines, the recreational water guidelines and the wastewater guidelines and to develop a workplan leading to the publication of the three revised guidelines by 2020. The experts recognized the importance of harmonized water quality regulations based on health (i.e. health-based targets) and the concept of preventive health risk assessment
and risk management (i.e. WSPs). The key outputs of the Dübendorf meeting are being used as a guide to the future work on each of the WHO water quality guidelines.

This meeting will build on the outcomes of the Dübendorf meeting by bringing together experts to progress the drinking-water guidelines workplan. Technical discussion will progress the post–fourth edition workplan that was refined at the Dübendorf meeting, leading to the publication of the first addendum to the fourth edition of the GDWQ.

2.2 Objective of the meeting

The objective of the meeting was to:

- Review progress to date on specific cross-cutting activities related to the GDWQ or its derivative products.

2.3 Participants

Sixteen participants attended the meeting, including staff from WHO headquarters and representatives of the expert groups responsible for preparing the WHO drinking-water guidelines. A list of participants is given in Annex 5.

2.4 Organization of the meeting

The meeting consisted of a series of plenary sessions together with a few presentations. Shane Snyder chaired the meeting, and Marla Sheffer acted as rapporteur. The meeting was organized according to general themes, and the order of items presented in the agenda, attached as Annex 6, does not necessarily represent the order of items presented in this meeting report.

2.5 Opening session

Jennifer De France welcomed new participants and announced that the current meeting would be focused on cross-cutting issues for the Chemical and Microbial WGs and that a Microbial WG meeting would be held immediately following this meeting.

2.6 Declarations of interests

All experts participating in the meeting completed the WHO standard form for declaration of interests prior to the meeting. At the start of the meeting, all participants were asked to confirm their interests and to provide any additional information relevant to the subject matter of the meeting.

The following participants declared current or recent (within the past year) financial interests related to commercial organizations:

- Joe Cotruvo  Personal consulting services to Coca Cola, Water Security Corporation, American Chemistry Council and Halosource, to the combined value of
WHO Meetings on the GDWQ, 2–5 December 2013, Geneva

- Mark Sobsey
  Co-founder of Aquagenx, on the Water Science Advisory Board of Amway, to the combined value of US$ 10,000 per annum. Non-financial academic interests (Developing a scientific report on household point-of-use drinking-water treatment processes for Unilever Co. and undertaking microbiological performance research for Bromine Compounds Ltd and ProCleanse)

On the basis of these declared interests, no significant conflict was registered in relation to the objectives of the meeting considering the types of issues that were addressed.

2.7 Plan of work

Each agenda item was discussed in detail, and a summary of the discussions as well as next steps were recorded for each. The agenda items have been numbered consecutively in this meeting report; the numbers do not bear any relation to the numbers of agenda items in previous meeting reports on the GDWQ.

#30. Alternative disinfectants: Silver

**Background:** Silver was added to the rolling revision as part of the agenda item on alternative disinfectants, as it is increasingly being used as a disinfectant. Lorna Fewtrell prepared a background document on the efficacy and toxicity of silver-containing compounds for review at the Dübendorf meeting. The database on silver is limited, and it was suggested that Lorna Fewtrell may need to speak to researchers involved in this area to obtain unpublished information. Additions to the background document suggested at that meeting included other types/treatments involving silver (colloidal silver, nanosilver, silver coatings) and toxicity outside of water. The background document will eventually form the basis of a fact sheet.

**Presentation by Lorna Fewtrell:**
- The key questions to be answered are: Is silver an effective water disinfectant? Is it toxic? Is there enough evidence to come to meaningful answers?
  
  **Efficacy**
  - For ionic silver applications, a handful of studies have looked at disinfection of potable water; these reported log reductions between 2 and 7, depending on the bacterial species and starting concentration. Generally, a long contact time (3+ hours) was required. There is limited evidence that environmental bacteria might be more resistant to ionic silver. There were no published studies on viruses or protozoa.
  - Copper/silver has applications in hospital hot water systems and swimming pools. In hospital systems, copper/silver seems to reduce *Legionella* colonization, but it does not eradicate the microorganism; cases of Legionnaires’ disease often decrease (at least for a while). In swimming pools, copper/silver is effective against bacteria, but not viruses.
  - Silver nanoparticle applications are largely experimental, using a wide range of possible filtration matrices. They are typically tested on bacteria. It is sometimes difficult to tease out the role of silver nanoparticles from the impact of filtration alone, it is impossible to
compare between studies, and silver measurements in filtrate are not always reported. Some approaches may have potential for household water treatment (HWT).

- Silver-coated ceramic filters use either silver nanoparticles or silver nitrate for biofilm reduction or water disinfection. In the studies identified, the effectiveness of the filter was emphasized over the effectiveness of the silver component.
- The conclusion for efficacy is that ionic silver is not very effective; copper/silver has some effectiveness in hospitals and also in swimming pools, but not without chlorine; silver nanoparticles have some potential; and silver-coated ceramic filters do not show convincing evidence of efficacy.

**Toxicity**

- Silver can distribute widely in the body and can remain in the body for long periods. The liver and kidney are key organs for deposition. Silver can also cross the blood–brain and placental barriers.
- In vivo studies use different forms of silver, different exposure routes, different dosing regimens and different test animals. There is some suggestion of mild toxicity at high doses and/or with repeated administration. Case-studies in humans suggest that silver is largely non-toxic (except for argyria).
- In vitro studies have been conducted in secondary cell lines, looking for cytotoxicity and oxidative stress in liver and lung cells. The size of nanoparticles and the coating impact on toxicity (the smaller the nanoparticle, the more toxic). Salts are more toxic than nanoparticles.
- In summary, silver can distribute throughout the body, causes mild toxicity at high doses and has cytotoxic effects.

**Preliminary conclusions**

- Silver does not appear to be a great antimicrobial in the drinking-water context (but it sometimes kills indicator bacteria, i.e. *Escherichia coli*).
- Silver is unlikely to do harm at the lifetime health advisory level of 0.1 mg/L in the USA (which is based on a cosmetic effect).
- There is probably enough evidence to draw meaningful conclusions.

**Summary of discussion:**

- Doses considered “high” in this presentation are at the milligrams per litre level (compared with the lifetime health advisory level of 0.1 mg/L in the USA).
- The draft background document did not cover the extent to which silver leads to bacterial resistance, which has been studied in other contexts. Does this have implications for the use of silver in drinking-water applications? Is it necessary to address these environmental aspects? Is it possible that discrepancies in the literature reflect resistance developing or not being controlled for?
- Lorna Fewtrell has not looked at silver resistance. She does not think that silver works very well as a disinfectant, but it will probably continue to be experimented on, as there is a great demand for it in the global community. She does not feel that silver resistance is affecting study results, particularly in laboratory studies.
- This is a very important document. People are trying to use silver, but it is questionable as to whether it works. Although it is not a very reliable disinfectant, it probably will not harm people either (although studies reporting its accumulation in neurons in mice should be further investigated).
Lorna Fewtrell did not address the major commercial use of silver as a bacteriostat on devices such as carbon filters, used to prevent microbial growth on the devices. In the USA, companies cannot claim that their product disinfects drinking-water, but they can claim that it is protecting the device from excess microbial growth. More about the bacteriostatic effect of silver on devices should be added to the document.

The toxicology and distribution of silver are very dose dependent. When silver salts encounter chloride in the stomach, silver chloride forms, which is very insoluble and would be eliminated. There is therefore a threshold for uptake; if that dose is exceeded, uptake occurs. The dose dependence of the body burden of silver should be discussed in the document.

The reactions of silver ions with halogens like chloride to form insoluble precipitates may explain some of the discrepancies between controlled laboratory studies and observations in typical waters encountered in practice.

Based on this preliminary review, it is proposed that WHO should make a statement that it does not recommend the use of silver as a disinfectant for drinking-water, but also that use of silver as a disinfectant probably will not cause harm below certain levels.

In Australia, a warning note was issued about the use of copper/silver as a disinfectant in swimming pools and spas, casting doubts on whether it works. This led to the development of criteria for the registration of disinfectants; copper/silver has not passed that barrier. This document will assist in answering questions on the efficacy and harm of these disinfectants.

Measuring silver (ionic and nanoparticles) is not that straightforward, and the literature may be biased and not entirely accurate. When inductively coupled plasma–mass spectrometry is used to measure silver, silver may be lost during the preparation of the sample. Concentrations in the literature should be viewed with skepticism, as it is often not clear how the analysis was performed. These analytical chemistry measurement issues need to be addressed carefully. Mark Sobsey will provide this information.

A few papers have not yet been included in this document, but they will not likely change the conclusions. Paul Hunter can share these with Lorna Fewtrell.

An important issue is that none of the primary papers appear to use disinfectant concentration × contact time (CT) values, although these values could be derived from some of the papers. In a comparison of effectiveness, a 5 log decline is meaningless without knowledge of the dose and exposure time.

Sometimes silver is adsorbed onto the container; even if one starts off with an acceptable dose of silver in water, it will be adsorbed onto the container, and the concentration in water will decline.

If silver is adsorbed onto the container, it might cause harm over the long term? as it leaches from the container.

Absorption of silver from all sources is more important to consider than exposure to silver only through drinking-water. Silver can, of course, enter drinking-water from sources other than its use as a disinfectant.

If silver is potentially cytotoxic and crosses the placental barrier, what might it do to the fetus? Early in embryogenesis, there is rapid cell replication, and minor insults to certain cell lines at crucial times could lead to potentially substantial outcomes. Just because there are no studies on this does not mean that it is not a problem.

The toxicity section of the background document is still to be expanded. A few papers on in vitro studies suggest developmental issues; and in one in vivo study in rats in which
silver crossed the placental barrier and accumulated in the fetus, no adverse effects were noted.

- There is very little transference from the laboratory to the real world. In the real world, silver will precipitate or form colloids in drinking-water, whereas laboratories use distilled water.
- There is a claim that products marketed as silver/peroxide combinations accelerate the release of active oxidants. This was not included in the document (but data suggest that it does not work).
- Is silver acting as a bacteriostat rather than a biocide? Is it known with confidence that regrowth is unlikely? Few studies consider the possibility of regrowth. In a study that John Fawell mentioned at the Dübendorf meeting, when the silver levels in the water fell to very low levels, bacterial regrowth occurred.
- Silver forms are applied to ceramic pot filters. Despite silver’s presence, to prevent microbial growth, those filters continue to be prone to biofilm development and clogging. There is evidence that a truly preventive, long-term effect is absent, in that context.
- It might be useful to require any new disinfectant being promoted to demonstrate specific (3–4?) log reduction requirements for bacteria, viruses and protozoa.
- Akihiko Hirose has some information on environmental stability plus some toxicity studies to share with Lorna Fewtrell.
- There are very few chronic toxicity studies. There are chronic inhalation studies, but the longest ingestion study is only 28 days in length. The document should note that there are no reliable chronic toxicity studies.
- Some studies in humans have found that exposure to silver over long periods is without adverse effects.
- The GDWQ mentions that chronic exposure to silver could lead to argyria (these are old studies, probably from therapeutic uses of silver).
- There is no GV established for silver in the GDWQ, as available data are inadequate to permit the derivation of such a value.

**Expected product(s):** New background document and fact sheet on silver as an alternative disinfectant (first addendum)

**Next steps (Chemical and Microbial WGs):**

- Members of the Chemical and Microbial WGs are to share any relevant literature with Lorna Fewtrell as soon as possible. Mark Sobsey will share information on analytical chemistry measurement issues, and Paul Hunter will provide some additional papers that should be included in the document but will not likely change its conclusion. Akihiko Hirose will share some information on environmental stability plus some toxicity studies.
- Lorna Fewtrell will revise the draft background document based on feedback from the Chemical and Microbial WGs by mid-December 2013 and send the revised document to Jennifer De France, who will send it to the Chemical and Microbial WGs for comments.
- Once the background document has been finalized, a fact sheet will be prepared (modelled on the fact sheet on sodium dichloroisocyanurate; see agenda item #31). Linkages between this fact sheet and the summary statement in chapter 12 need to be determined.
#31. Alternative disinfectants: Sodium dichloroisocyanurate

**Background:** Sodium dichloroisocyanurate (NaDCC) is used as an alternative disinfectant in emergency situations. John Fawell prepared a fact sheet on this alternative disinfectant based on the background document on NaDCC, which informs the summary statement included in the GDWQ, for review at the current meeting. Linkages between this work and the existing summary statement in the GDWQ and the background document are to be determined. This fact sheet is to be the model for the other alternative disinfectant fact sheets.

**Summary of discussion:**
- The Chemical and Microbial WGs were unable to review the fact sheet in detail due to time constraints.
- One question to be answered is whether the language used in the fact sheet is appropriate for the purpose.
- Sodium trichloroisocyanurate is a similar biocidal product, and it would result in less cyanuric acid residue.

**Expected product(s):** New fact sheet on NaDCC as an alternative disinfectant (first addendum)

**Next steps (Chemical and Microbial WGs):**
- Chemical and Microbial WG members are asked to provide their comments on the fact sheet to Jennifer De France and John Fawell.
- The Chemical and Microbial WGs should consider whether trichloroisocyanurate should be added to the agenda for parallel consideration as an alternative disinfectant.
- The link between this fact sheet and the existing summary statement in chapter 12 still needs to be determined.

#32. Alternative disinfectants: Iodine and bromine

**Background:** Iodine and bromine were added to the rolling revision as part of the agenda item on alternative disinfectants, as they are increasingly being used as disinfectants. These were identified as high-priority items at the Dübendorf meeting. WHO commissioned Cranfield University to look at the toxicity and efficacy data on iodine and bromine. This work has just started.

**Summary of discussion:**
- Ruth Bevan prepared a briefing note on the use of iodine and bromine as drinking-water disinfectants, focusing on the efficacy and toxicity data.
- Should other forms of iodine and bromine be looked at, such as iodide and iodate or bromide and bromate? There is already a guideline for bromate, so it is not necessary to include it. It makes sense to include bromide, are there concerns about it competing with iodide, and it could interrupt thyroid activity. Also, bromine use as a disinfectant will produce bromide.
- Different chemical forms of bromine are being used as disinfectants, such as elemental bromine, bromine chloride and organobromine compounds, which are used primarily for
swimming pool and cooling tower disinfection. Resin forms of bromine are used in point of use applications. All these forms need to be reviewed.

- The literature in a drinking-water context is limited and rather old. Mark Sobsey should be able to share his Master’s student’s literature review on bromine with the Chemical and Microbial WGs in the near future.
- The iodine issue is broader than the current GDWQ-recommended short-term emergency use. WHO is concerned about inadequate iodine in the diet. If iodine-deficient people were using iodine as a disinfectant, it would be of benefit to them. What is the daily dose of iodine in water that would not be harmful and would be indirectly beneficial to those people, and how does it relate to the adequate disinfection dose? This needs to be consistent with the recommendations from other groups in WHO.
- The distribution of iodine deficiency globally is fairly patchy, mostly in inland, mountainous areas. It should not be assumed that what is good for some people (those living in mountainous regions) is good for others (e.g. people living in coastal areas with adequate iodine intake) (similar to the case for fluoride and fluorosis).
- The briefing note is missing some literature and perhaps misinterpreting some statements. Joe Cotruvo will convey his concerns to Ruth.

