FIND HARMFUL ALGAL BLOOM MANAGEMENT COMPLICATED AND CONFUSING?

USING DATA AND INFORMATION, TO ENABLE IMPROVED AND TIMELY RISK MANAGEMENT OUTCOMES

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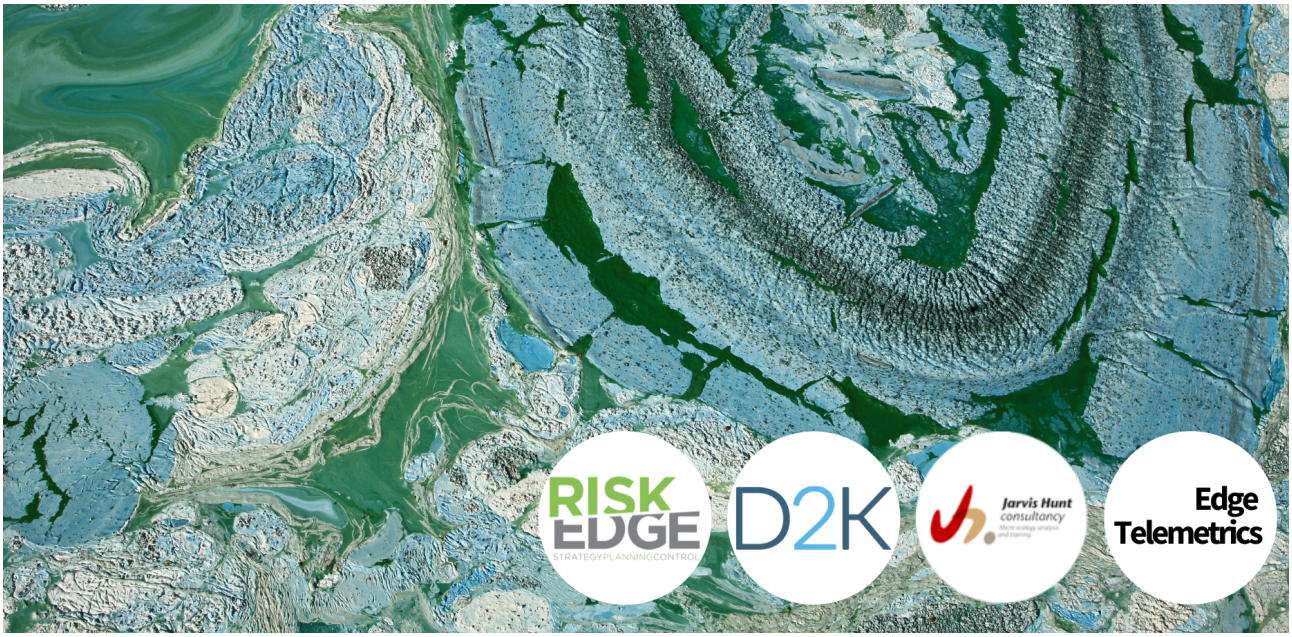

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#riskcommunication #riskmanagement #harmfulagalblooms #HAB

The water industry is extremely complex, with a range of products and services such as drinking, raw, and recycled water, dam and recreational management, and sewage services.

