CANADIAN WATER NETWORK
RÉSEAU CANADIEN DE L'EAU

IDENTIFYING AND PRIORITIZING MUNICIPAL WASTEWATER AND BIOSOLIDS RESEARCH NEEDS

Advisory Workshop
Toronto, Ontario

March 29, 2012
Summary Report

Identifying and Prioritizing Municipal Wastewater and Biosolids Research Needs

An Advisory Workshop
Toronto, March 29, 2012

Summary Report

Executive Summary

Under the sponsorship of the Canadian Council of Ministers of the Environment (CCME) and the Canadian Water Network (CWN), an advisory workshop was convened on March 29, 2012 as part of an ongoing consultation to determine scientific research priorities for CWN's Canadian Municipal Water Consortium (CMWC), a national research consortium addressing municipal water management needs.

The purpose of the workshop was three-fold:

- To review the concept and evolution to date of a national Science and Research Coordinating Body (SRCB) for municipal wastewater and biosolids research, a body formed in 2010 as an initiative from CCME.

- To summarize the development by the SRCB of a draft *"National Research Agenda for Municipal Wastewater and Biosolids"* (the Agenda) and to present a brief review of its content.

- To generate, using the Agenda as background, a short list of potential research project areas to be initiated over the next year that would generate significant partner interest, value and co-investment and launch key national activities within the larger end-user community.

Participants invited to the workshop manage municipal water issues to varying degrees and included personnel from municipalities, consulting firms, provincial and federal departments, the Assembly of First Nations, NGOs, public interest groups and others.

The focus of the workshop was to identify, from a large list of potential research project areas, a smaller subset of compelling areas that could gain traction in the Canadian context, understanding that there would likely be regional variations in both need and application and recognizing that relevance and overlap at an international level might exist. The workshop generated six important research project areas that participants felt had strong potential to both address clear needs and garner interest from prospective partners who could help collectively to ensure strong design and support for

meaningful research and application of results. The six *Research Project Areas* identified are shown in Table 1. These areas will be further explored and refined through consultation processes by CWN through its CMWC and are expected to lead to calls for research proposals likely in the fall of 2012.

Table 1. Research Themes, Sub-Themes and Topics of the National Research Agenda for Municipal Wastewater and Biosolids and the Draft Research Project Areas Generated from Agenda Topic areas at the March 29, 2012 Workshop.

Title #	Theme	Sub-Theme	Topic	Research Project Area
9	Biosolids	Biosolids application	Effects & mitigation strategies (incl. social issues)	Investigate fate & transport of emerging substances of concern (ESOCs) from land-applied biosolids
2	Municipal wastewater treatment	Nutrients	Process research	Low cost, more efficient technology for nutrient (N, P) removal
8	Biosolids	Biosolids & sludge treatment & management	Process research & optimization	"Green energy from sludge": Optimization of anaerobic digestion to increase biogas production and improve biosolids quality
13	Climate change & sustainability	Sustainable wastewater / biosolids management	Energy reduction / resource recovery processes	Systems integrated view of resource recovery opportunities (reclaimed water, energy, nutrients, organics) in representative wastewater systems (collection and treatment)
5	Municipal wastewater treatment	Wastewater treatment plant processes & optimization (incl. nutrients)	Receiving water effects & mitigation strategies	Emerging substances of concern (ESOCs): Treatment processes (i.e., removal or destruction)
3	Municipal wastewater treatment	Emerging substances of concern (ESOCs)	Source control (for both wastewater and biosolids)	Identify the contribution of sources (i.e., hospitals, nursing homes, etc.) to influent wastewater

1.0 Background

In response to developing the Canada-wide Strategy for the Management of Municipal Wastewater Effluent and the Canada-wide Approach for the Management of Wastewater Biosolids, both the Municipal Wastewater Effluent Coordinating Committee (MWWE CC) and the Biosolids Task Group (BTG) of the Canadian Council of Ministers of the Environment (CCME) identified a need for better national coordination of research that would underpin regulations, actions and advancements taking place in these areas. As a result, the CCME recommended forming a Science and Research Coordination Body (SRCB) to better coordinate and disseminate research on municipal wastewater and biosolids in Canada.

Representatives from Canadian Water Network (CWN), Canadian Water and Wastewater Association (CWWA), Environment Canada (EC), Municipal Wastewater Effluent Coordinating Committee (MWWE CC), and Biosolids Task Group (BTG) formed a "Core Group" in 2010 to advance the intent of the SRCB goals. This group established an initial set of tasks in 2011, including developing a draft *National Research Agenda for Municipal Wastewater and Biosolids* (the Agenda).