**Expected product(s):** New background documents and fact sheets on iodine and bromine as disinfectants (first or second addendum)

**Next steps (Chemical and Microbial WGs):**

- **Chemical and Microbial WG** members are asked to send their comments on the briefing note to Ruth Bevan. Mark Sobsey will share his student’s literature review on bromine when it is available (2014). Joe Cotruvo will provide missing literature and his comments on the briefing note.
- **Ruth Bevan** will prepare the background documents on iodine and bromine and submit them to Jennifer De France, who will send them out to the Chemical and Microbial WGs for review.
- Shorter fact sheets will be prepared from the final background documents (based on the NaDCC model; see agenda item #31).

**#33. Potable reuse**

**Background:** At the Dübendorf meeting, it was concluded that WHO should produce guidance on planned indirect potable reuse of treated wastewater, and this was considered a high-priority item. Pressure on water resources due to climate change, increases in population and the increasing size of cities has led to the proposal for and, in some cases, the implementation of planned indirect (and perhaps direct) reuse of wastewater in many countries. The end product of treated wastewater would be used to augment drinking-water sources or replace drinking-water for non-potable uses in urban areas. The requirement is for internationally recognized guidance to assist regulators, providers and health professionals. It would help support the population’s perception of the acceptability of, and need for, these processes. The guidelines would take the form of a stand-alone document that sets the WHO guidelines into the particular context of potable reuse, which fits with a number of ongoing initiatives, such as the desalination guidance.
Presentation by David Cunliffe:

This issue was discussed at the Dübendorf meeting (and prior to that). Extending the drinking-water guidelines into potable reuse is becoming more popular. Worldwide, only one guideline has been completed to date; Australia has a guideline, California has developed a draft guideline and there is current USEPA guidance for the USA (see http://nepis.epa.gov/Adobe/PDF/P100FS7K.pdf). An International Water Association conference on water reuse in Namibia in October 2013 discussed this issue. Considering the growing interest in this area, it is surprising that there are not more existing guideline documents. So far, work in the context of the GDWQ has not developed greatly; a briefing note consisting of a one-page background to justify the need for a guideline as well as a chapter outline has been prepared by John Fawell.

Kah Cheong Lai has raised a number of issues that need to be considered in the development of a WHO guideline: definitions of planned and unplanned potable reuse, identifying emerging contaminants of concern, standards required for water treatment, indicators for tracking water quality, potential impacts of climate change and outbreaks on the microbial quality of sewage, storage and environmental buffers, sanitation safety plans, factors that influence public acceptance of potable reuse and regulatory issues, among others.

Summary of discussion:

- The title of the briefing note refers to indirect potable reuse; why is direct not included?
- The general feeling is that indirect potable reuse is more broadly practised and slightly less controversial. The principles are the same; the differences are storage and dilution issues. The United States and Australian guidelines suggest that they should start with indirect potable reuse and later move towards direct potable reuse.
- The Chemical and Microbial WGs should not exclude direct potable reuse. There is a growing trend for direct reuse in North Carolina. This interest in direct reuse should be addressed.
- In the context of WSPs, the Chemical and Microbial WGs should be addressing potable reuse in terms of broad guidance in this area.
- The Chemical and Microbial WGs agreed that the title of the guidance should be “Potable reuse” and that the reference to indirect reuse should be dropped.
- The guidance should be on potable reuse, but factors specific to indirect and direct potable reuse may need to be identified separately.
- If WHO takes on the task of developing guidance on potable reuse, it needs to understand the resources and time commitment involved. It is a very complex issue, requiring intensive involvement and many different types of expertise, from toxicology to public perception to operation. Meeting once a year to develop this guidance will not be sufficient.
- The Australian guidelines took 18–24 months to prepare and gain endorsement. Drinking-water production is complex in and of itself, but the development of potable reuse guidelines is eminently doable.
- The issue should focus primarily on microbiological aspects, and chemicals (pharmaceuticals) should have much less emphasis. There are mechanisms to deal with chemicals in reuse water, but microbial quality, which is by far the greatest risk, should be emphasized over chemical quality.
• In terms of public perception, the biggest gap is chemicals. The Australian potable reuse guidelines had to deal with chemistry, because that was the issue that the public was concerned about.

• A 1998 National Research Council report in the USA referred to potable reuse as the “option of last resort”, which crushed potable reuse efforts across the country. This report has since been updated by the National Academy of Sciences, and the subsequent report did not make that statement.

• The USEPA has water reuse guidelines, which were revised recently.

• The potable reuse guidelines can be applied to very challenged waters. Social inequity issues and treating different bodies of water to different extents need to be considered carefully. Should all drinking-water be held to the same standard as potable reuse water? This is a concern that needs to be taken into consideration.

• The ultimate goal is to convince the public that their drinking-water is safe, but the public cannot be forced to drink it. Public acceptance and support of the project are the immediate objective, not actual consumption of the potable reuse water.

• The Australian guidelines dealt only with the safety of potable reuse. The issue of equity did get raised, but it was not a focus.

• It needs to be emphasized that water is contaminated over a wide range of levels. Clean source water is the obvious choice, but if that choice is not available, then there is a range of other options available. If it is necessary to use wastewater as a water source, advice should be provided that in terms of microbial quality, the lowest polluted source should be used as the water source.

• There are other issues to address, not just the quality of the source waters; otherwise, desalinated water would be preferred. These other issues to be considered include cost, energy (and greenhouse gas emissions), water quality, water availability and flood protection.

• The water cycle in the context of changing climate needs to be emphasized. More flood water as well as more severe drought will both affect the water supply.

• If wastewater is treated to a certain level, it would be a waste to discharge it back into source waters with higher levels of pollution. Nevertheless, some people using reverse osmosis and oxidation often insist that the water be returned to the environment, which recontaminates the water. It is a complicated issue, mixing science, emotion and politics.

• The guidance document may want to start out by explaining that if a community wants to increase its water resources, there are various options available in the toolbox, potable reuse being one of the tools available.

• Perhaps fact sheets should be prepared to explain what flood water and wastewater are and what contaminants they may contain.

• The issue needs to be examined more holistically, rather than focusing on potable reuse in wealthy developed countries. Pollution is often caused by an upstream discharger. If it were to recycle its water, there would be ancillary benefits. WHO needs to consider lower-tech options than reverse osmosis, which would be prohibitively cost restrictive for most communities.

• In North Carolina, the levels of representative chemicals in ambient water that is being used for the water supply are being compared with the high-quality reclaimed water that is approved for non-potable (e.g. agricultural) reuse, which has to adhere to strict microbiological requirements for bacteria, viruses and protozoa. People are asking why,
if this high-quality water can be produced, it is not being considered for potable reuse, especially if the microbial quality is better than that of water used as source water.

- There could be backlash from communities that their drinking-water is full of chemicals, but the people with potable reuse are getting cleaner water. There is a danger that communities might start monitoring for all these chemicals in their water.
- North Carolina did not adopt the California model using reverse osmosis. A dual disinfection barrier was key to its effectiveness, consistently producing water of high microbiological quality. In Australia, reverse osmosis is used for chemicals, not for microbial contaminants.
- It may be useful to include case-studies, showing how different regions have dealt with reuse.

**Expected product(s):** Potable reuse guidelines (time frame unknown)

**Next steps (Chemical and Microbial WGs):**

- **Kah Cheong Lai** is going to be leading this effort. A more complete draft will be developed for discussion at the potable water reuse meeting in Singapore in June 2014.
- A working group will need to be established, and the **Secretariat** will be contacting people to become involved in the near future.
- **Chemical and Microbial WG** members with comments on the proposed document should send them to Jennifer De France.

### #34. Quality of the evidence

**Background:** WHO guidelines must meet the highest-quality standards for evidence-based guidelines, be based on high-quality systematic reviews of all relevant evidence, use GRADE (Grading of Recommendation Assessment, Development and Evaluation) to assess the quality of the evidence and strength of the recommendations, incorporate multiple processes to minimize bias and optimize usability, and incorporate transparency in all judgements and decision-making. The GRADE approach examines five domains of quality to permit judgement of the overall quality of the body of evidence for each outcome. Recommendations are judgements based on the quality of the evidence as well as on trade-offs between benefits and harms, values and preferences, and resource uses. The strength of a recommendation reflects the extent to which there is confidence that the desirable effects of a management strategy outweigh the undesirable effects. It is necessary for the drinking-water group to systematically review and update the evidence and recommendations in the existing Guidelines in accordance with GRC processes.

**Presentation by Phil Callan:**
The WHO GRC was established to improve the quality of guidelines across the board. There have been discussions with the GRC secretariat in terms of how evidence in the GDWQ is reviewed and reported. For each of the key recommendations in the GDWQ, an assessment of the quality of evidence is needed. The GRC suggests that the GRADE approach be used, but it would be useful to identify other approaches for assessing the quality of evidence internationally. The four levels of evidence in the GRADE categorization (high, moderate, low, very low) are explained in a handout provided. The approach will apply to all of the WHO water guidelines.
An assessment of the body of evidence should be included for each background document prepared for the GDWQ. This is not a requirement of the GRC, but the GRC is encouraging the inclusion of this assessment.

Presentation by Paul Hunter on “Evidence-based public health: Evidential quality and the role of systematic review”:

Many different types of evidence are used when making medical decisions: opinions of experts, observational studies, intervention studies, etc. If viewed as a pyramid, expert opinion is at the bottom, followed by case–control studies, cohort studies and randomized controlled trials (RCTs). At the top of the pyramid are critically appraised individual articles, critically appraised topics and systematic reviews (at the very top).

Following systematic review with meta-analysis, one ends up with estimates of effect size relating to $x$ participants and $y$ studies of a specific validity, more or less consistent across the studies. How is this translated into strength of the recommendations? One issue with systematic reviews is that they are still not free from bias.

GRADE is a way of rating systematic review results, as high (e.g. RCT), moderate, low (e.g. observational study) and very low (e.g. expert opinion). The GRADE score is decreased according to study limitations, important inconsistency, uncertainty about directness, imprecise or sparse data, and high probability of reporting bias. The GRADE score can be increased by strong evidence of an association from two or more observational studies with no plausible confounders, very strong evidence of association, evidence of a dose–response gradient, and evidence that the influence of all plausible confounders would have reduced the observed effect.

Issues for the use of GRADE with the GDWQ include the fact that much of the evidence underlying recommendations in the GDWQ is from observational studies; it is difficult or impossible to do high-quality studies free from bias; and it may be difficult to distinguish a high-quality systematic review of poor-quality evidence from a poor quality review of high-quality evidence.

Summary of discussion:

- It is good to see an attempt to apply GRADE to evidence underlying the fundamental recommendations in the GDWQ, such as disinfection (e.g. chlorination) and filtration. Is there epidemiological evidence? Epidemiological evidence may be available from HWT, but study durations are short, which greatly weakens the evidence for RCTs. There are some prospective cohort studies, but they are rated as low. If they are still valuable and can get considered as better evidence, what would be the criteria for the credibility of these studies?
- Areas with reasonable levels of evidence need to be distinguished from those without reasonable levels of evidence. With respect to HWT, there have been four double-blinded studies for household chlorination, and none found a positive impact; in fact, there may even have been a negative impact, where people were more likely to have illness with chlorination. A large number of unblinded RCTs all suggest a 30–40% reduction in diarrhoea from household chlorination.
• This is the sort of bias one would expect from unblinded studies of self-reported disease. Double-blinded studies trump all of the unblinded RCTs. Similarly, if observational studies are considered, they may provide different insight, but they would still be trumped by studies at the top. If there are no RCTs, then observational (case–control, cohort) studies need to be considered, but as soon as an RCT is available, these observational studies are trumped. RCTs are not, and never will be, available for a lot of what is being discussed here, and reliance on observational studies will be necessary. These observational studies could get bumped up 1 or 2 points if they are very good studies.

• Studies on pathogen presence do not fit into GRADE, but they are still good evidence.

• Blinding does not mean anything if people do not use the intervention (e.g. there was only 32% use in a chlorination study in India).

• Compliance was low in the household chlorination study in India. However, the study reported results by those who used the intervention, and the compliant group had higher diarrhoea incidence than the non-compliant group (because chlorine affects the infectivity of Cryptosporidium).

• Clear criteria for minimum standards about randomization and setting up a control group would be useful and would lead to the generation of higher-quality data. There is already guidance on this.

• In emergency situations, chlorine is used exclusively; what if there are no studies showing the usefulness of chlorination in these situations?

• Extrapolation from non-emergency situations to emergencies with a large outbreak should not be done, as the pathogens are very different (in an emergency setting, not much other than cholera risk matters).

• Another approach is to document reductions in pathogens in water treated with chlorine or filtration or both. There is very good microbiological evidence from countless chlorination and filtration studies showing expected log reductions by these treatment processes at the household scale or in municipal systems. If those data on pathogen concentrations in treated compared with untreated water are subjected to quantitative microbial risk assessment (QMRA) and, from the results, reductions in the risk of annual infection or disability-adjusted life years (DALYs) are calculated for specific pathogens, can those sources of evidence based on pathogen reductions linked to QMRA provide the basis for quality of evidence, or has it no credibility? The answer is that it has credibility, but only in the absence of better quality data.

• The GRADE system does not take QMRA into consideration. It would be considered low-quality evidence. Pathogen removal in distributed network systems is convincing evidence.

• Ecological and cross-sectional studies are more common for environmental contaminants, but they are not part of the pyramid presented.

• While GRC recommends the use of GRADE, it can be modified or alternative approaches can be used as long as there is sufficient justification and the methods are clear and transparent. The WHO indoor air quality guidelines group has modified GRADE to be more applicable for its evidence review (approach coined GRADE+). However, it is still not being used for all parts of the WHO indoor air quality guidelines (and further modifications may be needed). GRADE, as it stands, may therefore not be applicable for the GDWQ either.
• A lot of the GDWQ guidelines are based on JECFA and JMPR evaluations. These groups have not graded their evidence in the past, but JECFA is starting the process of GRADE in terms of systematic reviews. GRADE is not that appropriate for toxicology studies. JMPR is waiting for the JECFA process to be completed. The drinking-water group needs to harmonize its efforts with those of its WHO colleagues.

• For toxicology studies, the Klimisch et al. (1997) systematic approach for evaluating the quality of experimental toxicological and ecotoxicological data may be more useful than the GRADE approach.

• Most of our chemical GVVs are based on toxicological studies.

• For the core recommendations of the GDWQ, still to be identified, a systematic review and grading of the evidence must be done. For the other recommendations, it would be desirable (and transparent) to do some sort of evaluation of the evidence.