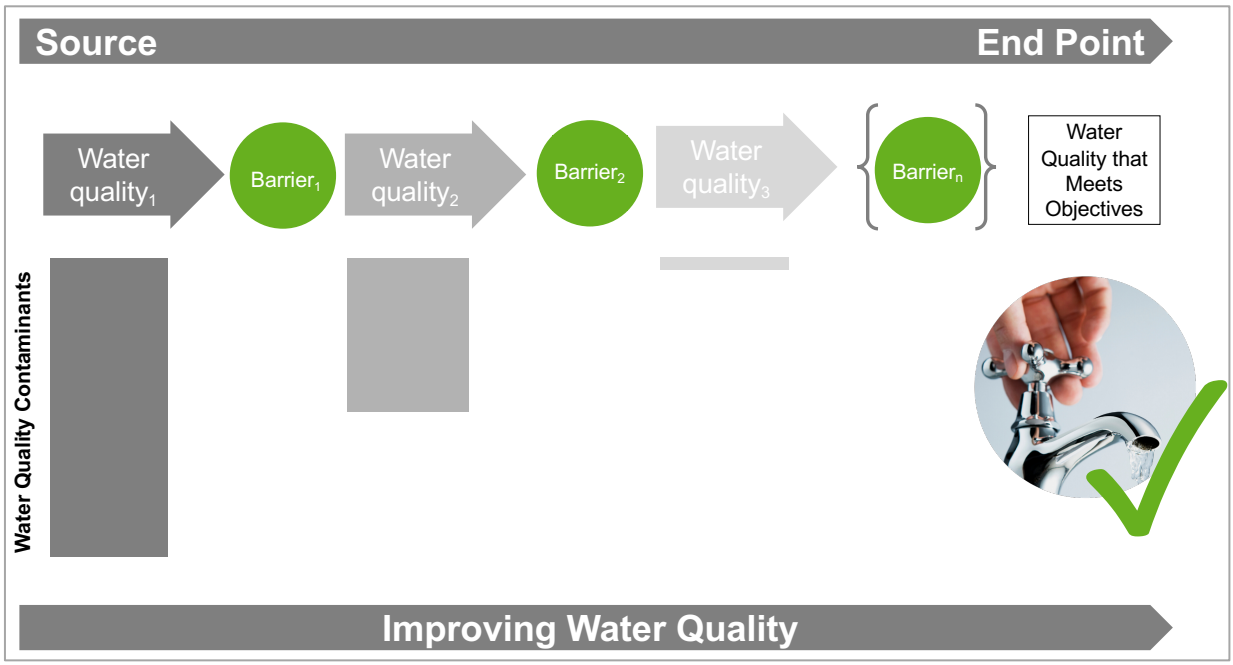


Figure 1. Source to end point supply chain and the multiple barrier approach – each barrier reduces contamination and provides insurance.[1]

For compliance, organisations must manage their risks across all areas, from source to endpoint. From a risk management and multiple barrier perspective (Figure 1), prevention is better than cure, and much better starting at the source.

[1] Davison, A. (2020) The Application of ISO 31000 to Drinking Water Quality Risk Management: A Practical Approach. Published by Risk Edge Pty Ltd, Sydney, Australia. ISBN: 978-0-9875560-0-4.

The Australian Drinking Water Guidelines[2] enshrine this concept as follows:

> *"**Australian Drinking Water Guidelines – Guiding Principle 1:** The greatest risks to consumers of drinking water are pathogenic microorganisms. Protection of **water sources** [our emphasis] and treatment are of paramount importance and must never be compromised."*

Each utility will have its own responsibilities, depending on where it sits in the supply chain and the objectives for management for that part of the supply chain. Risk is the impact of uncertainty on achieving objectives – the impact can result in either positive or negative outcomes (ISO 31000). Understanding and identifying risks, requires the input of fit for purpose data and information, to allow informed and timely decisions to be made.

Many people are now relying on water bodies not only for their drinking and irrigation water, but also as their 'blue infrastructure' – their mitigation of climate change effects and their aesthetic, cultural and recreational needs. Organisations should therefore be ready to understand their water quality (as well as quantity) obligations as part of an overall urban water security approach.

Cyanobacteria are a major risk to source water quality and water use objectives. These and other organisms, can impact the whole source to endpoint supply chain, and require monitoring and interpretation, with focused and timely actions, to ensure effective treatment and management. But how do you know what to look for?

Understanding and managing the risks from harmful algal blooms relies on several factors. We look at these in more detail below.