2.0 Draft National Research Agenda for Municipal Wastewater and Biosolids

An initial draft of the *National Research Agenda for Municipal Wastewater and Biosolids* was generated in April 2011 and discussed at CWWA workshops in May and December 2011. This resulted in a revised draft that was then made available nationally for consultation and comment online (www.cwn-rce.ca/news-and-events/national-research-agenda-for-municipal-wastewater-and-biosolids/) during January and February 2012. Invitations to review the Agenda for this last consultation were sent out nationally using various listservs and, as a result, provided exposure to several thousand people nationally. Many comments and suggestions were received giving rise to a disposition table prepared at CCME's request to describe how these comments and suggestions were addressed through revisions to the Agenda. The **disposition table** is available on CWN's website (www.cwn-rce.ca/wp-content/uploads/2012/05/municipal-wastewater-biosolids-disposition-table.pdf). The **Agenda** has now been finalized and is also available on CWN's website (www.cwn-rce.ca/wp-content/uploads/2012/01/national-research-agenda-report-final-version1.pdf). It was subsequently used as background for the March 29, 2012 workshop.

The Agenda identifies a large number (53) of research needs expressed as *Topics* that are expected to be of interest to a broad range of stakeholders across Canada. Priorities are expected to vary nationally by region, perspective and specific circumstances; the comments received from each consultation round reflected some of this variation. The document includes the development criteria and weighting factors to prioritize the *Topics* within *Themes* and *Sub-themes* and these are used in a matrix operation to produce a ranked order of the *Topics*. Given the range of interests and needs across Canada, the intention is that stakeholders can adjust the criteria and weightings and use them in the matrix operation to more accurately address specific regional needs. As well, as conditions such as effluent requirements or costs of energy, as examples, change with time, adjustments can be made to reflect these changing conditions.

3.0 Launching Initial Research through CWN's Canadian Municipal Water Consortium

CWN agreed to lead the task (as defined by the Core Group) of building on this national consultation process to launch research projects in areas of identified shared need through its Canadian Municipal Water Consortium (CMWC) http://www.cwn-rce.ca/research/consortium/municipal-water-management/. To accelerate the process, CWN has pledged some of its grant resources to serve as seed money. CWN will apply its research protocols involving stakeholder consultations, partner matching and management tools through the CMWC to create research projects.

For this first phase of work, CWN anticipates providing a tranche of $450,000 as research seed funding to support initial priority areas to be identified as a result of this workshop. The goal in using these funds and CWN protocols is to attract significant partner interest and co-investments to support the research.

3.1 Identifying Some Initial "Winners"

The intention of CWN is to launch effective, end-user defined research projects nationally in the areas of wastewater and biosolids that will provide clear value to address stakeholder needs identified through national consultations. This is expected to catalyze further interest and future investment in the ongoing work in this area to increase value for all participants. The plan is to identify and post calls for research proposals that:

- address an area of need, interest and importance to many municipalities within regions across Canada
- are characterized by compelling drivers that will improve the likelihood of progress in the making of key decisions on important issues
- are likely to catch the attention of and attract participation and co-investment by municipalities, governments or other partners (through CWN consortium matching procedures for example in which interested partners are connected with researchers and their project proposal ideas
- can lead to strong success stories and case studies illustrating the value of the consortium approach

4.0 Workshop Process Overview

The primary goal of the March 29, 2012 workshop was to identify a short list of compelling, researchable project areas that could garner attention and co-investment to provide clear value to stakeholders and to have the potential to produce success stories to encourage further participation and support. The workshop sessions used the draft *National Research Agenda for Municipal Wastewater and Biosolids* and the consultation feedback as a logical and reasonable background framework to identify key shared priority needs from which to make choices.

A total of 35 invited participants were involved in the workshop, representing an expanded "focus group" of perspectives across the spectrum of end users contributing to the Agenda document (Appendix A lists the participants). They worked with the prioritized list of *Topic* areas presented in the Agenda document as a starting point. They then selected and prioritized *Topics* within the list to create a short-list of potential researchable project areas to serve as a basis for soliciting interest from potential partners leading to calls for research proposals.