• Just because there is low quality of evidence does not mean that the recommendation is low quality. Other factors need to be taken into consideration besides quality of evidence, such as balancing benefits and harms.

• The presentation was primarily on human information in a medical context. A different scale needs to be used when looking at animal data (e.g. giving a confidence level of assessment based on end-points available, etc.). The two should not be compared.

Presentation by Lorna Fewtrell:
Lorna Fewtrell was asked to look at how the evidence for silver used as a disinfectant could be graded. Although the body of evidence is supposed to be graded, each individual study needs to be looked at in order to arrive at a conclusion. For silver, there are no RCTs or observational studies. Therefore, Lorna suggested a modification: define the components or aspects of an ideal study in terms of the question to be answered (i.e. equivalent of an RCT), then score up or down on the basis of study limitations, unexplained inconsistencies, indirectness, imprecision, publication bias, adequacy (Klimisch et al. 1997), big effect, and cross-species/population/study consistency.

In the first example, on the efficacy of ionic silver, an ideal study (equivalent to the RCT) would present data on pH, temperature, water type, form of silver, silver concentration and exposure duration and would consider regrowth and a good range of microorganisms. All studies had some study limitations, but none too serious (−1), and the studies were inadequate, covering only a small range of bacteria and no viruses (−1). On the other hand, there were no real unexplained inconsistencies, indirectness or imprecision, and publication bias was possible, but unlikely. There was also no big effect and no cross-species/population/study consistency. The overall rating is “Low”.

In the second example, on in vitro toxicity, a good study would adequately characterize silver nanoparticles, ensure purity, investigate the effect of the capping agent, use a range of doses, use a variety of validated tests and include positive controls. The GRADE score is reduced by 1 for both study limitations and adequacy (because of heavy reliance on secondary cell lines), but increased by 1 for cross-species/population/study consistency. The overall rating is “Moderate”.

To make this work, the study definition (equivalent to the RCT) needs to be clearly outlined. Should the same categories of quality of evidence (high, moderate, low, very low) be used,
or should different terminology be used, making it clear that the approach being used is not GRADE?

**Summary of discussion:**

- RCTs are the gold standard because they are experimental. A lot of efficacy data are experimental, and it is correct to give these data high marks. As the studies Lorna reviewed are not measuring what she is interested in, they are indirect, and another point should be knocked off for that.
- Statistical methods used were not used as a basis for the grading, but they could be included in the definition of the ideal study.
- As papers are reviewed and decisions are made on whether or not to include them in the background document, certain studies may be excluded, such as those that use inappropriate controls or do not follow OECD guidelines. Is this not performing some level of grading of the evidence?
- If all non-ideal papers for the silver as an alternative disinfectant examples were excluded, there would not be many left.
- Caution needs to be exercised here. People bias systematic reviews by including or excluding studies. If studies are going to be excluded, the criteria for exclusion need to be determined before the studies are reviewed; the exclusion criteria cannot be modified after the review of the papers has begun. People who are good at this do two meta-analyses, including all the papers in the first one and only the high-quality papers in the second one.
- Some other elements need to be added to Lorna’s approach. For ions, a basic question is relevance to environmental conditions that are going to be encountered (e.g. halide ion concentration in test water, hardness of test water); factors determining the “ideal” study need to be tailored to the specific study. For the cell culture example, care needs to be taken in interpreting the results; the compound may be toxic to cells on the plate, but may never actually reach the target organ in vivo.
- When doing microbiological assays, particularly for bacteria, there are a lot of issues related to the plating method used. Have the organisms been plated in a way that tries to address injured or physiologically stressed or viable but non-culturable organisms? Methods that are good at addressing whether those types of organisms are still present are generally not utilized. To what extent are data from experimental systems relevant when this phenomenon is not typically accounted for? How can this be accounted for using the grading system?
- Experimental studies are of high quality if they are properly designed. The issue is of directness: is the outcome relevant to the question to be answered?
- For background documents based on JECFA and JMPR evaluations, where does the burden of work fall in terms of assessing the quality of the evidence? It is the responsibility of JMPR and JECFA to do a review of the evidence for their own evaluations; only when background documents are based on original reviews of the literature will it be necessary for the Chemical and Microbial WGs to perform an assessment of the quality of the evidence.
- When background documents are based on national reviews (e.g. Health Canada nitrate/nitrite review), how would the studies be evaluated? It would be desirable to apply the same approach, but the Secretariat has not yet discussed this with the GRC.
• It needs to be borne in mind that many negative results do not get reported. This is publication bias, a serious problem in systematic reviews (especially in drug trials). There are ways within systematic reviews to adjust for this. However, for the silver example, if it is decided that silver is not an effective disinfectant, the grading of the evidence becomes immaterial.
• In a global review, is it possible to grade to take into account data from different regions if they are the only data available? In other words, can more weight be given to lower-quality data from developing countries? If it is believed that interventions have different effectiveness in different regions, subgroup analysis should be performed from the start. If not, then these must be treated as poor quality studies.
• Can recommendations be made on how to deal with studies from developing countries, taking into consideration the different settings, conditions and study designs?
• If high-quality studies are available, the decision is based on those. If high-quality studies are not available, studies at the next level down are examined, and a judgement is made on what to recommend given the quality of the evidence, the potential seriousness of the impact, etc.
• The WHO Secretariat needs to consult with JMPR and JECFA. This process will evolve with time. As the group goes through the process, it will start to see where the gaps are, which will help in deciding priorities for the future.

Expected product(s): Assessment of quality of the evidence incrementally added to key recommendations and background documents (time frame unknown)

Next steps (Chemical and Microbial WGs):
• Lorna Fewtrell is to modify her proposed approaches for grading the evidence based on input provided at this meeting.
• The Secretariat will continue to consult with JMPR and JECFA as well as the GRC and will keep the group apprised of any developments in this area.

#35. Cyanobacteria

Background: The progress of the revision of the book Toxic cyanobacteria in water (originally published in 1999 and being revised by Ingrid Chorus) was noted at the Dübendorf meeting. Two issues that required a detailed review included the use of biovolumes instead of cell numbers and the proposed approach to developing GVs. Detailed comments were requested on the draft chapters relating to these issues from the Chemical WG after the meeting.

There was agreement that development of the fact sheet on cyanobacteria in recreational water should be halted until Toxic cyanobacteria in water was revised; however, the fact sheet on cyanobacteria in drinking-water should be completed as soon as possible.

Update on progress:
• The USEPA and Health Canada are doing major reviews of cyanobacteria. WHO and Ingrid Chorus should hold off on completing the Toxic cyanobacteria in water book until those reviews have been published.
The cyanobacteria review is a collaborative effort between Health Canada and the USEPA. The USEPA is reviewing the health assessment, which is currently undergoing an expert peer review consultation. Comments will be received by January 2014, and a health advisory is anticipated by fall 2014. Health Canada is expecting a guideline in late spring or early fall 2014. A review of treatment technology and analytical methods, including field test kits and onsite monitoring, will be included. The focus of the review is microcystins, as there are not enough data for cylindrospermopsin or anatoxins.

Phil Callan has updated the cyanobacteria fact sheet based on feedback received. The focus has changed from treatment to WSPs; the fact sheet has been shortened and simplified; and the effectiveness of chlorination for anatoxin-a and the effectiveness of ozonation have been questioned. Another issue relates to inconsistency between the fact sheet and the GDWQ text and treatment tables, which needs to be addressed.

The Chemical and Microbial WGs are asked to send detailed comments to Phil Callan and Jennifer De France. Perhaps Health Canada’s treatment group can look at the treatment-related aspects of the fact sheet.

Expected product(s): Fact sheet on the management of cyanobacteria in drinking-water supplies (first addendum)

Next steps (Chemical and Microbial WGs):
- The Chemical and Microbial WGs should send detailed comments on the cyanobacterial fact sheet to Phil Callan and Jennifer De France as soon as possible.
- Health Canada (Michèle Giddings) and the USEPA (Santhini Ramasamy) should send their draft guideline documents on cyanobacteria to Phil Callan and Jennifer De France as soon as they are available.
- Phil Callan will revise the fact sheet on cyanobacteria in drinking-water to take into account comments received.

#36. Translating the Guidelines into national standards

Background: At the Dübendorf meeting, WHO regional offices emphasized their need for guidance on using the Guidelines to establish national standards, in particular advice on selecting priority parameters. John Fawell and David Cunliffe were to continue to work on the document on translating the Guidelines into national standards. As this document is developed, there will be a training exercise on how to develop national standards in a couple of countries or regions; feedback from this exercise can feed into finalization of the document.

Summary of discussion:
- Phil Callan and David Cunliffe have been leading work on this agenda item; John Fawell has also been involved, as was David Drury originally.
- A draft paper of almost 50 questions and answers was provided to participants. Feedback on the questions, responses and division of the questions into sections would be appreciated.
- The level of detail is not a concern at present. The focus is trying to get the answers right; editing it to the proper language for the intended audience will occur later.
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- At the Dübendorf meeting, it was suggested that recreational water and wastewaters be included also (although possibly in separate documents), so this document may grow in the future.
- Caveats should be avoided; regulators seeking this advice want something short and complete.
- The questions have already been sent to the WHO regional offices, but little response was received. The revised document will also be sent to the regional offices for input.

**Expected product(s):** Guidance on translating the GDWQ into national standards (time frame unknown)

**Next steps (Chemical and Microbial WGs):**
- The Chemical and Microbial WGs are to send feedback (including answers to questions that have not yet been answered as well as suggested revisions to already existing responses) to Phil Callan and Jennifer De France.
- Phil Callan, David Cunliffe and John Fawell will revise the document in light of comments received.

### 2.8 Closing session

Jennifer De France concluded that this was a short but useful session covering a number of cross-cutting issues, and we now have a good path forward. She thanked the group for their participation, Shane Snyder for chairing and the governments of the the United Kingdom, Japan, the United States and Australia for their support of the meeting.

### 3. MICROBIAL ASPECTS WORKING GROUP MEETING

A WHO meeting of the Microbial WG on the GDWQ was held in Geneva, Switzerland, on 5 December 2013. The WSH Programme of WHO headquarters organized the meeting.

#### 3.1 Background

A WHO Joint Expert Meeting on Water Quality and Health was held in Dübendorf, Switzerland, from 18 to 22 March 2013. Participants included WHO staff, representatives of the WHO regional offices and representatives of the expert groups responsible for preparing the WHO guidelines related to drinking-water, recreational water environments and the safe use of wastewater, excreta and greywater in agriculture and aquaculture.

The key purpose of the Dübendorf meeting was to promote the harmonization of the drinking-water guidelines, the recreational water guidelines and the wastewater guidelines and to develop a workplan leading to the publication of the three revised guidelines by 2020. The experts recognized the importance of harmonized water quality regulations based on health (i.e. health-based targets) and the concept of preventive health risk assessment and risk management (i.e. WSPs). The key outputs of the Dübendorf meeting are being used as a guide to the future work on each of the WHO water quality guidelines.
This meeting will build on the outcomes of the Dübendorf meeting by bringing together experts to progress the drinking-water guidelines workplan. Technical discussion will progress the post–fourth edition workplan that was refined at the Dübendorf meeting, leading to the publication of the first addendum to the fourth edition of the GDWQ.

3.2 Objectives of the meeting

The objectives of the meeting were to:

- Review progress to date on post–fourth edition activities of the GDWQ with a particular focus on updates needed for the first addendum related to microbial aspects; and
- Determine next steps in developing the first addendum of the GDWQ related to microbial aspects.

3.3 Participants

Ten participants attended the meeting, including staff from WHO headquarters and experts on microbial aspects related to drinking-water quality (hereafter referred to as the Microbial WG). A list of participants is given in Annex 8.

3.4 Organization of the meeting

The meeting consisted of a series of plenary sessions together with a few presentations. David Cunliffe chaired the meeting, and Marla Sheffer acted as rapporteur. The meeting was organized according to general themes, and the order of items presented in the agenda, attached as Annex 9, does not necessarily represent the order of items presented in this meeting report.

3.5 Opening session

Jennifer De France explained that the purpose of this meeting is to define concrete next steps, building upon the outcomes of the Dübendorf meeting so that the work related to microbial aspects can be further progressed to enable the preparation of draft documents for future meetings.

In terms of the overall next steps for the GDWQ, a GRC planning proposal is to be submitted, and a WHO Guideline Steering Group, Guideline Development Group (which is to replace the Drinking-water Quality Committee) and External Review Group will be established in 2014; the P&P manual will be updated to incorporate the development of the drinking-water, wastewater and recreational water guidelines and will be finalized in 2014, although input from the GRC will be needed before the manual can be finalized; and there will be a meeting with experts on microbial aspects of drinking-water quality in June 2014 to coincide with Singapore International Water Week. The first addendum to the fourth edition will be published in 2015 (Q4), the second addendum in 2017 (Q4) and the fifth edition in 2020 (Q4).
3.6 Declarations of interests

All experts participating in the meeting completed the WHO standard form for declaration of interests prior to the meeting. At the start of the meeting, all participants were asked to confirm their interests and to provide any additional information relevant to the subject matter of the meeting.

The following participants declared current or recent (within the past year) financial interests related to commercial organizations:

- Mark Sobsey Co-founder of Aquagenx, on the Water Science Advisory Board of Amway, to the combined value of US$ 10 000 per annum.
  Non-financial academic interests (Developing a scientific report on household point-of-use drinking-water treatment processes for Unilever Co. and undertaking microbiological performance research for Bromine Compounds Ltd and ProCleanse)

On the basis of these declared interests, no significant conflict was registered in relation to the objectives of the meeting considering the types of issues that were addressed.

3.7 Plan of work

Each agenda item was discussed in detail, and a summary of the discussions as well as next steps were recorded for each. The agenda items have been numbered consecutively in this meeting report; the numbers do not bear any relation to the numbers of agenda items in previous meeting reports on the GDWQ.

#37. PICO questions

**Background:** To ensure that all of the intervention recommendations in the GDWQ are developed in accordance with the requirements of the WHO GRC, key questions to be answered in the Guidelines must be developed following the PICO (population, intervention, comparator, outcomes) format. PICO questions are not being derived for policy recommendations, threshold levels or surveillance recommendations. The PICO questions will be used to guide the evidence synthesis.

**Summary of discussion:**
- Phil Callan prepared a briefing note on PICO questions based on discussions with GRC as to what they expect from the drinking-water group. Mark Sobsey added some additional PICO questions, and a hard copy of the revised document was circulated.
- There are GRC requirements for evidence-based recommendations, of which there are four types in the GDWQ: interventions, best practices (or policy recommendations), threshold levels (e.g. microbiological guidance) and surveillance recommendations (guidance for surveillance and monitoring that indicate effective system performance and control). PICO questions need to be derived for intervention recommendations only (not for best practices, threshold levels or surveillance recommendations).
• For intervention recommendations (e.g. chlorination and filtration), following development of the PICO questions, a systematic review of the literature and an assessment or grading of the quality of evidence are required. Engineering interventions may be difficult to examine using systematic reviews, etc., and recommendations may be based on case-studies and expert opinion. If there are implications for cost related to surveillance recommendations, GRC would also want to see some sort of assessment. Although PICO questions do not need to be derived for threshold levels, an adaptation of the GRC method to synthesize data and assess the quality of evidence will generally be required.