Context Setting

The first factor involves context-setting. You need to understand what the water body is being used for, as this will have a bearing on the stakeholders and their value drivers e.g.:

- **Recreators** – value drivers might include understanding whether they can swim or row on the water.
- **Irrigators** – value drivers might include understanding whether the water is fit for purpose for replenishing off-stream watering troughs for cattle.
- **Drinking water providers** – value drivers might include understanding whether they can treat the water, given the bloom level and type, given the treatment train they have in place.
- **Regulators** – value drivers might include understanding the impacts on all of the above to ensure end users remain protected (e.g. via obligations with a public health or resource management act).

Guideline Choice

Fitness for purpose relies on knowing what guidelines or other values to apply, when determining the standard that should be applied, to meet your stakeholder value drivers and end uses. Further,

[2] ADWG (2011) NHMRC/NRMMC (National Health and Medical Research Council/Natural Resource Management Ministerial Council) (2018) Australian Drinking Water Guidelines National Water Quality Management Strategy. Version 3.5. ISBN Online: 1864965118.

while guidelines might be in place, it's often the case that your alert levels include 'tweaking' based on regulator input, to ensure contextualisation. So, you'll need to understand not only what the guidelines say, but whether there are specific elements that apply only to you, in your context.

In addition, there also needs to be an awareness of the specific application of the guidelines, to analytical and the timing of the data. Guidelines are generally constructed by, and, for the most part, manually interpreted by humans. Guidelines tend to rely on data at a point in time rather than a data continuum. Because of this fact, gaps and uncertainties in interpretation can occur.

As an example, there is a gap between the amber and red alert levels in the NHMRC recreational water guideline (NHMRC, 2008)[3]. This guideline does not specifically account for a total biovolume between 0.4 and 4mm^3/L, where potentially toxic cyanophytes make up less than 75% (this being the percentage level set for dominance). For experienced users, interpreting this gap may not be an issue, but it may lead to another aspect of the guideline being used instead, potentially creating an interpretation and end user risk.

To illustrate this point, let's take a sample with the following characteristics:

- Mixed potentially toxic cyanobacteria.
- A low cell count of *Microcystis aeruginosa.*
- No corresponding biovolume.
- No corresponding species level identification.

If we couple these characteristics with an incorrect interpretation, the result is a score that is not reflective of the actual risk state. Taking context into account (which an experienced analyst is likely to do) means a red level alert may be more appropriate (Table 1). This outcome highlights the importance of not only understanding the guidelines being used, but of also having the requisite information and experience, to use them correctly.

Table 1. Sample characteristics and their impact on analysis and interpretation.

ANALYST EVENT	INTERPRETATION EVENT	RISK LEVEL OUTCOME	
Interpretation is performed correctly e.g. by experienced and informed analyst	Both *M. aeruginosa* levels and context (sample site and end use) are used in the interpretation	☑	Red risk alert level chosen
Interpretation is performed incorrectly e.g. by inexperienced or uninformed analyst	Only *M. aeruginosa* levels are used in the interpretation.	☒	Lower risk alert level chosen than appropriate

[3] National Health and Medical Research Council (NHMRC) (2008) Guidelines for managing risks in recreational water. ISBN Online: 1864962720.

We have uncovered this exact scenario in developing the code for an automated interpretation of the algal alert levels from NHMRC (2008) and have backfilled the gap based on experience, to ensure a practical, risk-appropriate outcome, with a systematic application of the logic.

Monitoring and Sampling Protocols

You've now identified the context and chosen the appropriate guidelines to apply, the next thing to look at is whether the monitoring and sampling protocols are sufficient, to yield the best contextual information – for instance, are you sampling in the right places, at the right frequency (depending on season), with the right parameters.