4.1 Pre-Workshop Survey Synthesis: Generating Top 15 Topic Areas

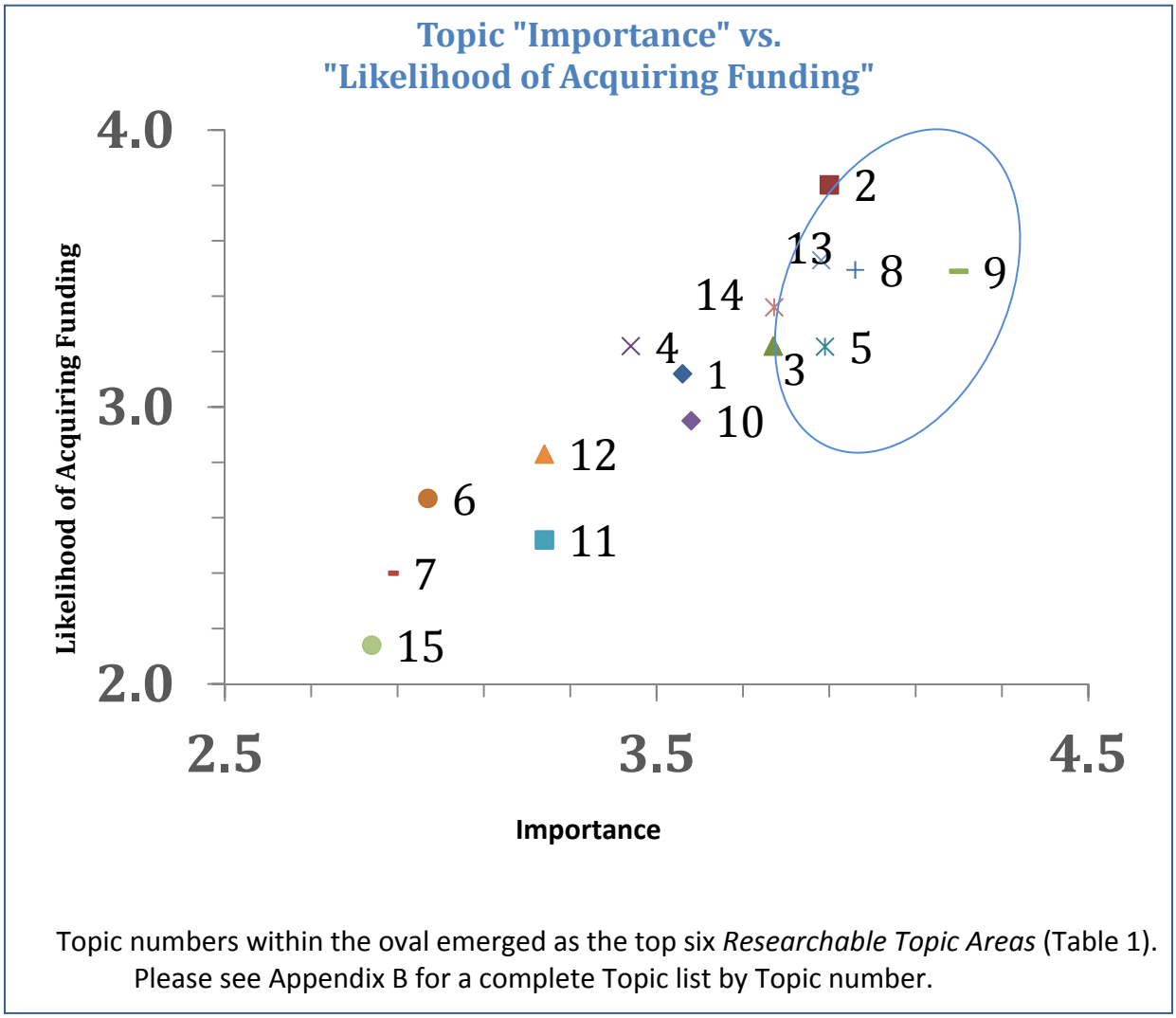
Based on the survey feedback provided during the public consultation on the draft Agenda in January and February 2012, a list of preferred research *Topics* was selected from those presented in Table 9 of the draft Agenda. The 15 *Topics* are presented in Appendix B of this report together with a listing of *Sub-topics* included to elaborate on features associated with each *Topic*. These 15 *Topics* were those that received the most "selections" from respondents based on their top three choices. The list of *Topics* was provided to the workshop participants in advance of the workshop with a request to review them and the relevant supporting information provided in the Agenda in preparation for the selections to be made during Session 3 of the workshop (Appendix C presents the workshop's agenda).

4.2 Workshop Session 3: Narrowing to Top Six Topic Areas

During Session 3 of the workshop, participants reviewed the list of 15 preferred research *Topics* that had been provided before the event and explored them as a group, considering each of the two trigger questions below. Using electronic voting, which allowed the group to assess them in real time, they rated each *Topic* on a scale of 1 to 5 based on the following questions:

- In your opinion, how **important** is this *Topic* to the needs of Canadian municipalities?
- In your opinion, what is the **likelihood** that partners could be found willing to support (co-fund) advancing research on this *Topic*?

Figure 1 presents the results of the voting by participants; the numbers are those assigned to the 15 Topics as listed in Appendix B.