• Examples of possible PICO questions for various interventions (chlorination, filtration, coagulation and filtration, and multiple barriers) were given.

• How many intervention recommendations are included in the GDWQ? Chlorination (for water utilities) is one.

• The drinking-water group should not do this activity just because GRC requires it. Why should the group use its resources to answer these questions? What would add value to the group’s own work? Are there any questions that would be useful for the group to answer?

• Since GRC appears to want the group to answer PICO questions on chlorination, it might be a useful intervention recommendation to start with. However, PICO questions on the various options relating to chlorination (e.g. contact time, dose) are going into too much detail. It will be difficult enough to get data together just for chlorination. For contact time and dose, it is necessary to consider individual pathogens, and a population impact is not going to be seen.

• The evidence base on the effectiveness of chlorine is not that simple in the literature. Chlorination by itself in faecally polluted water is probably not that valuable. There is evidence that shows indirectly that chlorine is of value. Its effect on microbiological quality is clear, but it is much more problematic to evaluate its effects on human health. It would not be that difficult to use the QMRA approach for this evaluation; epidemiologically, however, this would be much more difficult. Comparing chlorination with no treatment is going to be problematic (although the Netherlands does not chlorinate, it has very high quality water and uses disinfection at the plant).

• There are not a lot of epidemiological studies that will be helpful in this regard. Are there examples for specific pathogens? What about a non-blinded trial on the introduction of chlorine into households in Uzbekistan during a cholera epidemic, where chlorination could have reduced the risk of cholera?

• Cholera is a more objective outcome measure, and the lack of blinding may not be as significant an issue.

• One difficulty is in separating the effects of disinfection from those of other treatments (especially filtration) with which it is combined.

• Experimental evidence has credibility. There are many studies (laboratory, pilot and field studies) in which people have chlorinated water and measured the concentrations of pathogens before and after. Can these studies provide a basis, perhaps using the QMRA approach, for associating chlorination with health effects?

• PICO analysis is different from grading levels of evidence. PICO compares doing an intervention with not doing it. The focus needs to be on the question to be answered. GRADE would have to be used to assess the quality of the studies used to answer the
questions. It needs to be remembered that GRADE applies not to individual studies, but to the totality of the body of evidence as a whole.

- Is it possible to look at chlorination and different target populations? There may not even be enough data to look at chlorination and the total population.

- Studies showing the impact of chlorination on disease would be best. What about Walkerton, Ontario, where people got sick and died when the chlorinator stopped working? This would be an interesting study, as vulnerable populations, primarily the very young and the very old, were affected.

- There has been a systematic review of causes of outbreaks in Europe: temporary failures of disinfection led to 5/60 outbreaks, chronic failures, 12/60 outbreaks. Lack of filtration was more important (skewed towards Cryptosporidium outbreaks). Outbreak data from the USA are also available.

- There are outbreak data available (e.g. Steve Hrudey’s 2004 book, *Safe drinking water; lessons from recent outbreaks in affluent nations*), but they may not be extensive enough for this exercise.

- There may be some old before and after studies (e.g. epidemiological studies performed by Rebecca Calderon before and after filtration). For filtration and Cryptosporidium, the North Battleford (Canada) incident and other case-studies could be used as information sources.

- In medical practice, it is always good to check that what is thought to work actually works. One of these PICO questions could probably be answered in a day or two using various sources of information. It would certainly not hurt to see a collection of data showing that chlorination works.

- The first step is to identify key recommendations for which there needs to be a systematic review. Chlorination, filtration and the multibarrier approach might be a good start. A few PICO questions for each recommendation would then be submitted to the GRC.

- The key recommendations together with the PICO questions need to be submitted to the GRC within the next 6 months.

**Expected product(s):** Key recommendations together with PICO questions for submission to GRC by mid-2014

**Next steps (Microbial WG):**

- **Phil Callan** will prepare a full list of all recommendations in the GDWQ (intervention, best practices, threshold, surveillance) and circulate the list to the appropriate WGs.

- As only the intervention recommendations require the full PICO question approach, **Microbial WG** members are asked to identify PICO questions for the intervention recommendations on the list as well as potential sources of information that can be used to answer those questions.

**#38. Boil water fact sheet**

*Background:* A fact sheet on boiling water and public health was prepared in response to concerns over inconsistent advice regarding boiling, but it has not yet been published. Two outstanding questions remain: 1) the impact of boiling on spores (especially bacterial spores) and the caveat in Table 7.8 of the GDWQ on boiling and spores; and 2) should the
log reductions of Giardia extrapolated from two papers (which presented 100% inactivation) be identified as calculated log reductions?

Summary of discussion:

- Spores are not an issue in the context of boiling drinking-water and public health (they may be an issue for the disinfection of hospital equipment or canning, but these are not drinking-water issues).
- Table 7.8 states that spores are more resistant to thermal inactivation and that treatment by boiling must ensure sufficient temperature and time. That statement should be deleted, as it was noted that the Bacillus fact sheet states that spores are not an issue for water.
- Table 7.8 refers to the HWT document for log reduction removals, and the HWT document refers to the GDWQ. The intent was to anchor the information in the supporting document to the Guidelines. The original values for log reduction may have been included in the 2002 report Managing water in the home, which preceded both the third and fourth editions. Joe Brown prepared the original table, and he has sent an earlier draft with some references. Ana Maria de Roda Husman will check her computer for other old drafts containing the references used.
- A caveat should be added to the fact sheet that boiling does not apply to chemicals.
- The phrase “more than enough time” needs to be amended in the fact sheet.
- A footnote should be added to the fact sheet to explain that log reductions were calculated from the original papers.

Expected product(s): Revised text in chapter 7 and Table 7.8 (first addendum) and finalized fact sheet

Next steps (Microbial WG):
- David Cunliffe will make the revisions suggested above for the first addendum.
- Jennifer De France is to finalize the fact sheet.

#39. Treatment tables

Background: Chapter 7 includes a treatment section with two tables (Tables 7.7 and 7.8) summarizing treatment processes that are commonly used to reduce microbes; it also refers to Annex 5 on treatment methods and performance. The treatment tables are out of date and need to be updated. Recommendations at the Dübendorf meeting included updating Tables 7.7 and 7.8 with log reductions and with some information on CT values and turbidity; cross-linking both tables to documents with more information (e.g. CT values for chlorine); and including a note on Table 7.10 on the limitations of the use of E. coli as an indicator for other pathogens. A way forward needs to be proposed, including the identification of additional resources that should be reviewed in revising these treatment tables.

Presentation by Masaki Sagehashi:
Masaki Sagehashi has conducted a preliminary literature survey for Tables 7.7 and 7.8. He employed two search methods: 1) direct searching and 2) tracing by key articles. In the first method, he selected keywords and searched with PubMed. If there were enough hits, he
checked the abstracts and classified their relevance. If there were not enough hits, he changed the keywords. This method was used only for Table 7.7. In the second method, he selected key articles for each item, then found related articles using PubMed. Articles were selected if they had high relevance to the key article or filtered using keywords. This method was used for both Tables 7.7 and 7.8 (membranes). Duplicates of articles obtained using both approaches were deleted, and articles were selected by considering their relevance to items in the tables by their titles and/or abstracts.

The numbers of articles having high relevance to some of the items in Table 7.7 (“1. Pretreatment: roughing filters, storage reservoirs, bank filtration” and “2. Coagulation, flocculation and sedimentation: conventional clarification, high-rate clarification, dissolved air flotation, lime softening”) were shown; no articles were found for storage reservoirs, high-rate clarification or lime softening. The numbers of articles having high relevance to various aspects of “3. Filtration” and “4. Primary disinfection” were also obtained. For Table 7.8, the numbers of articles retrieved for the technologies listed under “2. Membranes, porous ceramic or composite filtration” were also shown.

Masaki asked for input on the adequacy of the methods used, the key articles used for the two tables, the priority of items in Table 7.7, the number of articles required for estimation, difficulty in elucidating minimum removal (i.e. under failing conditions) from the scientific articles, the need to include reclaimed water, rainwater harvesting, wastewater, grey water, dialysis, etc., and how to deal with combined processes.

Summary of discussion:

- Table 7.7 was largely derived from the Mark LeChevallier text on Water treatment and pathogen control and later (fourth edition) from Dutch references (from Hijnem, Beerendonk and Medema); Table 7.8 on HWT was added to the fourth edition.
- This is just the start of the investigation. Because of time limitations, only a limited number of key articles were selected. Another group of key articles needs to be selected. Not enough articles have been retrieved to estimate a range.
- The literature retrieved has not yet been reviewed to determine if there will be an impact on the two tables.
- Ana Maria de Roda Husman has the list of original references for Table 7.7 (revised in November 2009). Jennifer De France has contacted Joe Brown to get the material he used to develop Table 7.8.
- QMRAspot (free online software) may be a useful tool to aggregate the data set.
- It is unclear where minimum log₁₀ reduction values (LRVs) might be found for some of these technologies, such as membrane filters.
- If there is insufficient information, minimum and maximum LRVs may not be carried forward to future editions; instead, expected log reductions may have to be used. Some text that includes treatment variation may need to be written, as was done for HWT in Table 7.8.
- Table 7.7 has an error on the second page: the two headings, which apply to the first page of the table only, need to be changed to one heading: Removal. This may necessitate splitting the table into two parts, a and b.
- It would be an interesting exercise to combine the treatments for chemicals and pathogens in one table. This information could possibly be added to the annex.
Expected product(s): Updated Table 7.7 (with correction of heading error) and Table 7.8 (fifth edition)

Next steps (Microbial WG):
• The Public Utilities Board (PUB) of Singapore has volunteered to lead this effort. A report will be ready for review at the next meeting of the Microbial WG.

#40. Water treatment and pathogens

Background: At the Dübendorf meeting, the updating of the Water treatment and pathogen control book (by Mark LeChevallier) to include WSPs, validation methods, information on surrogates, issues included in aggregating multiple steps and the multibarrier approach was identified as a medium priority.

Summary of discussion:
• The Water treatment and pathogen control book was the original source for Table 7.7.
• It has been difficult to find a willing participant to revise the document. Mark LeChevallier would like to be involved, but needs a co-author. Someone who does this work on a daily basis would be ideal. Gertjan Medema is one possibility. Or perhaps he could suggest someone else who could take this on. Ana Maria de Roda Husman will ask Jack Schijven. PUB (Singapore) will be continuing the literature research started by Masaki Sagehashi and should be involved too. There are other people with specialized expertise who are keen to participate in the GDWQ as contributors (e.g. Karl Linden at the University of Colorado).
• Health Canada has updated its treatment tables within its QMRA model, which might provide some information useful to updating Tables 7.7 and 7.8.

Expected product(s): Revised Tables 7.7 and 7.8 (fifth edition) (see also agenda item #39); updated Water treatment and pathogen control book (time frame unknown)

Next steps (Microbial WG):
• Mark Sobsey will ask Gertjan Medema and Karl Linden if they would be interested in taking on this project, and Ana Maria de Roda Husman will ask Jack Schijven.
• Jennifer De France will follow up with PUB in the context of the literature survey initiated by Masaki Sagehashi.

#41. Microbial fact sheets and pathogenic and non-pathogenic strains: Tables 7.1 and 7.2

Background: Tables 7.1 and 7.2 list a range of pathogens, only some of which include the type and subtype. These and other inconsistencies need to be corrected, the organisms included in the tables need to be reviewed to determine if they should be retained and suggestions for new organisms to be included need to be considered. The information in the tables needs to correspond to the information given in the fact sheets in chapter 11. The existing fact sheets need to be reviewed and referenced. A prioritized workplan for revising the fact sheets needs to be established, and focal points need to be assigned.
Summary of discussion:

- The tables and fact sheets all need updating. The fact sheets were originally drafted in 2001, reviewed in 2002 and published in the third edition. Ana Maria de Roda Husman has pointed out shortcomings with Tables 7.1 and 7.2.
- The Microbial WG needs to take another look at both tables to correct inconsistencies and to determine which organisms need to be demoted or promoted from one table to the other (pathogens transmitted through drinking-water or organisms suspected of being transmitted through drinking-water but for which evidence is inconclusive).
- Additional fact sheets may be needed. The template for the fact sheets provided for this meeting (General description, Human health effects, Source and occurrence, Routes of exposure, Significance in drinking-water and Selected bibliography) is the same one used for the fourth edition. It might be appropriate to divide up work on the fact sheets by specialties: viruses, bacteria, protozoa.
- Decisions need to be made as to which fact sheets are more urgent for revision; if there are only 5–10, these could be revised for more substantive discussions at the Microbial WG meeting in Singapore in June 2014.
- The fact sheets include a mixture of organisms that are and are not significant; is it necessary to keep both?
- All of the organisms listed in Tables 7.1 and 7.2 should have a fact sheet (if they do not already).
- In Table 7.2, the “Level of evidence” heading should be changed to a more appropriate heading.

Expected product(s): Revised Tables 7.1 and 7.2 (including possibly a revised heading for the level of evidence) (first addendum); revised microbial fact sheets for chapter 11 (second addendum or fifth edition)

Next steps (Microbial WG):

- Ana Maria de Roda Husman and David Cunliffe will review Tables 7.1 and 7.2 and identify new information that needs to be included or inconsistencies that need to be corrected.
- Phil Callan and Jennifer De France will confirm that there is a fact sheet for each organism included in Tables 7.1 and 7.2. They will also email the Microbial WG members and ask their opinions on which microbial fact sheets need updating, which ones should be deleted (e.g. non-significant organisms), if any, which ones should be added (e.g. emerging pathogens), and the priorities for these tasks (and justification for the priorities). They will also ask for volunteers in the various areas of expertise to write the fact sheets or for proposals for people outside group to be approached to write the fact sheets.
- Fact sheets identified as high priorities should be revised and discussed at the Singapore meeting.

#42. Background vs incidents (including short-term fluctuations)

Background: The short-term fluctuations document by Peter Teunis was not published. However, a short summary of the document was included in section 7.1.3 in the GDWQ. Health-based targets should be based on normal variation in the system and not on 100-
year events or extreme events. Short-term fluctuations or system breakdowns should be defined to differentiate from natural noise or variability. Outbreaks are the final events of short-term fluctuations in drinking-water. At the Dübendorf meeting, determining whether the text included in section 7.1.3 is sufficient or whether it should be expanded and reviewing the consequences of outbreaks were identified as high priorities (for the first addendum). A workplan needs to be developed. The question about whether health-based targets should be set for general conditions or for the 95th percentile remains a high priority (first addendum) issue with implications for chapters 3, 7, 8 and 9.