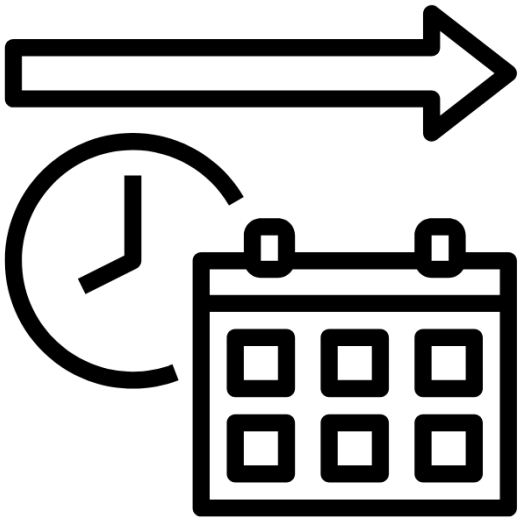
Key Parameter Inputs

- Scum visualisation
- Specific genus and species of potentially toxic taxa
- Total biovolume
- Total toxins

Parameter inputs for most current guidelines include scum visualisation, specific genus and species of potentially toxic taxa, total biovolume and toxins. You will need to make sure you have all the required inputs, for your risk category results to be meaningful. If not all parameters are available, then interpretation of the guidelines may not reflect the alert level required, to produce an appropriate, risk-weighted response.

Timeliness

For assessment results to have value, the assessment needs to be undertaken in a timely fashion so that information can be provided to the managers and end users of the water body, to help them make relevant risk-timed decisions and management choices.



Central to this requirement is the need to understand what constitutes timely provision of results – so you should be having a chat with your laboratory service provider about their turnaround times for analytical results – and hold them to it. You will also need to ensure that your provider is certified to undertake the analyses that you require. Also gold, is the ability to have machine to machine delivery of results instead of delivery via email or other form needing human intervention.

It's worth reviewing certification requirements against what your service provider is delivering – if you find a gap, there are plenty of credible service providers around – however, the tyranny of distance (getting the samples to the provider in a timely fashion), can sometimes be a complicating factor.

So, what can you expect from your laboratory service provider? Well, as a guide, reputable laboratories should be able to provide you with analysis for potable and recreational end uses as follows:

- Cyanobacteria analysis including biovolume, *within 24-72 hours*.
- Requested toxin analysis following *within a week*.

- All *potentially toxic taxa* identified to *species level*, and clearly indicated as such on the report.

This information enables operators and asset managers to make the necessary time critical decisions for water treatment and recreational activities.

Interpretation

You've now got your results in the time you've agreed with your provider, but what happens now – how do you interpret your results against the guidelines and tailored alert level frameworks? You need to have some way of applying a consistent approach to interpretation, that is delivered in a systematic manner, and generates outcomes that are consistent with the guidelines and generate messaging that is consistent with your harmful algal bloom management plan. As we mentioned earlier, interpretation can be fraught.

Many utilities undertake the interpretation process manually, often with the use of Excel-based spreadsheets. The process relies on access to the appropriate resource being available, at the time the results are received from the laboratory service provider.

Because organisations may not have experienced staff with a sound knowledge and understanding of cyanobacteria, utilities may outsource data interpretation, alert level determination, and recommendations to external service providers, increasing cost and time taken to make operational decisions and act upon them.

In addition, the manual interpretation of cyanobacterial laboratory results creates organisational risks including increased costs from incorrect interpretation of results and unnecessary toxin analysis, incorrect or inconsistent application of the NHMRC alert level framework, reduction in revenue from closed waterways, and delayed risk management responses.

Manual processes are inherently prone to error and rely on the interpreter being available, and trusted. Manual transcription of data into spreadsheets is also prone to error. It is good scientific practice to multiple-check findings, therefore having a supplier that provides results in both human and machine-readable formats can help improve data veracity and confidence in outcomes.

We advocate a concept of 'multiple barrier monitoring' to ensure that checks and balances are in place at all steps along the information supply chain – this is especially important where the data entry and interpretation are still manual and can include cross checks and double manual entry. If there is reliance on one interpreter or expert only, an uncertainty is introduced which may create errors in the risk basis of the decision made – ultimately ending up with a non-conforming approach to the risk management of the finding.

Do you have multiple barrier monitoring and checking in place, or do you rely on one resource to do the interpretation?