Topic numbers within the oval emerged as the top six *Researchable Topic Areas* (Table 1). Please see Appendix B for a complete Topic list by Topic number.

Figure 1. Relative relationship between Topic "Importance" and "Likelihood of Acquiring Funding"

Although all 15 *Topics* are considered important areas for research-based investigation, only the top six priority *Topics* (those on the upper right of Figure 1) were selected for further discussion and development by workshop participants; this narrowing was done to make the subsequent tasks more manageable. The six *Topics* shown in Table 1 served as the focus for the breakout discussions in Session 4 of the workshop. Based on the format and design of the workshop process and the prior consultations, the expectation is that these six *Topics* represent a reasonable set of ideas to target since they arose from two separate end-user based selection processes and, as a consequence, they are considered to have sufficient importance so as to generate interest, value and co-investment from the larger end-user and research communities.

It was emphasized during the workshop that none of the *Topics* proposed in the Agenda and, in particular, the remaining nine in Figure 1, should be thought of as lost from future research considerations. Should a group of end users with sufficient resources express interest in having research conducted on any of the remaining *Topics*, the CMWC will undertake efforts to cooperatively initiate supportive research projects.

4.3 Workshop Session 4: Breakout Challenge — Developing Compelling Project Ideas

Participants were assigned to breakout tables and each was given one of the top six *Topics* selected in Session 3. Each breakout group had, as a reference, the example project titles suggested in the Agenda and during the consultations to seed discussions. However, it was not necessary to select from among these. Participants were encouraged to be creative and generate new project ideas as a result.

Each table was given the following challenge: Within the assigned *Topic* area for each table, identify the three descriptive project titles and/or focus areas that, if posted on the CWN matching forum, would be most likely to garner significant interest and strong responses from both the partners and research communities; will it catch their attention, make them want to read further and ultimately have them consider joining in?

The breakout sessions produced 18 possible research titles and these are listed in Appendix D. The participants were then asked to reconvene in plenary to review and vote on how compelling and likely to succeed the titles were. Following the participant voting, the six titles (the numbers for which are in blue) that received the most votes are in Table 1.

4.4 Workshop Session 5: Exploring Possibilities for Research Partnerships

It is clear that many of the ideas brought out by the work done in Sessions 3 and 4, and from the comments made by the participants, have much in common with those resulting from other similar processes in Canada and elsewhere internationally. Our invited colleagues from the United States stated that the priorities identified here resonate with many of the issues faced in their country. This also appears to be the case elsewhere based on the association of several workshop participants with international research organizations, such as the Global Water Research Coalition, of which both CWN and the Water Environment Research Foundation, are members. Therefore, as part of moving forward on these research initiatives through the CMWC, CWN will investigate potential for partnership possibilities with like-minded international organizations to further leverage potential for the research.

5.0 Participant Workshop Evaluation

Thirty one of the 35 participants completed the workshop survey and it appears from their responses that the level of satisfaction with the workshop was high.

- Of the five points under "Overall Workshop Quality" all responses were "Excellent" or "Good" with "Fair" selected by one respondent under one heading, "Workshop Program";
- 29 of 31 respondents said that they "would attend another workshop on this topic" (two made no selection);
- 29 of 31 respondents said that they "would recommend future workshops to others" (two made no selection);
- The very large majority of the responses to the four questions related to quality of the 4 Sessions were either "Excellent" or "Good";
- 31 of 31 respondents said "Yes" that "work to maintain the National Research Agenda for Municipal Wastewater and Biosolids should be undertaken in the future"; responses from those who suggested who should do this work ranged from the existing Core Group to CCME to a group made up of municipal and other stakeholders to CWN; suggestions of who should support the work financially involved mainly CCME or the federal government;
- Many respondents said that they were pleased with the electronic voting and its ability to reach consensus in real time;
- Some suggestions were offered on what to "improve upon in future workshops"; they included requests for:

    - more information on and better group discussion of selected project titles (several respondents);
    - more opportunity for municipalities in particular to discuss partnerships on possible projects;
    - descriptions of benefits from the Agenda to be taken back to organizations;
    - a change in voting protocol to get more separation between votes on items; and
    - broader representation from other areas of and groups within Canada

6.0 Next Steps

Based on a survey completed by the participants and from subsequent comments from them, there was clearly a high degree of satisfaction with the workshop and its level of engagement. Participants felt the overall approach provided a very effective way to narrow down and focus on priority areas. They were pleased with the combination of an expanded focus group, the use of the real-time electronic voting, and the background provided by the Agenda, and the results of its national consultation process.

Responses on the workshop survey showed that virtually all participants found the Agenda to be a useful document and believe that work on it should be continued into the future to keep it current.