Summary of discussion:

- Australia is debating the use of 50th versus 95th percentiles for microbial data; it will probably go with the 50th percentile.
- Normalized variation needs to be considered, as opposed to catastrophic variation. Treatment should not be attempting to deal with catastrophic variation in the source water (as this is not very cost effective).
- Regular occurrences of delivery interruptions in some systems (e.g. operational 6 hours per day only) have profound effects on performance and management. These systems are highly vulnerable. A better way to address this needs to be found, to discourage the systems from operating in this manner.
- This also relates to risk-based monitoring; if there are risk events, this needs to be taken into consideration in the monitoring programme.
- Guidance is needed on 50th/95th percentiles and on the relationship between short-term fluctuations or system breakdowns and outbreak situations. Some text to capture these issues needs to be written up in section 7.1.3, which is very short and not sufficient.
- A table showing various kinds of variabilities could be included, with examples of more specific situations that have to be addressed and guidance to address them.

Expected product(s): Revised text for section 7.1.3 (first or second addendum)

Next steps (Microbial WG):

- David Cunliffe will write up some bullet points on issues that need to be included in section 7.1.3 for discussion at the next meeting of the Microbial WG in Singapore in June 2014. Microbial WG members are asked to contribute their ideas. Tasks for Microbial WG members will be identified at the Singapore meeting.

#43. Aggregating multiple steps for overall water treatment performance

Background: At the Dübendorf meeting, there was a detailed discussion on the issue of the validity of aggregating the effects of multiple steps on overall water treatment performance with respect to microbial reduction. Han Heijn’s studies from Kiwa Water Research (KWR) showed that the efficacy from multiple steps was lower than the efficacy from each of the processes individually. On the other hand, studies in Australia have found multiple steps to be effective. It was agreed to review examples and papers from KWR to evaluate the advantages and disadvantages (high priority) and to add text/edit chapter 7, section 7.3.2, on the integration between unit processes and the need to incorporate moments of poor performance when aggregating the efficacy of unit processes to overall treatment efficacy.
WHO Meetings on the GDWQ, 2–5 December 2013, Geneva

The need for a literature review should be confirmed and a workplan developed.

Summary of discussion:

- There needs to be more of a focus on multiple barriers (see agenda item #44), on the “catchment to tap” paradigm, on barriers that improve and protect source water. Although the GDWQ promotes the multiple-barrier approach, it does not provide advice on how to add up the individual steps.
- There are supporting texts, such as the distribution system text, which is to be published by June 2014, but the text in the Guidelines is too focused on treatment plants and needs to be broadened.
- One of the issues raised at the Dübendorf meeting was the flow through chapter 7, which is disjointed. The flow was retained from the third edition, dealing first with hazards, then performance targets, treatment to achieve the performance targets, and concentrations in water. If there is a better order, it should be changed for the fifth edition. The structure of chapter 7 should be discussed with the whole Microbial WG at the June 2014 meeting.
- It would be useful to get feedback on the chapter’s structure and content from people who actually use it.
- The current structure is based largely on QMRA, but it may make more sense to anchor the structure along the lines of the hydrological cycle, from source to consumer.
- It is recognized that the chapter needs to provide the user with advice on QMRA, but there has to be a better way to do this than to introduce it right up front in the chapter.
- It would be better to introduce WSPs first, then source water protection, distribution integrity, etc.
- There is sufficient time before the fifth edition is published in 2020 to do a major modification of the structure of chapter 7. This is as high a priority as modifications to the chapter’s text on aggregating multiple barriers. This is a complete rewrite. As people’s views need to be canvassed, this process needs to be started soon.
- This is related to updating the QMRA work in chapter 7 (see agenda item #51), which has a high priority. There needs to be a discussion on what should be retained in and what should be removed from the GDWQ.
- The literature review was identified as a high priority at the last meeting. However, Tables 7.7 and 7.8 need to be revised first, so the literature review is no longer an immediate priority.

Expected product(s): Revised chapter 7 (fifth edition)

Next steps (Microbial WG):

- **Ana Maria de Roda Husman** will circulate her old suggestions for restructuring chapter 7 (if she can find them) and ask the Microbial WG for ways to improve the chapter’s flow and structure.
- **David Cunliffe** will suggest further revisions to improve the flow of chapter 7, including microbial methods, reference pathogens and QMRA.
- Restructuring chapter 7 will be discussed in detail at the Singapore meeting of the Microbial WG in June 2014.
#44. Multiple-barrier approach

**Background:** The importance of the multiple-barrier approach, in particular the problem of intermittent distribution in developing countries, was discussed at the Dübendorf meeting. It was decided to ensure that the “catchment to tap” paradigm is captured in chapter 7. Text needs to be added to chapter 7 on catchment protection of surface water, catchment protection of groundwater, safe piped water distribution and storage, safe water in buildings and safe storage in household water systems, based on the supporting documents. Guidance on distribution systems was identified as a high priority. If text for chapter 7 is needed, a workplan needs to be developed.

**Summary of discussion:**
- The distribution system text is to be published by June 2014.
- There is overlap between this agenda item and agenda item #43 above.

**Expected product(s):** Revised text for chapter 7 (fifth edition)

**Next steps (Microbial WG):**
- The Microbial WG will discuss this issue in greater detail at the Singapore meeting in June 2014, in the context of the restructuring of chapter 7 for the fifth edition.

#45. Legionella

**Background:** Prior to the Dübendorf meeting, it was noted that the risks posed by *Legionella* spp. in institutional hot water systems and the recommended management solutions probably need further consideration. Aspects that may be inadequately addressed in the GDWQ and supporting documents are recommendations for surveillance and analytical methods for detection and molecular typing. At the Dübendorf meeting, it was noted that the range of sources of *Legionella* is expanding, with more detection from cold water and from new devices with hot/cold water and compressors. It was suggested that the text in chapter 6 (Special circumstances) should be edited to include alternative sources of exposure and to expand on risk analysis and WSPs. A lower priority was to review the *Legionella* document. The present meeting was asked to confirm that there is a need to update the text in chapter 6 and, if so, to develop a workplan.

**Summary of discussion:**
- Additional sources of *Legionella* include ice machines, hot/cold water systems in offices and wiper fluid from vehicles.
- Ana Maria de Roda Husman has a PhD student doing a systematic review on alternative sources of *Legionella* (other than tap water); it should be completed in early 2014.
- A group in Australia is doing the same type of review (Joanne O’Toole and others at Monash University).

**Expected product(s):** Revised text of chapter 6 (second addendum)
Next steps (Microbial WG):
- The Microbial WG will wait for the outcomes of the two systematic reviews on alternative sources of *Legionella* and then revise the text of chapter 6 for the second addendum.

#46. Turbidity

*Background:* The text in the GDWQ on turbidity needs to be revised, as the guidelines are being misused or misinterpreted, with different nephelometric turbidity unit (NTU) values being given for public acceptability, disinfection and measurement of filtration effectiveness. There is a need to expand advice on turbidity, breaking it down into its various components (use as a surrogate for performance measurement in operational monitoring, acceptability, disinfection) in both chapter 7 and chapter 10 of the GDWQ. The usefulness of turbidity as an indicator of water quality needs to be emphasized. The development of a fact sheet on turbidity should be considered. This was identified as a high priority at the Dübendorf meeting. A workplan for the development of this text needs to be decided upon.

*Summary of discussion:*
- The fourth edition included increased text on turbidity, most of it in chapter 10 on acceptability, but also on p. 141 and in Table 7.8. A more detailed discussion in relation to filtration efficacy and disinfection (especially chlorination) is needed.
- This is a health issue, so text is needed in chapter 7 (section 7.3.2 or a new subsection in section 7.3). Text that does not belong in chapter 10 on acceptability will be deleted.
- More clarity is needed on how turbidity is addressed in the Guidelines, including measurement aspects.
- Health Canada updated its turbidity guideline in 2012.

*Expected product(s):* Revised text in chapters 7 and 10 (first addendum)

Next steps (Microbial WG):
- *Michèle Giddings* will send the Health Canada turbidity guideline to David Cunliffe.
- *David Cunliffe* will coordinate the needed work on turbidity; he will suggest an approach for the June 2014 meeting of the Microbial WG.

#47. Vulnerable groups

*Background:* The Final Task Force meeting in 2003 recommended that guidance be developed to address the specific concerns of vulnerable populations in the fourth edition of the GDWQ, in particular to propose effective action for the reduction of waterborne disease in these populations. Text was developed for chapters 6 and 7 to address this issue. The Dübendorf meeting concluded that future iterations of the Guidelines should consider how vulnerable subpopulations exposed to different waters under different local circumstances should be identified, how risk should be assessed for vulnerable subpopulations and whether health-based targets should be set for vulnerable subpopulations. It was also concluded that future iterations of the water quality guidelines should present vulnerable groups more consistently and that the standpoint on vulnerable
groups should be harmonized in the overarching document on the three water guidelines. The present meeting was to identify next steps for work on vulnerable groups, given other priorities and efforts already taken to address vulnerable groups in the fourth edition.

**Summary of discussion:**

- Potential activities include:
  - Harmonization of terminology throughout the Guidelines and supporting documents
  - Stand-alone document on how to identify vulnerable subpopulations in local settings
  - Meta-analysis to assess disease burden for vulnerable subpopulations
  - Systematic literature review to determine available data to be able to perform risk assessment for vulnerable subpopulations.

- Maggie Montgomery has done some work on targeted populations. HWT is one way to deal with targeted populations. The Microbial WG needs to take a look at the work that Maggie Montgomery’s group has done in this area.

- Besides young, old, pregnant and immunodeficient (YOPI) persons, vulnerable populations include displaced people, low-income populations and people with access to unimproved sources. There is a need to improve the definition of vulnerable groups in the GDWQ.

- Vulnerability determinants need to be determined.

- As the WSH unit is now in the Family, Women and Children cluster, the work of the drinking-water group needs to be integrated with the work of other groups within this cluster.

**Expected product(s): Unknown (fifth edition)**

**Next steps (Microbial WG):**

- Ana Maria de Roda Husman will send her presentation on vulnerable subpopulations, updated with Maggie Montgomery’s information on targeted populations, to the Microbial WG for their comments.

- Phil Callan, Bruce Gordon and Jennifer De France are also asked to provide feedback to Ana Maria de Roda Husman on her vulnerable groups presentation.

- A teleconference with Microbial WG members in advance of the June 2014 meeting is needed to develop a way forward in the coming months.

- The issue will be further discussed at the June 2014 Microbial WG meeting.

- Ana Maria de Roda Husman has a student to work on this project for the next 6 months.

**#48. Microbial methods**

**Background:** There is a need to include in the GDWQ general information on microbial methods, on the value of the different methods (e.g. culture, microscopy, nucleic acid amplification/detection, including quantitative polymerase chain reaction, immunoassay), and on when particular methods should be used to detect pathogens. Examples, limitations for each of the methods and data interpretation for methods that are most useful for characterizing the data should be included. Information should also be included in the QMRA document. A WHO project is in development on rapid testing to help in decision-making in low-resource settings, and a pilot study will be done. The Dübendorf meeting concluded that text should be included in section 7.4, in the QMRA document and in the
rapid testing project. The present meeting was asked to confirm whether there is still a need to add text to section 7.4 and whether this text will be out of date by the time the fifth edition is published in 2020.

Summary of discussion:
• There was insufficient time for detailed discussions on this topic.

Expected product(s): Unknown at this time

Next steps (Microbial WG):
• The Microbial WG needs to await completion of the QMRA text before making any decisions on a way forward for this agenda item.
• Microbial methods will be incorporated into the review of chapter 7 at the June 2014 meeting of the Microbial WG.

#49. Antimicrobial resistance

Background: Since the 1940s, antimicrobial drugs have significantly decreased mortality from infectious diseases and supported advancements in modern medicine, such as surgery. However, the world is now facing a crisis, because antimicrobial resistance is progressively eroding the effectiveness of antimicrobial drugs. At the Dübendorf meeting, it was noted that recent publications on antimicrobial resistance in wastewater suggested that recycling or reusing water may be a source of contamination. It is important to learn the relevance of antimicrobially resistant bacteria and to understand the different mechanisms in the transference of antimicrobial resistance genes. The present meeting was asked to review the initial work on a literature search related to antimicrobial resistance and water, sanitation and health (WASH) and review the workplan. These activities can be incorporated with the antimicrobial resistance activities on wastewater.

Presentation by Mark Sobsey:
The terms of reference for a project on antimicrobial resistance and WASH were sent out to the group electronically as a background document. The visibility of antimicrobial resistance has been elevated to a high level within WHO, and WSH has been encouraged to address antimicrobial resistance as part of a greater effort by WHO to bring best practices to the issue.

Antimicrobial resistance is not mentioned in any of the water guidelines. Much has been done in recent years to look for antimicrobially resistant bacteria, and a high percentage of bacteria have been found to harbour antimicrobial resistance traits. Recent review articles include one by Nick Ashbolt. Within WSH, terms of reference were developed to conduct a systematic review to determine what is known from the literature about antimicrobial resistance in relation to WASH, particularly in the context of the Guidelines.

A postdoctoral fellow has been recruited to do this systematic review and to write the report, which will be available by the end of March 2014. This report will inform a briefing note that will be presented to the WHO leadership, representing the WSH position on this issue. The systematic review has been conducted, and 4500 articles have been culled to 450
that were relevant according to the criteria established. At a quick glance, most of these articles are about exposure. Whether incremental increases in health risks are associated with exposure is likely to still be unclear from the literature retrieved. How should this be articulated to the WHO leadership? And how should this be incorporated in the Guidelines? This should be addressed, but there probably will not be much to say on how it impacts our management of drinking-water (or wastewater).

A working group to help guide this process has been established; Paul Hunter is a member, as well as Ana Maria de Roda Husman, Nick Ashbolt and others. Their mandate is to oversee the progress of the literature review. The original schedule calls for a draft by the end of 2013 or by mid-January 2014. Feedback on how to revise and improve the document should be received by the end of March.

Summary of discussion:
- The draft will be ready by the end of March 2014, with more refinements anticipated for May 2014. The briefing note should be prepared by April or May 2014. The plan is to make these publications available for the World Health Assembly in May 2014, where a resolution on antimicrobial resistance is likely to be presented.
- The terms of reference include an assessment of the overall quality of the evidence. However, Mark Sobsey is not sure how to apply the quality of evidence criteria to the types of studies being identified in the systematic review.
- Drug-resistant organisms that are medically important need to be differentiated from those that are not; only if drug resistance is transmissible can those that are not important become important.
- Some boundaries were placed on the literature search. The effort is limited to looking at the literature about the public health consequences of genes moving around in the environment.
- Genes responsible for antimicrobial resistance were around long before antibiotics were invented.
- There will probably be a session on this at the Singapore meeting of the Microbial WG in June 2014.
- In terms of whether the Guidelines should address this issue, Mark Sobsey feels that unless something stunning is found in terms of incremental increases in health risk from drinking-water exposure, it is not that high a priority and probably should be a fifth edition item.