Being able to automate and systematise the interpretation process could ultimately save cost and lives.

Messaging

The output of the decision is now achieved and you are confident in the veracity of the finding, the next thing to think about is its relevance, the algal risk management that needs to be put in place, and who needs to know. Communication and well-defined procedural adherence contribute to the timeliness of responses, and aid in information dissemination to stakeholders and customers.

Streamlined and integrated processes from a centralized point of reference is part of robust quality assurance and risk management. These processes prevent mixed messaging and discourage individuals from 'interpreting' policies and 'adjusting' procedures in response, potentially changing the intent and the outcome, a common root cause of issues found during audit.

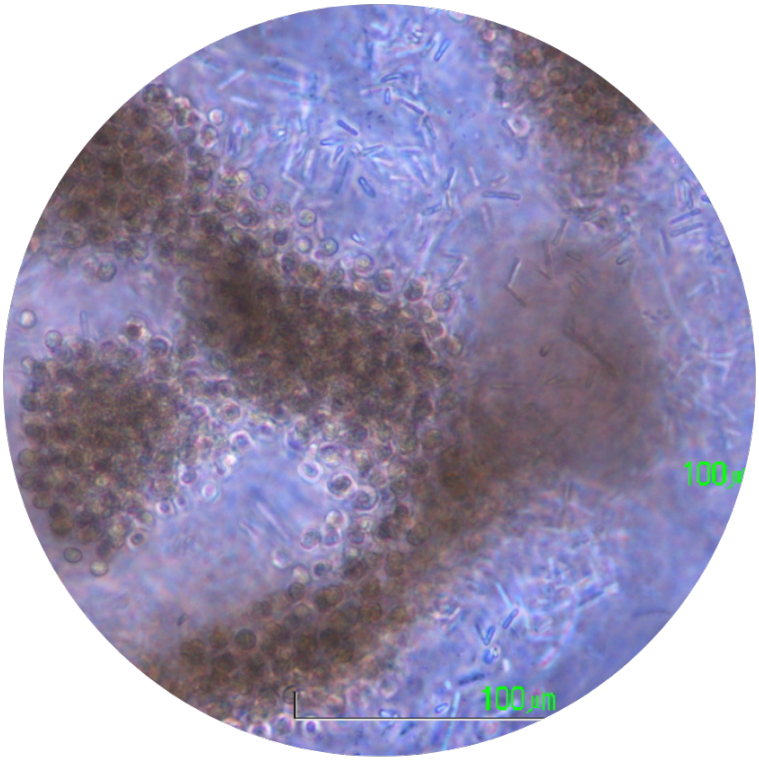
As well as consistency with your harmful algal bloom plan, the messaging needs to be in a form that is tailored to the end user of that information and to the medium of the message's journey e.g.:

- **Operators** – SMS alerts (often requiring satellite transmission capability in remote water body areas).
- **Drinking water producers** – SCADA alerts to give effect to pumping rules for selecting fit for purpose quality raw water.
- **Public health and other regulators** – SMS and emails.
- **Rate payers and water body users** – transparent information telemetered to dashboards at the site of use and on websites, showing whether the water is suitable for a particular end use – in a way water body users will understand e.g. boil water alerts and safe or not safe to swim or fish.

Could you be doing better?

There are many risks to achieving various or all of the above – we have identified some of these in Table 2. At the end of the day, as a water resource manager, the buck stops with you, so good questions to be asking for your own due diligence are:

- Is my service provider skilled and accredited to identify potentially toxic cyanobacteria?
- Do we require identification of potentially toxic taxa to species level?
- When was the last time I checked the scope of accreditation of my service provider – are they able to perform identification to the level I require?



- Is my service provider providing adequate turnaround times to allow me to meet my operational needs and legal obligations?
- Does our organisation have the skillset to understand how to interpret the results against the relevant guidelines?
- Do we have delays in getting information out to the right people, in the right format?
- Does my harmful algal bloom plan need a review?
- Do our internal data management processes support our immediate and longer term operational needs – how easy is it to find and assess critical information quickly?
- Can I identify historical or seasonal trends to help us move from reactive to preventative/proactive responses?
- Can I predict whether a bloom is about to occur in my water body?