The next phases of the work will be devoted to exploring the possibilities that can arise from the suggested research *Topics* and possible project titles resulting from the workshop. Efforts will focus in part on how they may relate to existing programs and interests with a view to collaborative work elsewhere. In particular, CWN will further examine how the six recommended research project areas compare with the existing declared research focus areas for the CMWC, with which there appears to be considerable overlap, and how that may assist in refining a possible call for research proposals. Additional focus group work and use of the CWN online forum are likely mechanisms to be put to use over the next few months to build on the results of the March 29, 2012 workshop to develop towards full-scale research proposal calls likely in the fall of 2012.

Acknowledgements

On behalf of the CCME and the Core Group, the Canadian Water Network would like to thank the workshop participants for their interest and commitment to this effort and most of all for the value of their input and the genuine sincerity with which it was provided.

Appendices

Appendix A. List of workshop participants

NAME	POSITION	ORGANIZATION
Workshop Participants		
Arora, Susheel	Director, Wastewater & Stormwater Services	Halifax Water
Bicudo, José	Senior Project Engineer	Region of Waterloo, Water Services
Brown, Trevor	Senior Project Engineer, Engineering and WW Programs	Region of Waterloo, Water Services
Cairns, Bill	Chief Scientist	Trojan Technologies
D'Andrea, Michael	Director, Water Infrastructure Manager	City of Toronto
Drca, Paul	Manager, Environmental Quality	City of Windsor
Fesko, Paul	Manager, Strategic Services, Water Resources	City of Calgary
Hull, Jack	General Manager, Integrated Water Services	Capital Region District, Victoria
King, Bowdin Dr.	Development Officer	Federation of Canadian Municipalities
Knezevic-Stevanovic, Andjela	Head, Environment Management Group	Metro Vancouver
Lam, Dr. Bu	Senior Manager, R & D, Community Gov't Services	Nunavut
Leblanc, Irving (Bing)	Director, Housing & Infrastructure; Water Specialist	Assembly of First Nations
Majeau, Josée-Anne	Conseillère en gestion des matières résiduelles	MDDEP, Service des matières résiduelles
Marsalek, Jiri	Former Head, Urban Water Management	Environment Canada
McCartney, Daryl PhD, PEng	Executive Manager, Edmonton WMCE	University of Alberta
Moore, Larry	Chief Executive Officer	Walkerton Clean Water Centre
Noss, Chuck	Senior Physical Scientist	USEPA
Nutt, Stephen	Senior Partner	XCG Consultants
Payne, Michael	Residuals and Biosolids Utilization Specialist	Black Lake Environmental
Sampson, Rob	President	N-Viro
Schraa, Oliver	President	Hydromantis Environmental Software Solutions
Schutzman, Bill	Associate Director (biosolids, nutrients & H_2O reuse)	Agriculture and Agri-food Canada
Smyth, Shirly Anne	Engineer	EC, Canadian Centre for Inland Waters
Soroczan, Cate	Senior Researcher	Canada Mortgage and Housing
Trudeau, Mary	Principal, ICF Marbek	ICF Marbek
Van Rossum, Tony	Environmental Services Engineer	City of London

Veale, Barbara	Co-ordinator of Policy Planning and Partnerships	Grand River Conservation Authority
Vieira, Denise	Environmental Scientist	BCWWA
Woltering, Dan	Research Director	WERF

Core Group		
Anderson, Barbara	Senior Policy Advisor	Ontario Ministry of Environment
Lebeau, Benoit	Engineer, Non-Agricultural Source Material Specialist	OMAFRA
Seto, Peter	Principal Advisor Wastewater Programs,	Environment Canada
Lawrence, John	Director, Aquatic Ecosystem Management	Environment Canada
Monteith, Hugh	Senior Consultant	Hydromantis Environmental Software Solutions
Farquhar, Grahame	Senior Advisor	CWN
Lishman, Lori		Environment Canada

Canadian Water Network (did not vote)		
Conant, Bernadette	Executive Director	CWN
Schneider, Lyle	Web and Database Specialist	CWN
Chik, Alex	Technical Assistant	CWN
Farquhar, Grahame	Senior Advisor	CWN
Levangie, Janice	Programs Development Coordinator	CWN
Willoughby, Jenn	Manager Strategic Marketing and Outreach	CWN

Appendix B. 15 Research Topics Prioritized by Responders to Consultation on the National Research Agenda for Municipal Wastewater and Biosolids.