Expected product(s): Additional text for GDWQ (time frame unknown)

Next steps (Microbial WG):
- The report on antimicrobial resistance and WASH will be available for consideration by the Microbial WG at the June 2014 meeting in Singapore.

#50. Reference pathogens

Background: It was identified at the Dübendorf meeting that reference pathogens (index pathogens and indicators) used for performance targets differ from place to place. Issues included the need to add norovirus and helminths as reference pathogens in wastewater,
the use of protozoa as the reference pathogen for helminths, norovirus and dose–response, and reference pathogens and risk for all groups. Although there is text on the terminology describing reference pathogens, index organisms and indicators in the drinking-water guidelines, common terminology on helminths, indicators, index organisms and reference pathogens needs to be included in all the water guidelines. One problem is how to address the terminology across the guidance regarding helminths versus *Ascaris*. *Ascaris* is relevant to sludge and wastewater, but there are other helminths that are relevant for reuse in agriculture. The way forward (as a medium priority for the second addendum) was identified as reviewing the data, including seasonality and potential reference data such as DALYs and dose–response data, finding data on helminths, increasing the text on viruses and bacteria and providing examples. The QMRA guidebook was to be used as a reference for the discussion on the text review.

Summary of discussion:
- As the Dübendorf meeting recommended that the QMRA document be used as the reference for the discussion on the text review, the Microbial WG needs to await completion of the QMRA text before progressing on this agenda item.

Expected product(s): Revised text in chapter 7 (second addendum)

Next steps (Microbial WG):
- The Microbial WG will await completion of the QMRA text before deciding on next steps.
- The issue of reference pathogens will be incorporated into the review of chapter 7 at the Microbial WG meeting in June 2014.

#51. QMRA

Background: Following the Dübendorf meeting, the Microbial WG requested a response as to how the following issues were being dealt with in the QMRA document: performance targets, multiple-barrier approach/aggregating multiple steps for water treatment performance, short-term fluctuations and microbial methods. A response was received from Susan Petterson, one of the key authors of the QMRA document. The Microbial WG expressed its desire to confirm that issues related to the GDWQ are sufficiently addressed in the draft QMRA document.

Summary of discussion:
- This discussion relates to the earlier discussion on the structure and flow of chapter 7 in reference to QMRA.

Expected product(s): Revised text in chapter 7 (fifth edition)

Next steps (Microbial WG):
- The Microbial WG will review the draft QMRA document to confirm that issues related to the GDWQ are adequately addressed.
- QMRA will be incorporated into the review of chapter 7 at the June 2014 meeting of the Microbial WG.
3.8 Closing session

Jennifer De France confirmed that the key issues had been discussed at the Microbial WG meeting and that a way forward on some of these issues had been developed. A more substantive meeting will be held in Singapore in June 2014 with all of the Microbial WG experts, with time for more in-depth discussions. Action items have been identified, and Phil Callan and Jennifer De France will be in touch on those issues to ensure that there are documents to review at the meeting in June 2014.

Jennifer De France thanked the experts for their participations and their useful feedback. She also thanked the governments of the the United Kingdom, Japan, the United States and Australia for their support of the meeting.

4. CHEMICAL MIXTURES MEETING

A WHO meeting on chemical mixtures was held as part of the Chemical WG meeting on the GDWQ in Geneva, Switzerland, on 4 December 2013. The list of participants is given in Annex 1. The meeting was chaired by David Cunliffe, and Marla Sheffer acted as rapporteur. The agenda is included in Annex 2.

4.1 Background

Jennifer De France explained that this was a WHO/USEPA collaboration on the regulation of chemical mixtures in drinking-water and source water. The tasks were to review available tools for human health risk assessment and management approaches, building on the already established WHO/IPCS framework methodology for such assessments; to explore innovative chemical grouping, screening and prioritization approaches; to provide practical recommendations to support risk assessment and risk management; and to identify key challenges and associated research needs.

At the Dübendorf scoping meeting, convened in March 2013, discussions were initiated on these topics. The key outcome of the meeting was that there is sufficient information to develop a toolbox to help regulators address some chemicals in source water and drinking-water as groups. The toolbox should include information on available tools for the risk assessment of chemical mixtures. Toxicology, risk assessment, mode of action, common origins, and analytical and treatment aspects should be considered in grouping chemicals. The above factors for grouping of chemicals can be considered in the problem formulation stage of the WHO/IPCS framework.

The report of the scoping meeting was finalized following the meeting, and WHO commissioned Cranfield University to do the work proposed by the group. A draft document entitled “Risk assessment and management of combined exposure to multiple chemicals in drinking-water and source water” was prepared, for discussion at the current meeting.
4.2 Objective of the meeting

The objective of the meeting was to:

- Further the work on chemical mixtures in drinking-water and source water through the review of the draft publication and identification of next steps.

4.3 Introduction

Ruth Bevan of Cranfield University indicated that she was looking for answers to the following questions: Who is the document aimed at? What is the overall purpose of the document? How do we see the document being used? As the document needs to be example led, what examples can be used to illustrate various sections? Should these be current or newly developed examples?

General discussion points:

- The document is aimed at regulators. However, the document needs to be understood by those who are regulated, so it has a broader audience than just regulators.
- Its overall purpose is to support grouping chemicals in a scientifically rigorous way.
- This is a developed country problem; the tools should not be restricted in their availability, or use by certain developing countries will be excluded.
- This should be a very pragmatic, hands-on document; the problem formulation piece should be very developed; the framework should be better integrated; and the tools should be presented in terms of the WHO/IPCS framework.
- There is a need for understanding of the users’ (stakeholders’) needs in terms of the types of chemicals to which they are exposed.
- All risk management issues are pretty straightforward (using analytical methods, treatment methods, common origin); the difficult issue is how to deal with the toxicological significance of groups of chemicals in order to arrive at risk reduction.
- What is the driver behind the toxicology that determines whether these chemicals can be grouped together?
- Radionuclides are an easy example, with screening techniques that can be used to identify whether there a need to proceed further.
- THMs were grouped because of their common origin on a technical basis, not on a pure toxicological basis.
- The USEPA needs guidance on how to group chemicals from a toxicological perspective.
- The WHO/IPCS framework deals with this and folds exposure into it. It is an iterative path; one goes down the path only as far as is necessary.
- In problem formulation, questions should be asked about the hazards of chemicals and why they might be grouped together. What is needed? What issue is being addressed?
- It is important to let the reader know that sometimes chemical mixtures are less toxic than the individual components (i.e. they cancel out each other’s toxicity). This is particularly true for endocrine disruptors.
- An attempt has been made to group nitrosamines toxicologically, but it failed. An attempt to group perfluorinated compounds also failed, because their toxicology was so vastly different. Indicator species are the new focus of interest.
• For chemicals with a common mode of action, relative potency factors can be used; for chemicals with response addition, the hazard index approach can be used.
• Combining chemical and physical stressors should be considered.
• Can the risk associated with exposure to a group of carcinogens be added based on their individual risk values? Is it scientifically credible to do this?
• Knowing the decision context is critical to answering this question about adding carcinogens. The approaches being proposing toxicologically should line up with more pragmatic approaches.
• Chemicals can be grouped according to functionality (e.g. cyanobacterial toxins).
• Australia has looked at the indicator approach for potable water reuse. Indicator chemicals are used to represent groups of chemicals. Sixteen or 17 chemicals were chosen as indicators of the need for routine monitoring of a broader range of chemicals. If they get a hit on the indicator chemical, this is a trigger to look further on other chemicals in the group.
• If some sort of grouping is not carried out, the numbers of chemicals involved can be overwhelming.
• Health Canada has already grouped some chemicals: total THMs, which reduces the regulatory burden; and benzene, toluene, ethylbenzene and xylenes (BTEX), with benzene as the driver for health concern.
• The indicator approach seems to be the route that California is taking. Indicators can be used to bin water quality. A few chemicals that are representative of a broader group of chemicals are measured, and the results are used as a trigger for specific treatment processes.
• The WHO/IPCS framework is very context specific.
• The USEPA needs to demonstrate benefit or real risk reduction. Traditionally, this has been done by use of the ADI or risk quantification. There are some substances that can demonstrate this (e.g. cholinesterase inhibitors), but chemicals like trichloroethylene and tetrachloroethylene present a whole different set of issues. The USEPA needs advice on how to deal with these as a group.
• Grouping compounds by similar toxic effects will be public health protective.

4.4 Organization and content of draft report

Ruth Bevan asked participants to consider the following:

• the content of the document (is the appropriate information included with correct terminology?);
• the order of the sections;
• how to avoid repetition of previously published background reading;
• examples to demonstrate the use of methods for groupings;
• the best way of demonstrating the use of tools within each framework tier;
• the best way of demonstrating the use of the framework. Previously published examples are available for tiers 0 and 1; should these be used, or should new ones be developed? What examples should be used for tiers 2 and 3? (It would be desirable to have an example for each tier.)
Participants provided comments on a section by section basis, as summarized below.

**Terminology:**

- In the WHO/IPCS framework, it was explained that simple and complex mixtures are understood to be different things by different people (they relate not to numbers of components but to whether they can be grouped toxicologically), as are the terms cumulative and aggregate exposure. A strong recommendation from the framework exercise was to use simple terminology that actually says what is meant.
- The terms that will be used in this document should be explained and defined clearly, but it can also be noted that they may be used differently by other jurisdictions and in other contexts.
- As these terms have been set within the existing WHO/IPCS frameworks, how much flexibility does this group have in changing that terminology?
- The terminology derived from the original WHO/IPCS framework should be adhered to.
- Although the original framework clearly states that the terms simple and complex mixtures should not be used, a later paper by Meek (2012) seems to suggest that they can be used. This needs to be clarified.
- “Simple mixtures” is deceptive terminology, as these mixtures might not be very simple.
- The terms simple and complex could be used to refer to components of known or unknown or variable composition (the framework identifies these as two of several different definitions being used). Another alternative is well characterized (simple mixtures) compared with not well characterized components (complex mixtures).
- The difference between the terms “independent joint action” and “multiple modes of action” is not clear.
- A term other than mixture may need to be used, as mixture implies co-occurrence at the same time without covering the temporal aspect.
- “Combined exposure” needs to be better defined.
- It is confusing to relate mode of action to components. The framework explains that combined exposure to multiple chemicals is also defined in the context of whether or not the components act by similar or different modes of action in induction of critical effects (i.e. “single mode of action” or “multiple modes of action”), but also states that these terms are not used in the framework to avoid confusion.
- The phrase “combined exposure to multiple chemicals” does not refer to the time frame of exposure. However, the original WHO/IPCS framework is titled “Risk assessment of combined exposures to multiple chemicals”, so it will be difficult to change this terminology. It is noted that the original definition does not preclude reference to a time frame of exposure, so the text needs to explain how the term is being applied in this context.
- The terminology issue will take some thought, and it cannot be resolved right now.
- It needs to be confirmed that the terminology used in section 8.2.8 on mixtures in the GDWQ aligns with the terminology used in this report.

**Section 1: Human exposure to multiple chemicals in source water and drinking-water:**

- As an introductory section, placing the definitions of simple and complex mixtures and chemical interactions right at the beginning of the section could cause confusion. Perhaps the definitions can be moved back and the introduction rewritten more
generally. Mixtures and types of chemicals that could occur in water can be explained without coining terms to describe them.

- Ruth Bevan asked for suggestions on what should be included in sections 1.3 and 1.4 (Occurrence of simple and complex mixtures in drinking-water and source water, respectively).
- One example of a simple mixture could be nitrate/nitrite.
- THMs is another example of a mixture.
- Volatile organic compounds (VOCs) in groundwater are a simple mixture, whereas DBPs in drinking-water are a complex mixture.
- Are THMs a good indicator for DBPs?
- Other possible examples of the occurrence of chemical mixtures in source water are cyanotoxins, polychlorinated biphenyls and dioxins, and endocrine disruptors (pharmaceuticals, non-steroidal anti-inflammatory drugs).
- Ruth Bevan will ask people to submit additional examples of mixtures when they review the draft.
- Mixtures are changing constantly over time, and this needs to be captured under occurrence.
- Spatial aspects as well as temporal aspects are important.
- Drinking-water is only one small contributor to total exposure. Inhalation and diet are also important. Is it important to look for substances in the diet that act by a similar mode of action (e.g. nitrate/nitrite in diet)? How can the focus on the narrow exposure via drinking-water relative to the total exposure through other routes be rationalized?

Section 2: Human health risk assessment for combined exposure to multiple chemicals:
- This section explains the WHO/IPCS framework.
- Ruth Bevan needs to take a closer look at the decision-tree developed by Cefic (see p. 17). There have been some developments since the WHO/IPCS framework was developed. In particular, the maximum cumulative ratio (MCR) is a very useful screening tool that is pretty simple to apply and should be included in the toolbox.
- On p. 16, it is unclear why “mixtures that are not subject to regulatory requirements” are being considered.
- There is a low probability of synergistic action at the levels at which these chemicals occur in water; additive action is more likely.
- It needs to be determined how the framework should be applied in a water context (as opposed to, for example, food).
- The reference to the USEPA (2002) guidance for conducting cumulative risk assessments (on p. 16) should be checked; it might be just a framework, not actual guidance.
- Much of the text in this section is available elsewhere; does it need to be duplicated?
- It needs to be presented that the WHO/IPCS framework has been additionally evolved here. For example, how do new developments (e.g. MCR) impact the framework?

Section 3: Managing combined exposure to multiple chemicals in source water and drinking-water:
- More introductory text is needed before the tiers are introduced in the text.
- Source water quality should be discussed first.
Problem formulation in a drinking-water context should be discussed up front as the most important step.

Each case-study will start with the problem formulation step.

Risk management is related to drinking-water only; why is source water being considered?

What is in the source water needs to be characterized to determine needs related to drinking-water, including treatment. By managing the source water (organic matter, dissolved organic carbon, total organic carbon) through WSPs, preventive risk management, etc., the source water is linked to drinking-water outcomes.

A case-study on source water might be useful.

The USEPA looks at risk assessment in an integrated fashion. If the source water is kept clean, there is less concern about drinking-water quality. This is accomplished by setting ambient water quality criteria under the Clean Water Act in the USA.

Case-studies as text box entries throughout the text would be useful for illustrative purposes. What is missing is contextualizing this approach for drinking-water.

The tiers are introduced only as examples. Other options for the tiers are possible, such as, for exposure assessment, biomonitoring (tier 3), monitoring data (tier 2) and scattered exposure measurements and modelling estimates (tier 1).

Why does the tier 0 hazard assessment start with a worst-case scenario? Why is it assumed that every component is as toxic as the most toxic component? The worst-case scenario is used as a screening-level assessment, to get an answer quickly and easily as to whether there is a need to progress further.

The threshold of toxicological concern (TTC) approach is used (in a published case-study) as a tier 0 assessment.

