

## **Supporting information.**

### **Lessons and Guidance for the Management of Safe Drinking Water during Extreme Weather Events**

Stuart J. Khan,<sup>a\*</sup> Daniel Deere,<sup>b</sup> Frederic D.L. Leusch,<sup>c</sup> Andrew Humpage,<sup>d</sup> Madeleine Jenkins,<sup>e</sup> David Cunliffe,<sup>f</sup> Shona K. Fitzgerald<sup>a</sup> and Benjamin D. Stanford<sup>g</sup>

<sup>a</sup>School of Civil & Environmental Engineering, University of New South Wales, NSW 2052, Australia.  
[s.khan@unsw.edu.au](mailto:s.khan@unsw.edu.au)

<sup>b</sup>Water Futures Pty Ltd, NSW, Australia. [dan@waterfutures.net.au](mailto:dan@waterfutures.net.au)

<sup>c</sup>Smart Water Research Centre, School of Environment, Griffith University, Gold Coast Campus, Edmund Rice Drive, QLD 4222, Australia. [f.leusch@griffith.edu.au](mailto:f.leusch@griffith.edu.au)

<sup>d</sup>Australian Water Quality Centre, SA Water House 250 Victoria Square, Adelaide, SA 5000, Australia.  
[Andrew.Humpage@sawater.com.au](mailto:Andrew.Humpage@sawater.com.au)

<sup>e</sup>Centre for Appropriate Technology, South Stuart Highway, PO Box 8044, Alice Springs NT 0871, Australia. [madeleine.jenkins@gmail.com](mailto:madeleine.jenkins@gmail.com)

<sup>f</sup>SA Health, PO Box 287 Rundle Mall Adelaide SA 5000, Australia. [David.Cunliffe@sa.gov.au](mailto:David.Cunliffe@sa.gov.au)

<sup>g</sup>Hazen & Sawyer, 4011 WestChase Boulevard, Suite 500, Raleigh, NC, 27607, USA.  
[bstanford@hazenandsawyer.com](mailto:bstanford@hazenandsawyer.com)

This supporting information provides the text of the questions that were included in the Introductory Questionnaire and the Case Study Template described in the Methods Section of this manuscript. Further details are available in the final project report:

B. D. Stanford, B. Wright, J. C. Routt and S. J. Khan, Water Quality Impacts of Extreme Weather-Related Events, Report Web Report #4324, Alexandria, VA, USA, 2014.

### **Introductory Questionnaire (IQ)**

The IQ consisted of 12 open-ended questions about extreme weather occurrences over the last 5-10 years resulting in the greatest impacts on drinking water utilities. Open-ended responses were solicited to facilitate fast, yet substantially descriptive, responses. The intent of the IQ was to focus participants on project objectives, to facilitate initial idea development and data gathering with the project partners, and to begin to better understand the most important issues, regionally and globally. The specific questions that were asked are listed below:

1. What weather event (or related pattern or sequence of events) has occurred over the last 5-10 years resulting in the greatest impact on your utility?

2. Describe the weather event (or pattern or sequence) in terms of measureable weather parameters, type/description, location/extent, and duration/frequency, etc. Compare to prior normal levels of the key parameters (e.g., 100-year flood, in rainfall over X number of days).
3. What were the specific water quality-related impacts of the events on source water, treatment, and/or finished or distributed water?
4. What data and/or documentation (e.g., reports, operating data summaries, photos, video, audio, etc.) do you have relative to this event, or sequence of events, which you may be willing/able to share or discuss further with our team?
5. What were the issues impacting your staff or operations at the time of the event, and/or after the event (water quality-related or other)?
6. What were the issues impacting your customers at the time of the event, or after the event (water quality-related or other)?
7. What were the adaptive measures taken during the event? Describe, with costs if available.
8. What are your most significant “lessons learned” from the experience(s), and how have they been incorporated into your current operations and/or planning?
9. What do you see as your greatest future weather-related water quality challenge for your utility?
10. What are the estimated associated costs or other constraints to adapt to this challenge? 11. What information is needed to determine and plan for future water quality and weather-related adaptive changes?
12. Provide any additional, helpful comments which are not captured in the above responses. IQ respondents were also asked to provide their identifying information, to acknowledge understanding of confidentiality of project materials and data, to indicate the amount of time spent on questionnaire responses, and to provide additional comments and feedback to the team for clarification and/or to improve future data-gathering efforts.

The IQ was administered using an online survey application (Survey Monkey™), and participants were offered the alternate option of providing written responses via email. Where multiple, different events had occurred, or where there was responsibility for multiple utility operations, respondents were given the option to submit separate or consolidated IQ responses. The IQ was delivered to Australian and US project partners in advance of the workshops to enable preliminary compilation of results for workshop presentation and discussion purposes.

## **Case Study Framework**

After several iterations, the finalized case study framework included collection of information regarding the degree of anonymity requested by each utility, its geographic location, system size by number of service connections, contact information, and a list of extreme weather event descriptors for selection. The actual writing of the case studies was completed largely by the participating utility or agency volunteers, though the Project Team actively engaged each participant in follow-up conversation to refine and strengthen the case studies. While the actual case studies and associated

formatting are shown in individual case study write-ups, the major headings/topic areas and information requests used to frame the data collection are provided here for ease of reference.

1. General description of the extreme weather-related event(s)
2. Description of how/when the water quality impact(s) were recognized
3. Effects on source water quality and/or ability to provide, use, or treat the water
4. Effects on finished water quality and/or ability to provide adequate supply
5. Concerns or exceedance of State or Federal regulations or guidelines
6. Impacts on facility infrastructure, staff, and operations
7. Customer impacts, complaints, or public perception issues
8. Response/reactive measures taken during the water quality event
9. Costs of immediate response to water quality and weather event
10. Adoption of response plans and preventative measures for future events
11. Costs of preparing for future water quality/weather events
12. Lessons learned and advice for future event preparedness
13. Citations and/or links to published references/reports
14. Acronyms/definitions used
15. Key words
16. Images, graphs, and supporting information