Theme	Sub-theme	Topic[1]	Points[2]	Sub-topics[3]
1. Municipal wastewater treatment	WWTP processes & optimization (including nutrients)	Optimization	35.5	Automation, modelling, sensors, control, system integration, guidance manuals, organizational/management issues, operator training
2. Municipal wastewater treatment	Nutrients	Process research	35.5	Nitritation, biofilms, biological aerated filters, BNR, BPR, media processes, chemical processes, membranes, gas permeable membranes, physical processes
3. Municipal wastewater treatment	Emerging substances of concern (including unconventional contaminants from industry)	Source control (for both wastewater and biosolids)	31	Manufacturing facilities, other industry (secondary use), household, commercial and institutional, hospital, long-term care centres, research facilities (academic, government, commercial)
4. Municipal wastewater treatment	WWTP processes & optimization	Small/rural treatment systems	25	SBRs, lagoons, wetlands, package plants
5. Municipal wastewater treatment	WWTP processes & optimization (including nutrients)	Receiving water effects & mitigation strategies (including social issues)	22	Cold temperature regions, marine coastal regions, estuary regions, specific sensitive receiving waters, risk assessment and management, quantification of social benefits of improved effluent quality and integration of social benefits with economic benefits
6. Municipal wastewater treatment	Pathogens	Process research (new)[4]	16.0	Emerging pathogens of concern (including viruses, bacteria and parasites), antibiotic resistant microbes, prions, physical processes (UV, gamma-rays, etc.), chemical processes (including advanced oxidation)
7. Municipal wastewater treatment	Pathogens	Receiving water effects & mitigation strategies (including social issues) (new)[4]	16.0	Impacts on health of humans downstream from effluent discharges, risk assessment and management
8. Biosolids	Biosolids & sludge treatment & management	Process research & optimization	32.5	Pre-treatment technologies, dewatering technologies, anaerobic digestion, composting, aerobic digestion, combustion/incineration, alkaline stabilization, thermal drying, gasification/pyrolysis/plasma, social issues (i.e., odours)

9. Biosolids	Biosolids application	Effects & mitigation strategies (including social issues)	21	Runoff to receiving waters (nutrient, metals, ESOC, etc.), subsurface migration to groundwater, aerosols, effects on health of humans near biosolids application sites, soil effects, crop uptake, animal uptake (worms, insects, voles, foxes, birds), ESOC present in biosolids, economic assessment of property values near biosolids application sites, socio-economic costs of crops grown with biosolids vs. crops grown with commercial fertilizers vs. organically grown crops, public perception, risk assessment and management, odours, bioaccumulation by grazing animals (e.g., milk producers)
10. Biosolids	Biosolids & sludge treatment & management	Contaminant identification, quantification and reduction	21	Emerging substances of concern, metals, nutrients, pathogens (including prions), odourous compounds
11. Biosolids	Biosolids application	Best management practices	15	Odour control, spreading guidelines, pathogen release, noise and dust control, vector control, carbon sequestration
12. Wet weather treatment	Treatment & retention	Combined sewer overflows	23.5	Retention basins (conventional), deep tunnel, in-sewer storage & routing, chemically enhanced settling in retention basins, chemically enhanced primary treatment at WWTPs, disinfection, effects of CSO and stormwater on recreational value of receiving waters and beaches, effects on WW and biosolids treatment from influx of cold runoff and solids during rapid snowmelt events.
13. Climate change and sustainability	Sustainable wastewater/ biosolids management	Energy reduction/recovery processes	31.5	In-sewer heat recovery, in-sewer hydraulic energy recovery, anaerobic co-digestion of organic wastes with sludge, anaerobic MBR for raw wastewater and/or sludge treatment, anaerobic fluidized bed or UASB reactors for raw wastewater and/or sludge treatment, improvements in WAS digestibility for enhanced biogas production, low energy disinfection, sludge pyrolysis and gasification, microbial fuel cells, digester gas fuel cells, algae growth for biodiesel production, hydraulic turbines at discharge weirs or drops, socio-economic issues, life cycle assessment
14. Climate change and sustainability	Sustainable wastewater/ biosolids management	Value-added products	25.5	Phosphorus & nitrogen (ammonia) recovery, biodegradable biopolymer, volatile fatty acids, adsorbent chars and oil from sludge pyrolysis, ceramic materials from sludge ash, light weight aggregate materials, methanol from methane in digester gas (for denitrification)
15. Climate change and sustainability	Climate change effects on receiving waters	Impact of fluctuating flows and rising temperature on receivers (new)[4]	19	Impact of climate change on assimilative capacity, establishment of triggering points for revision of EDOs due to climate change

Notes

1. During the January – February 2012 period for consultation on the Agenda, responders were asked to select their 3 most important Topics from the 53 listed in Table 9 of the Agenda. This list includes the 15 Topics receiving the most selections.

2. The “Points” column lists the points awarded to each of the Topics when ranked according to the criteria and weightings used in the Agenda.