For BTEX, the low tier will not work because of the huge disparity in toxicity between benzene and the other chemicals in the group.

It is agreed that there are cases where the early tiers are not helpful, particularly for the hazard assessment.

The iterative approach and problem formulation are both important and should be emphasized.

Case-studies are key to determining how useful this approach is going to be.

A minimum of four examples would be preferable: one that stops at each of the tiers. However, real-life examples may not fit exactly with this framework. Tier 1 may be reached on the exposure side, whereas tier 3 could be reached on the hazard side.

Several case-studies were suggested at the scoping meeting. Are they workable?

Should we include existing or de novo case-studies?

Case-studies could include VOCs, DBPs, THMs, cyanotoxins, haloacids (better than THMs, as they may be present together, but they have different toxicology; however, they are already controlled at the treatment level, and toxicology does not enter the picture).

Where data for the TTC are available, this is an approach that could be used for drinking-water. However, where an ADI exists, this should be used before the TTC.

It might also be helpful to take some de novo examples through the framework. A risk management example (not stepping through any tiers) might also be included to demonstrate that common sense risk management sometimes is sufficient.

Could the interconversion between chromium(III) and chromium(VI) form the basis for a case-study?
The USEPA in 2010 listed several chemical groups of interest: triazines, carbamates, organophosphates, chloracetanilides, endocrine disruptors, carcinogenic VOCs and nitrosamines.

The existing case-study on carbamate pesticides (in food) might be helpful in showing the utility of tiering from a drinking-water perspective; the pesticide example would be good to show the utility of the early tiers. However, carbamates may not be useful in a drinking-water context.

Data are needed on the exposure side for the co-occurrence of cholinesterase inhibitors or triazines; otherwise, this will not be a useful approach.

What about atrazine plus its metabolite? It needs to be kept in mind that transformation products could have vastly different toxicology from the parent compound. This might be an example of why this approach will fail.

NDMA is a good example of using the relative potency approach, as NDMA is the most potent chemical in the group. However, NDMA is by far the most frequently occurring nitrosamine found at the highest concentrations, so there would likely be no benefit to public health to force agencies to monitor for the other nitrosamines.

This shows how important the exposure component in the framework is. It can drive the assessment. Even on the hazard side (MCR), often only a single component is driving the assessment.

It gets a little more complicated, as nitrosamines can transfer nitroso groups from the nitrosamine to other receptors. As well, 99.9% of exposure to nitrosamines is endogenous.

NDMA dominates nitrosamines, just like chloroform dominates THMs. If NDMA is not found, the other chemicals in the group are unlikely to be present either.

Akihiko Hirose can provide Ruth Bevan with some text for a case-study on combined exposure to pesticides.

What about organotins as an example of a group of chemicals?

Appendices:

The appendices detail the rationale for considering compounds in an assessment group and all the tools that are available for use with the WHO/IPCS framework. Is all the information needed included in these two appendices?

The use of the tools given in the appendices will be illustrated through the case-studies in section 3.

Along with relative potency factor and toxic equivalency factor, there is potential for in vitro bioassays (e.g. estrogenicity) to be useful tools.

Various types of mixtures can be tested if the adverse outcome pathway has been identified.

Biological assays are not currently applied in a regulatory context for drinking-water, but they likely will become common in the next 5–10 years.

In the endocrine disruptor programme in the USA, they are considering replacing some of the expensive tier 1 battery assays with estrogen binding and androgen binding assays; however, this programme does not monitor water specifically, but rather individual chemicals that have the propensity to contaminant food and water.

Wastewater in the USA includes regulations based on in vivo bioassays.
Bette Meek will go through the appendices in detail and flag any omissions. She will also send Ruth Bevan her comments on the text by the end of December.

Ruth Bevan thanked everyone for their input. She will discuss the comments with Jennifer De France and John Fawell and then come back to meeting participants with a revised draft for another round of comments.

Jennifer De France informed the group that detailed comments on the draft report were welcome. Ruth Bevan will continue to develop this draft document based on feedback from this group and will send an updated version for comments in mid-2014. The project is supposed to be finalized by 2015. Authors will need to be identified to develop the case-studies.

4.5 Closing session

Jennifer De France acknowledged that it was a valuable meeting to ensure that we are on the right track. She thanked David Cunliffe for chairing the meeting, the USEPA for its support of the meeting and Ruth Bevan for agreeing to take on this challenging task.
ANNEX 1: List of participants for the Chemical Aspects Working Group and Chemical Mixtures meetings

LIST OF PARTICIPANTS

WHO Meeting on the Guidelines for Drinking-water Quality
Chemical Working Group Meeting
Chemical Mixtures Meeting

Geneva, 2–4 December 2013

Mari Asami*
Department of Water Supply Engineering
National Institute of Public Health
2-3-6 Minami
Wako
Saitama 351-0197
Japan

Ruth Bevan
Lecturer in Human Health and Risk Assessment, and Project/Resource Manager
Cranfield Health
Vincent Building
Cranfield University
Bedfordshire MK43 0AL
United Kingdom

Philip Callan
28 Helen Mayo Crescent
Bonython ACT 2905
Australia

Joseph Cotruvo
Joseph Cotruvo Associates/NSF International
5015 46th St NW
Washington, DC 20016
USA

David Cunliffe
Department of Health
Public Health
PO Box 6, Rundle Mall
Adelaide SA 5001
Australia

* Invited but unable to attend; # Participated in the Chemical Mixtures meeting only via teleconference
John Fawell*
Independent Consultant
9 Dandridge Drive
Bourne End
Bucks, SL8 5UW
United Kingdom

Michèle Giddings
Health Canada
Water Quality & Science Division
Water and Air Quality Bureau
3rd Floor (Room 3-005A)
269 Laurier Avenue West, A.L. 4903A
Ottawa, Ontario
Canada K1A 0K9

Owen Green
WCA Environment Ltd
Brunel House
Volunteer Way
Faringdon
Oxfordshire, SN7 7YR
United Kingdom

Akihiko Hirose
Division of Risk Assessment
National Institute of Health Sciences
1-18-1 Kamiyoga
Setagaya-ku
158-8501 Tokyo
Japan

Peter Marsden
Drinking Water Inspectorate
7E, 9 Millbank
c/o Nobel House
17 Smith Square
London SW1P 3JR
United Kingdom

Yoshihiko Matsui
Division of Environmental Engineering
Faculty of Engineering
Hokkaido University
N13W8 Sapporo
060-8628 Japan
Bette Meek
Associate Director, Chemical Risk Assessment
McLaughlin Centre for Population Health Risk Assessment
University of Ottawa
One Stewart Street, Suite 309
Ottawa, Ontario
Canada K1N 6N5

Edward Ohanian*
Associate Director for Science
Office of Water (Mail Code 4301T)
Environmental Protection Agency
Ariel Rios Building
1200 Pennsylvania Avenue, NW
Washington, DC 20460-0001
USA

Choon Nam Ong*
NUS Environmental Research Institute
National University of Singapore
Lower Kent Ridges Road
Singapore 119077

Santhini Ramasamy
Senior Toxicologist
Office of Science and Technology, Office of Water
Environmental Protection Agency Headquarters (Mail Code 4304T)
William Jefferson Clinton Building East 5233Q
1200 Pennsylvania Avenue NW
Washington, DC 20460
USA

Marla Sheffer
1553 Marcoux Drive
Orleans, Ontario
Canada K1E 2K5

Shane Snyder
Professor
College of Engineering
University of Arizona
1133 E. James E. Rogers Way
Harshbarger 118
Tucson, Arizona 85721
USA
WHO Secretariat

Richard Brown
World Health Organization
Evidence and Policy on Emerging Environmental Health Issues
20 Avenue Appia
1211 Geneva 27
Switzerland

Jennifer De France
World Health Organization
Water, Sanitation, Hygiene & Health (WSH)
20 Avenue Appia
1211 Geneva 27
Switzerland

Bruce Gordon
Water, Sanitation, Hygiene & Health (WSH)
World Health Organization
20 Avenue Appia
1211 Geneva 27
Switzerland

Philippe Verger
World Health Organization
Risk Assessment and Management
20 Avenue Appia
1211 Geneva 27
Switzerland
### ANNEX 2: Agenda for the Chemical Aspects Working Group and Chemical Mixtures meetings

#### Day 1: Monday 2 December 2013

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<th>Time</th>
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<tr>
<td>0830–0900</td>
<td>Daily preparatory meeting of chair, rapporteur and WHO secretariat</td>
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</tr>
<tr>
<td>0900–1030</td>
<td><strong>Session 1 - Introductions, objectives and updates</strong></td>
<td>Chair: Bruce Gordon</td>
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<tr>
<td></td>
<td>Welcome and introduction of participants (Maria Neira)</td>
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<tr>
<td></td>
<td>Update on key achievements on water quality and health (Bruce Gordon)</td>
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<tr>
<td></td>
<td>Meeting Overview, objectives and methods of work (Jennifer De France)</td>
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<tr>
<td>1030–1100</td>
<td><strong>Coffee</strong></td>
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<tr>
<td>1100–1230</td>
<td><strong>Session 2 – Pesticides</strong></td>
<td>Chair: David Cunliffe</td>
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<tr>
<td></td>
<td>Overview of updated templates for pesticide background documents (John Fawell/Jennifer De France)</td>
<td>See annotated agenda for reference documents and session objectives</td>
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<tr>
<td></td>
<td>MCPA (John Fawell/Jennifer De France)</td>
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<tr>
<td></td>
<td>Bentazone (Yoshihiko Matsui)</td>
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<td>Diquat (Yoshihiko Matsui)</td>
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<td>Dicofol (Pete Marsden)</td>
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<td>Dichlorvos (John Fawell/Jennifer De France)</td>
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<tr>
<td>1230–1330</td>
<td><strong>Lunch</strong></td>
<td></td>
</tr>
<tr>
<td>1330–1500</td>
<td><strong>Session 3 – Pesticides (cont.)</strong></td>
<td>Chair: David Cunliffe</td>
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<td></td>
<td>Update from JMPR (Philippe Verger)</td>
<td>See annotated agenda for reference documents and session objectives</td>
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<td></td>
<td>Prioritizing existing GDWQ pesticides for review, including aldrin, dieldrin and DDT (John Fawell/Phil Callan)</td>
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<td></td>
<td>Japan priority pesticides (Yoshihiko Matsui)</td>
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<td></td>
<td>Withdrawal of GVs including for pesticides (John Fawell/Jennifer De France)</td>
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<td></td>
<td>Allocation factors, including for pesticides (Michèle Giddings)</td>
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<tr>
<td>1500–1530</td>
<td><strong>Coffee</strong></td>
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<tr>
<td>1530–1700</td>
<td><strong>Session 4 – Background documents</strong></td>
<td>Chair: David Cunliffe</td>
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<tr>
<td></td>
<td>Review of background documents structure and content (Shane Snyder, Michèle Giddings, Barium (Joe Cotruvo)</td>
<td>See annotated agenda for reference documents and session objectives</td>
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### Day 2: Tuesday 3 December 2013

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<td>0830–0900</td>
<td>Daily preparatory meeting of chairs and rapporteurs</td>
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<tr>
<td>0900–1030</td>
<td><strong>Session 1 – Gaps in the GDWQ</strong> Chair: David Cunliffe</td>
<td>Introduction to data gaps in the GDWQ (John Fawell)</td>
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<tr>
<td></td>
<td></td>
<td>Overview of data gaps work and preliminary findings (Owen Green)</td>
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<td></td>
<td>See annotated agenda for reference documents and session objectives</td>
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<tr>
<td>1030–1100</td>
<td>Coffee</td>
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<tr>
<td>1100–1230</td>
<td><strong>Session 1 – Gaps in the GDWQ (cont.)</strong> Chair: David Cunliffe</td>
<td>Identify background documents that need updated based on data gaps work (Owen Green)</td>
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<tr>
<td></td>
<td></td>
<td>Identify additional background documents that need updating (Phil Callan)</td>
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<td>See annotated agenda for reference documents and session objectives</td>
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<tr>
<td>1230–1330</td>
<td>Lunch</td>
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<tr>
<td>1400–1500</td>
<td><strong>Session 3 – Background documents/update on progress</strong> Chair: David Cunliffe</td>
<td>Nitrate/nitrite (Michèle Giddings)</td>
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<tr>
<td></td>
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<td>Organotins (Akihiko Hirose)</td>
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<td>Nickel (Akihiko Hirose)</td>
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<td></td>
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<td>Sodium (Michèle Giddings)</td>
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<td>Manganese (John Fawell)</td>
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<td>See annotated agenda for reference documents and session objectives</td>
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<td>1500–1530</td>
<td>Coffee</td>
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<tr>
<td>1530–1700</td>
<td><strong>Session 4 – Background documents (cont.)</strong> Chair: David Cunliffe</td>
<td>BDCM (Michèle Giddings)</td>
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<tr>
<td></td>
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<td>Chlorate and chlorine dioxide (Joe Cotruvo)</td>
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<td>See annotated agenda for reference documents and session objectives</td>
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</table>
## Day 3: Wednesday 5 December 2013

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<td>0830–0900</td>
<td>Daily preparatory meeting of chairs and rapporteurs</td>
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<tr>
<td>0900–1030</td>
<td><strong>Session 1 - Background documents/update on progress</strong></td>
<td>Chair: David Cunliffe</td>
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<td></td>
<td>Bromate (Michèle Giddings)</td>
<td>See annotated agenda for reference documents and session objectives</td>
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<td></td>
<td>PFOS/PFOA (Ruth Bevan)</td>
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<td></td>
<td>Perchlorate (Shane Snyder)</td>
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<tr>
<td>1030–1100</td>
<td>Coffee</td>
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<tr>
<td>1100–1230</td>
<td><strong>Session 2 – Update on progress and wrap up</strong></td>
<td>Chair: David Cunliffe</td>
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<tr>
<td></td>
<td>Molybdenum (Akihiko Hirose)</td>
<td>See annotated agenda for reference documents and session objectives</td>
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<td>Personal care products (Pete Marsden)</td>
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<td></td>
<td>Update from PCS, including chromium (Richard Brown)</td>
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<td>Update from JECFA, including inorganic mercury (Philippe Verger)</td>
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<td></td>
<td>Wrap up and closing of GDWQ chemical meeting (Jennifer De France)</td>
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<tr>
<td>1230–1330</td>
<td>Lunch</td>
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<tr>
<td>1330–1500</td>
<td><strong>Session 3 – Chemical mixtures</strong></td>
<td>Chair: David Cunliffe</td>
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<tr>
<td></td>
<td>Introduction (Jennifer De France)</td>
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<td></td>
<td>Objectives and overview of session (Ruth Bevan)</td>
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<td></td>
<td>Review of draft document</td>
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<tr>
<td>1500–1530</td>
<td>Coffee</td>
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<tr>
<td>1530–1700</td>
<td><strong>Session 4 – Chemical mixtures (cont.)</strong></td>
<td>Chair: David Cunliffe</td>
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<tr>
<td></td>
<td>Review of draft document (cont.)</td>
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<tr>
<td></td>
<td>Confirmation on way forward and closing of chemical mixtures meeting (Ruth Bevan, and Jennifer De France)</td>
<td></td>
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</tbody>
</table>
ANNEX 3: Pesticide background document template