Table 2. Example risks to achieving sound harmful algal bloom risk management.

RISK	IMPACT	OBJECTIVES IMPACTED
Incorrect identification of potentially toxic taxa to species creating inaccurate inputs for guideline interpretation.	Data is not fit for purpose, interpretation will be incorrect. Organisation is unable to respond appropriately. Organisation is unable to meet, and is unaware of, compliance exceptions. End users are exposed.	Cost Timeliness of action Compliance Legal
Service provider does not have accreditation for species level identification, but provides it anyway creating inaccurate inputs for guideline interpretation.	Service provider exceeding scope of accreditation. Data is not fit for purpose, interpretation will be incorrect. Organisation unable to respond appropriately. Organisation in breach of compliance. End users are exposed.	Cost Timeliness Compliance Legal
Service provider does not have accreditation for species level identification and requires confirmatory identification from another service provider with the appropriate accreditation and skill, and then assess the need to test for the appropriate toxins.	Increase in turn around time for analytical results. Delay in management decisions. End users are exposed	Cost Timeliness of action
Service provider does not have accreditation for species level identification resulting in potentially	Data is not fit for purpose, interpretation will be incorrect.	Cost Timeliness of action

RISK	IMPACT	OBJECTIVES IMPACTED
additional, broader toxin testing, based only on the genera present.	Increased delay and more conservative approach in management decisions to mitigate risk. Increase in testing turnaround times. Increased cost from extra analyses. Lost revenue from unnecessary closing of water bodies.	
Manual interpretation of the laboratory results against guidelines, by one person.	Inconsistent interpretation of results. Impact on timeliness / appropriateness of management decisions. Increased delay in seeking toxin testing. Increase in the timeliness of information provision. Lost revenue from unnecessary closing of water bodies.	Cost Timeliness of action Compliance
Guidelines are difficult to interpret manually.	Inconsistent interpretation of results. Impact on timeliness / appropriateness of management decisions. Increased delay in seeking toxin testing. Impact on the timeliness of information provision.	Cost Timeliness of action Compliance
Outsourcing of interpretation of results against guidelines	Impact on timeliness / appropriateness of management decisions. Increased delay in seeking toxin testing. Impact on the timeliness of information provision.	Cost Timeliness of action Compliance

About the authors

Collectively, Jarvis Hunt Consultancy, Risk Edge, D2K Information and Edge Telemetrics are experts in harmful algal blooms, risk management and information generation. They have collaborated on development of an automated SaaS approach, AlgaeWatch™, which rapidly interprets results, against the NHMRC 2008 guidelines, specifies alert outcomes and produces reports and alerts.

AlgaeWatch™ is also fully customisable, allowing tailored alerts to be sent via SMS or email, ensuring timely, point of use information for improved compliance and risk management. Contact us if you want to know more:

info@d2kinformation.com; https://www.d2kinformation.com/software/#algaeWatch.

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Annette has more than 30 years experience in environmental management, integrated water cycle management, risk assessment and paralegal work across the private, multinational, academic and state government sectors.

Annette is a recognised global leader in risk assessment for water products and environmental management, validated through multiple national and international awards, invited contributions to conferences and seminars, and substantial publication list (including invited journal articles, book chapters and books). Annette is a qualified Lead Auditor.

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Lindsay Hunt is a phycologist with public and environmental health background. She has nearly 25 years' experience specializing in cyanobacteria and phytoplankton analysis and training, harmful algal blooms, lab management, laboratory accreditation and quality assurance.

Lindsay is a Senior Research Fellow with Griffith University, School of Environment and Science – Bioscience, and hopes to commence her PhD researching applied technologies and solutions for cyanobacteria, in the near future.

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