3. The “Sub-topics” identify subjects and issues relevant to the specific Topic.

4. Topics with the “New” designation were added as a result of input received during the January – February 2012 period for consultation on the Agenda and then ranked according to the criteria and weightings used in the Agenda. The Topics were not, however, available at the time responders made their 3 most important Topic selections.

Appendix C. Workshop agenda.

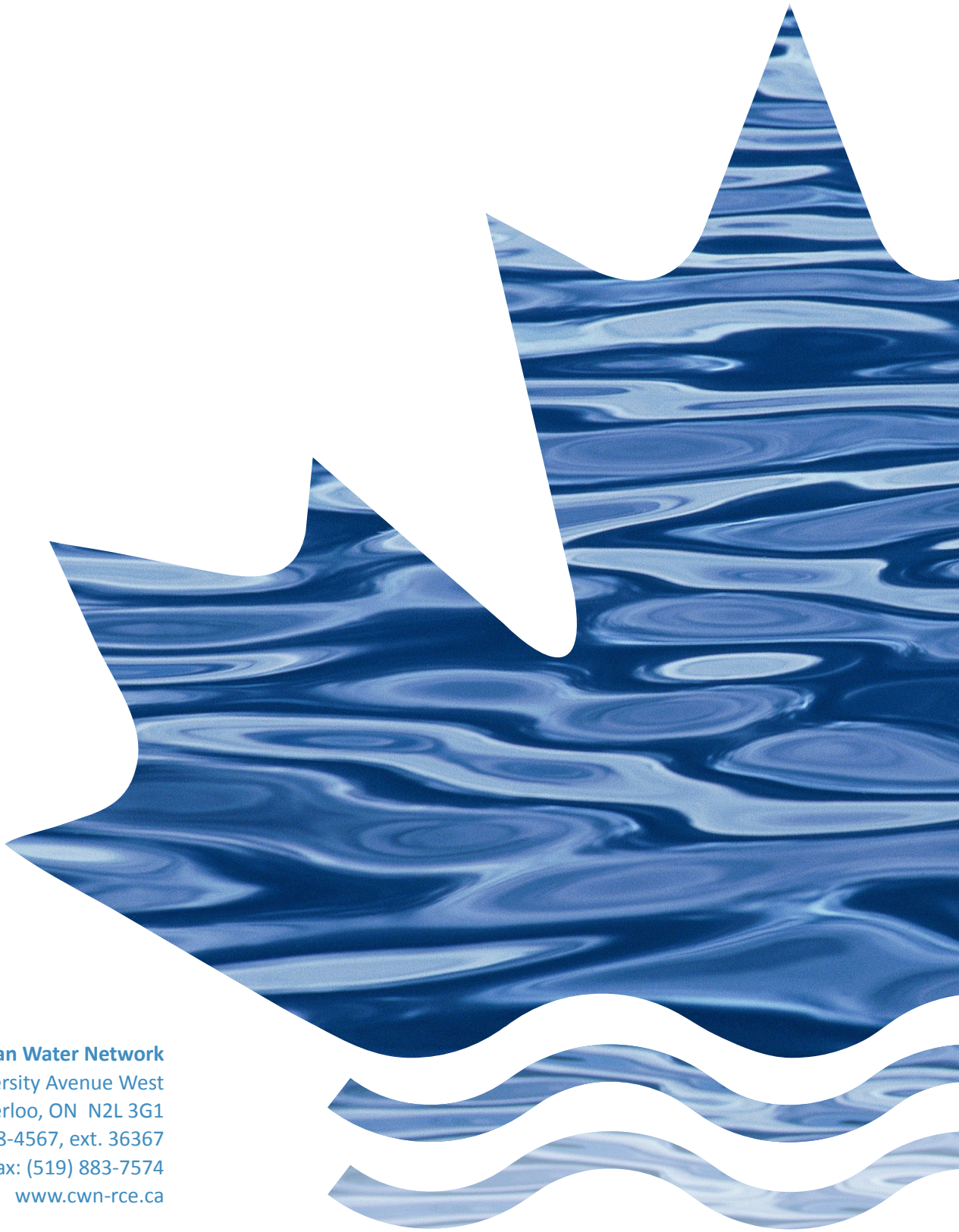
Time	Session	Contents
8:45 – 9:00	1. Welcome, introductions and plans - *G. Farquhar, CWN*	- An outline of the tasks and expectations for the workshop
9:00 – 10:15	2. Update on the status of *Draft National Research Agenda for Municipal Wastewater and Biosolids* (the Agenda) - *G. Farquhar, CWN* - *H. Monteith, Hydromantis*	- A brief background summary of the Agenda, why and how the work was done and the role of the Science and Research Coordinating Body (SRCB) - A summary of responses from a national consultation held during January-February, 2012 - An outline of the changes made to the Agenda resulting from the January-February, 2012 national consultation - A brief discussion on the future of the Agenda and the SRCB - Q&A
10:15 – 10:40	Break	
10:40 – 12:00	3. Prioritizing Research Topics - *G. Farquhar, CWN*	- Presentation of potential research Topics from the Agenda selected previously by respondents to consultations - Prioritization by participants of selected potential research Topics based on “Importance” and “Likelihood to Acquire Funding Partners” - Reporting - Q&A