Title [Chemical name]

- Introductory paragraph to provide ISO-approved name, IUPAC name, CAS No., plus any other relevant information (e.g. if pesticide is listed on Stockholm POPs Convention)

Major uses [1 paragraph]

Potential for occurrence in water [3–4 paragraphs]

- environmental fate and transformation products
- quantitative information on half-lives, etc. (if available)
- statement about propensity of pesticide to enter water based on physicochemical properties
- general statement on occurrence (broad studies are preferable, could provide range of measured concentrations in several countries)

Toxicity [2–3 paragraphs]

- short paragraph describing ADI (0–x mg/kg bw) and end-point on which it was based
- short statement describing ARfD (x mg/kg bw) and end-point on which it is based (or statement that JMPR did not consider it necessary to establish an ARfD)
- refer to JMPR document for more detailed information
- metabolites (if applicable)
- information on bioaccumulation in humans, when relevant

Derivation of the health-based value [1–3 paragraphs]

- derive value (from unrounded upper bound of ADI, calculated from NOAEL or LOAEL), give assumptions used (60 kg bw, 2 L of drinking-water, allocation factor); explain in detail only if not using default allocation factor; otherwise, state that exposure data are considered insufficient to justify modifying the default allocation factor for drinking-water of 20%
- contribution of dietary exposure to JMPR ADI (from JMPR report, where available)

Considerations in applying the health-based value

- source control and seasonal variation (when applicable)
- advice on need for monitoring (e.g. monitor only if pesticide used, no need to monitor for volatiles in surface water) and what to do in case of short-term exceedance
- include advice on when HBV should be incorporated into national standards
- mention availability of ARfD (if applicable) for use in spill situations

Analysis in water [1 paragraph]

- general statement as to whether it is possible to analyse down to level of HBV, with example of standard method (USEPA, AWWA, etc.)
Treatment [1 paragraph]
- statement as to whether it is possible to reduce to HBV by treatment, with type of process that may be used (e.g. biological, oxidation, carbon)
- by-products produced by treatment (when relevant)
- refer to other documents for additional information

Conclusion
- compare value with occurrence in water: e.g. Based on available information, pesticide occurs in water only at levels well below the HBV and is therefore not normally a concern in drinking-water.

References
- JMPR reference, including URL (JMPR report for dietary exposure, JMPR toxicological monograph for toxicity, as references included only in monograph; JMPR database can also be referenced)
- Reference all information that is not taken from JMPR report, as this will be the only background document

Disclaimer
- The literature has been searched up to [date]. (if key references are not recent)
ANNEX 4: List of chemicals for which occurrence data are to be requested from Member States

**Chemicals with provisional GVs**
1,2-Dibromoethane
Dichloroacetonitrile
1,2-Dichloropropane
Epichlorohydrin
Pentachlorophenol
Trichloroethene
Uranium

**Chemicals for which GVs have not been established due to inadequate data**
Bromochloroacetate
Bromochloroacetonitrile
2-Chlorophenol
Chloropicrin
Dibromoacetate
Dichloramine
1,1-Dichloroacetone
1,3-Dichloroacetone
1,3-Dichlorobenzene
1,1-Dichloroethane
2,4-Dichlorophenol
1,3-Dichloropropane
Monobromoacetate
Trichloroacetate
Trichloroacetonitrile

**Essential elements**
Copper
Iron
Manganese
Molybdenum
Selenium

**Others (not on WCA list)**
Cyanide
Dialkyltins/organotins
Mercury
Nitrate/nitrite

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2 This is a preliminary list. It will be modified as feedback from experts is received on the need to acquire occurrence data for the individual chemicals on the list.
ANNEX 5: Chemical background document template

Preface (completed by WHO)

Acknowledgements (completed by WHO)

Abbreviations used in the text

Table of contents

1. General description
   1.1 Identity
   1.2 Physicochemical properties
   1.3 Organoleptic properties
   1.4 Major uses and sources in drinking-water
   1.5 Environmental fate

2. Environmental levels and human exposure
   2.1 Air
   2.2 Water
   2.3 Food
   2.4 Estimated total exposure and relative contribution of drinking-water

3. Kinetics and metabolism in laboratory animals and humans

4. Effects on experimental animals and in vitro test systems
   4.1 Acute exposure
   4.2 Short-term exposure
   4.3 Long-term exposure
   4.4 Reproductive and developmental toxicity
   4.5 Immunological effects
   4.6 Genotoxicity and related end-points
   4.7 Carcinogenicity
   4.8 Mode of action

5. Effects on humans

6. Practical considerations
   6.1 Analytical methods and achievability
   6.2 Treatment methods and performance
   6.3 Prevention and control

7. Guideline value [or Conclusions]

8. Assessment of the quality of evidence

9. References
WHO Meetings on the GDWQ, 2–5 December 2013, Geneva

ANNEX 6: List of participants for the Chemical Aspects and Microbial Aspects Working Group meeting on cross-cutting issues

LIST OF PARTICIPANTS

WHO Meeting on the Guidelines for Drinking-water Quality
Chemical Aspects and Microbial Aspects Working Group Meeting on Cross-cutting Issues
Geneva, 5 December 2013

Mari Asami*
Department of Water Supply Engineering
National Institute of Public Health
2-3-6 Minami
Wako
Saitama 351-0197
Japan

Ruth Bevan
Lecturer in Human Health and Risk Assessment, and Project/Resource Manager
Cranfield Health
Vincent Building
Cranfield University
Bedfordshire MK43 0AL
United Kingdom

Philip Callan
28 Helen Mayo Crescent
Bonython ACT 2905
Australia

Joseph Cotruvo
Joseph Cotruvo Associates/NSF International
5015 46th Street NW
Washington, DC 20016
USA

David Cunliffe
Department of Health
Public Health
PO Box 6
Rundle Mall
Adelaide SA 5001
Australia

* Invited but unable to attend
Ana Maria de Roda Husman  
National Institute of Public Health and the Environment (RIVM)  
Center for Infectious Disease Control  
Laboratory for Zoonoses and Environmental Microbiology (LZO; Bag 63)  
Department of the Environment  
PO Box 1 / Antonie van Leeuwenhoeklaan 9  
3720 BA Bilthoven  
The Netherlands  

John Fawell*  
Independent Consultant  
9 Dandridge Drive  
Bourne End  
Bucks, SL8 5UW  
United Kingdom  

Lorna Fewtrell  
Institute of Geography & Earth Sciences  
Aberystwyth University  
Llandinam Building  
Penglais Campus  
Aberystwyth, SY23 3DB  
United Kingdom  

Michèle Giddings  
Health Canada  
Water Quality & Science Division  
Water and Air Quality Bureau  
3rd Floor (Room 3-005A)  
269 Laurier Avenue West, A.L. 4903A  
Ottawa, Ontario  
Canada K1A 0K9  

Akihiko Hirose  
Division of Risk Assessment  
National Institute of Health Sciences  
1-18-1 Kamiyoga  
Setagaya-ku  
158-8501 Tokyo  
Japan  

Paul Hunter  
The Norwich School of Medicine  
University of East Anglia  
Norwich NR4 7TJ  
United Kingdom
WHO Meetings on the GDWQ, 2–5 December 2013, Geneva

Peter Marsden
Drinking Water Inspectorate
7E, 9 Millbank
40 Nobel House
17 Smith Square
London SW1P 3JR
United Kingdom

Yoshihiko Matsui*
Division of Environmental Engineering
Faculty of Engineering
Hokkaido University
N13W8 Sapporo
060-8628 Japan

Edward Ohanian*
Associate Director for Science
Office of Water (Mail Code 4301T)
Environmental Protection Agency
Ariel Rios Building
1200 Pennsylvania Avenue NW
Washington, DC 20460-0001
USA

Choon Nam Ong*
NUS Environmental Research Institute
National University of Singapore
Lower Kent Ridges Road
Singapore 119077

Santhini Ramasamy
Senior Toxicologist
Office of Science and Technology, Office of Water
Environmental Protection Agency Headquarters (Mail Code 4304T)
William Jefferson Clinton Building East 5233Q
1200 Pennsylvania Avenue NW
Washington, DC 20460
USA

Marla Sheffer
1553 Marcoux Drive
Orleans, Ontario
Canada K1E 2K5
WHO Meetings on the GDWQ, 2–5 December 2013, Geneva

Mark Sobsey
University of North Carolina at Chapel Hill
CB No.7431
Rosenau Hall, Room 149C
Chapel Hill, North Carolina 27599-7431
USA

Shane Snyder
Professor
College of Engineering
University of Arizona
1133 E. James E. Rogers Way
Harshbarger 118
Tucson, Arizona 85721
USA

WHO Secretariat

Jennifer De France
World Health Organization
Water, Sanitation, Hygiene & Health (WSH)
20 Avenue Appia
1211 Geneva 27
Switzerland

Maggie Montgomery
Water, Sanitation, Hygiene & Health (WSH)
World Health Organization
20 Avenue Appia
1211 Geneva 27
Switzerland
ANNEX 7: Agenda for the Chemical Aspects and Microbial Aspects Working Group meeting on cross-cutting issues

Thursday 5 December 2013

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<tr>
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<th>Agenda item</th>
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<tr>
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<td>Daily preparatory meeting of chair, rapporteur and WHO secretariat</td>
<td></td>
</tr>
<tr>
<td>0900–1030</td>
<td><strong>Session 1 – Introduction, Alternative Disinfectants, Potable Reuse</strong></td>
<td>Chair: Shane Snyder</td>
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<tr>
<td></td>
<td>Welcome and introduction of participants (Jennifer De France)</td>
<td>See annotated agenda for reference documents and session objectives</td>
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<tr>
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<td>Meeting Overview, objectives and methods of work</td>
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<td>Declaration of interests and Election of officers (Jennifer De France)</td>
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<td>Alternative disinfectants</td>
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<td></td>
<td>- Silver (Lorna Fewtrell)</td>
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<td>- NaDCC (John Fawell)</td>
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<td></td>
<td>- Iodine and Bromine (Ruth Bevan)</td>
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<td>Potable reuse (John Fawell)</td>
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<tr>
<td>1030–1100</td>
<td><strong>Coffee</strong></td>
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<tr>
<td>1100–1230</td>
<td><strong>Session 2 – Other Cross-cutting Issues</strong></td>
<td>Chair: Shane Snyder</td>
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<td>Quality of the Evidence</td>
<td>See annotated agenda for reference documents and session objectives</td>
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<tr>
<td></td>
<td>- Introduction (Phil Callan)</td>
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<td></td>
<td>- Use of GRADE in public health interventions (Paul Hunter)</td>
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<td>- Evaluating the evidence of silver (Lorna Fewtrell)</td>
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<td>Cyanobacteria</td>
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<td>- Update on TCiW (Jennifer De France)</td>
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<td>- Cyanobacteria fact sheet (Phil Callan)</td>
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<td>Translating the Guidelines into National Standards (David Cunliffe)</td>
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<td></td>
<td>Wrap up and closing of GDWQ cross-cutting meeting (Jennifer De France)</td>
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ANNEX 8: List of participants for the Microbial Aspects Working Group meeting

LIST OF PARTICIPANTS

WHO Meeting on the Guidelines for Drinking-water Quality
Microbial Aspects Working Group Meeting
Geneva, 5 December 2013

Philip Callan
28 Helen Mayo Crescent
Bonython ACT 2905
Australia

David Cunliffe
Department of Health
Public Health
PO Box 6
Rundle Mall
Adelaide SA 5001
Australia

Ana Maria de Roda Husman
National Institute of Public Health and the Environment (RIVM)
Center for Infectious Disease Control
Laboratory for Zoonoses and Environmental Microbiology (LZO; Bag 63)
Department of the Environment
PO Box 1 / Antonie van Leeuwenhoeklaan 9
3720 BA Bilthoven
The Netherlands

Michèle Giddings
Health Canada
Water Quality & Science Division
Water and Air Quality Bureau
3rd Floor (Roomm 3-005A)
269 Laurier Avenue West, A.L. 4903A
Ottawa, Ontario
Canada K1A 0K9

Paul Hunter
The Norwich School of Medicine
University of East Anglia
Norwich NR4 7TJ
United Kingdom

* Invited but unable to attend
Masaki Sagehashi  
Department of International Health and Collaboration  
National Institute of Public Health  
2-3-6 Minami, Wako  
Saitama 351-0197  
Japan

Marla Sheffer  
1553 Marcoux Drive  
Orleans, Ontario  
Canada K1E 2K5

Mark Sobsey  
University of North Carolina at Chapel Hill  
CB No. 7431  
Rosenau Hall, Room 149C  
Chapel Hill, North Carolina 27599-7431  
USA

Shane Snyder*  
College of Engineering  
University of Arizona  
1133 E. James E. Rogers Way  
Harshbarger 118  
Tucson, Arizona 85721  
USA

WHO Secretariat

Jennifer De France  
World Health Organization  
Water, Sanitation, Hygiene & Health (WSH)  
20 Avenue Appia  
1211 Geneva 27  
Switzerland
ANNEX 9: Agenda for the Microbial Aspects Working Group meeting

<table>
<thead>
<tr>
<th>Time</th>
<th>Agenda item</th>
<th>Notes</th>
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<tr>
<td>1330–1500</td>
<td><strong>Session 1</strong></td>
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<td></td>
<td>Introduction (Jennifer De France)</td>
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<td>PICO questions (Mark Sobsey)</td>
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<td>Boil water fact sheet (David Cunliffe)</td>
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<td>Treatment tables (Jennifer De France, Masaki Sagehashi)</td>
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<td>Water treatment and pathogens (Mark Sobsey tbc)</td>
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<td>1500–1530</td>
<td><strong>Coffee</strong></td>
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<td>1530–1700</td>
<td><strong>Session 2</strong></td>
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<td>Microbial fact sheets and Pathogenic and non-pathogenic strains –</td>
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<td>Table 7.1 and 7.2 (Ana Maria de Roda Husman tbc)</td>
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<td>Background vs incidents (including short-term fluctuations) (David Cunliffe)</td>
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<td>Aggregating multiple steps (David Cunliffe)</td>
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<td>Multiple barriers (David Cunliffe)</td>
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<td>Legionella (David Cunliffe)</td>
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<td>Turbidity (David Cunliffe)</td>
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<td>Vulnerable groups (Ana Maria de Roda Husman)</td>
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<td>Microbial methods (Ana Maria de Roda Husman tbc)</td>
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<td>Antimicrobial resistance (Mark Sobsey)</td>
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<td>Reference pathogens (David Cunliffe)</td>
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<td>QMRA (David Cunliffe)</td>
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