12:00 – 1:00	Lunch provided by CCME	
1:00 – 2:30	4. Identifying titles and/or focus areas for possible research projects - *B. Conant, CWN* - *G. Farquhar, CWN*	- Development by participants working in breakout groups of titles and/or focus areas for possible research projects for each of the Topics prioritized in Session 3 - Prioritization by participants working in plenary of possible research projects identified above - Reporting - Q&A
2:30 – 2:50	Break	
2:50 – 3:45	5. Exploring possible research project partnerships - *B. Conant, CWN*	- Exploration of ways and means to acquire partnership funding and management support for the initiation of research projects - Reporting - Q&A
3:45 – 4:00	6. Closure - *G Farquhar, CWN*	

Appendix D. Project Titles that emerged from Session 4.

Title #	Theme	Subtheme	Topic	Title
9-1	Biosolids	Biosolids application	Effects & mitigation strategies (incl. social issues)	Investigate fate & transport of emerging substances of concern (ESOCs) from land-applied biosolids
9-2	Biosolids	Biosolids application	Effects & mitigation strategies (incl. social issues)	Methodology for testing toxicity of biosolids
9-3	Biosolids	Biosolids application	Effects & mitigation strategies (incl. social issues)	Decision screening tool based on LCA and TBL for evaluating DS management options (land application, incineration, land filling, etc.)
2-1	Municipal wastewater treatment	Nutrients	Process research	Low cost, more efficient technology for nutrient (N, P) removal
2-2	Municipal wastewater treatment	Nutrients	Process research	Lagoon nitrogen removal technologies for cold temperature
2-3	Municipal wastewater treatment	Nutrients	Process research	Phosphorus life cycle examination (biogeochemical modelling, sustainability assessment)
8-1	Biosolids	Biosolids & sludge treatment & management	Process research & optimization	"Green energy from sludge": Optimization of anaerobic digestion to increase biogas production and improve biosolids quality
8-2	Biosolids	Biosolids & sludge treatment & management	Process research & optimization	Biosolids management options for First Nations and small northern communities
8-3	Biosolids	Biosolids & sludge treatment & management	Process research & optimization	Breaking the biosolids barrier: Social research to breaking the barriers to land application (social, economic)
13-1	Climate change and sustainability	Sustainable wastewater/biosolids management	Energy reduction/resource recovery processes	Systems integrated view of resource recovery opportunities (reclaimed water, energy, nutrients, organics) in representative WW systems (collection and treatment
13-2	Climate change and sustainability	Sustainable wastewater/biosolids management	Energy reduction/resource recovery processes	Methodology to quantify resource recovery opportunities (like the EnerGuide)
13-3	Climate change and sustainability	Sustainable wastewater/biosolids management	Energy reduction/resource recovery processes	System design and technology capabilities required to advance resource recovery opportunities: Guide to develop TBL business case for RR opportunities

5-1	Municipal wastewater treatment	WWTP processes & optimization (incl. nutrients)	Receiving water effects & mitigation strategies	ESOCs: Treatment processes (i.e., removal or destruction)
5-2	Municipal wastewater treatment	WWTP processes & optimization (incl. nutrients)	Receiving water effects & mitigation strategies	Social education & marketing strategies: benefits of consumer source control on WWTP effluent quality, exposure/risk assessment of effluent ESOCs
5-3	Municipal wastewater treatment	WWTP processes & optimization (incl. nutrients)	Receiving water effects & mitigation strategies	Establish EDO – Understanding ESOCs on watershed context
5-4	Municipal wastewater treatment	Emerging substances of concern (ESOCs)	Source control (for both wastewater and biosolids)	Identify the contribution of sources (i.e., hospitals, nursing homes, etc.) to influent wastewater
5-5	Municipal wastewater treatment	Emerging substances of concern (ESOCs)	Source control (for both wastewater and biosolids)	Cost-benefit analysis of source control options
5-6	Municipal wastewater treatment	Emerging substances of concern (ESOCs)	Source control (for both wastewater and biosolids)	Identify effective metrics that could drive policy change



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