A NATIONAL STRATEGY TO ACHIEVE SAFE DRINKING WATER IN REGIONAL AND REMOTE COMMUNITIES

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Drinking water safety, health risks, Closing the Gap, improvement project prioritization and verification

ABSTRACT

A National Strategy is proposed to achieve the Closing the Gap Agreement target of providing safe drinking water to all regional/remote First Nations communities by 2031. As safety is defined differently in different State/Territory jurisdictions, the specific group of substances and corresponding Guidelines (limits) with which each First Nations water supply should comply must first be agreed and held in a jurisdictional standards table, along with community poulation data. A novel method of scoring safety based on health risks would be used to report annually on reductions in health risks achieved since an initial nationwide score was derived from existing measured data. Projects to improve safety would be prioritized for the limited funding available according to the criterion of decreasing ratio of reduction in individual's health risks relative to total (capital and discounted operating) cost per consumer. Existing monitoring programs would be reviewed and revised to ensure that measured data were available for calculation of health risk indexes in the prioritization procedure. Regional training programs for interested community members would be set up where possible to staff regional networks for sampling, transport and analysis, as well as develop a community water workforce.

INTRODUCTION

When the National Agreement on Closing the Gap (2020) was released, Outcome Nine concerned the provision of appropriate affordable housing to regional and remote First Nations communities. In August 2022, a new Target (9b) was introduced which aimed to improve essential services to meet "jurisdictional standards" by 2031. The first Priority Action for this Target was the formulation of a Target 9b Implementation Plan by October 2023. However, the Combined Closing the Gap 2023 Annual Report and 2024 Implementation Plan (NIAA 2024) reported that formulation of such a Plan was now stopped.

An ealier letter from the Department of Infrastructure (Vandenbroek 2023) stated that a new approach of more formal partnerships with First Nations peak bodies and communities was being considered instead. Work had already begun on data development to ensure "we have appropriate data to track the progress of the Community Infrastructure Target [9b]."

In their Review of the National Agreement on Closing the Gap (Productivity Commission 2024), the Commissioners were highly critical of Implementation Plans that were little more than "laundry lists"; i.e., lists of projects that could be regarded as contributing towards a particular Target. They called for a much more strategic approach: "*Implementation plans need to be more strategic and written in collaboration with Aboriginal and Torres Strait Islander people. Together, they need to agree on a strategy and a set of associated actions that are the most substantive and critical to achieving the objectives of the Agreement and how they will be implemented.*"

Although the Minister's letter indicates a more collaborative approach, its empasis on formal partnerships and data gives no indication of a more strategic approach being taken. How are the broad objectives of the National Agreement to be translated into specific objectives for any of the essential services? This paper proposes a National Strategy with the more specific objective of bringing safety of drinking water supplies for rural and remote First Nations communities up to State/Territory "jurisdictional standards". It further outlines the associated set of substantive actions critical to achieving this more specific objective. Finally, it considers how these actions could be implemented to achieve Target 9b by 2031.

Safety of drinking water was identified as a major objective in the 2024 Closing the Gap Implementation Plan. The second Priority Action for Target 9b in was to provide "safe and reliable water to First Nations regional and remote communities" with new infrastructure funded with $150M over four years from the National Water Grid Fund (NWGF), matched by the State/Territory responsible for each project. However, no definition of safety was provided at that time or since.

In framing a National Strategy, it is also critical to recognize that the NWGF and its matched funding is extremely limited compared with the total funding needed to achieve the safety objective by 2031. Successful applications to the NWGF from the States/Territories have been announced in press releases and on the NWGF website, but these have largely concerned improving reliablity, rather than safety. The Water Services Association of Australia (Vanweydevald 2022) estimated that $2.2 billion was needed to enable First Nations drinking water supplies to meet the Australian Drinking Water Guidelines (ADWGs – NHMRC 2022), on which all Australian "jurisdictional standards" of safety are based.

AN INITIAL STRATEGY FOR WATER SAFETY

The target time (2031) for improving safety of First Nations water supplies to jurisdictional standards is short compared with the necessary planning and activity involved. It is therefore critical to identify and execute those essential activities that can be commenced immediately to form an initial Strategy, as itemised in this Section and summarized in Figure 1.

Jurisdictional standards of water safety

A definition of safety has not yet been made public, so it is not possible to assess the extent to which the limited funds available will improve safety of First Nations drinking water. In a companion paper to this Conference, Fisher et al. (2024) noted that water is generally considered safe if measured values of various substances are below their respective ADWGs. Further, *it must be agreed which subset of the more than 200 substances listed in the ADWGs are to be included in the definition of "jurisdictional standards" of safety*. Given that each jurisdiction currently uses a different subset (sometimes even within a jurisdiction), and this may change with time, it is imperative that each water supply is linked to the subset of substances and ADWGs with which it is to comply, in *a jurisdictional standards table*.

Individual consumer's health risk

Fisher et al. (2024) then proposed a *definition of water safety based on the concepts of acceptable health risks* arising from acute (short-term) and chronic (lifetime) consumption of water containing the subset of substances with known (measured) characteristics. These concepts of risk are embodied in the AWDGs and already form the basis for assessing safety of water supplies in urban and large regional centres.

The concept of a *lifetime health risk index (HRI)* was then proposed, which scores the severity of a measured value of a substance as the number of times it exceeds its respective Guideline value (Fisher et al. 2024). By non-dimensionalising the risk severity, the single-substance indexes can be summed to produce a combined HRI for all such substances in a given water. Then the reduction in this combined HRI due to a proposed safety improvement project can be forecast along with the project's total (capital and discounted operating) cost. All health risk indexes used in this paper are precisely defined in Appendix A.

The Initial Strategy should include a review of all "no observable adverse effect limit" (NOAEL) studies from which the individual ADWGs are derived. This is needed to determine whether the rate at which the adverse health effects of a substance increase at a rate proportional to the Guideline exceedance or some other linear or non-linear rate (Fisher et al. 2024).

The ADWGs (NHMRC 2022) clearly states that the *acute health risk* from enteric pathogens (as indicated by presence of *E. coli* at consumers' taps) is of paramount importance in ensuring water safety. Consequently, reducing its HRI must be considered first (or possibly in combination with other microbial risks such as *Naegleria)*. As these microbial Guidelines are usually defined as presence/absence data, their HRIs have to be defined as the annual proportion of positive samples, rather than using the earlier definition for chronic (lifetime) health risk (see Appendix A for details).

Community health risk assessment

As water is supplied to communities rather than individuals, health risks need to be estimated on that basis. A community health risk index is proposed (Fisher et al. 2024) as the product of the community population and the individual's combined health risk index. Only then can a grand combined acute or lifetime health risk index be calculated for an entire jurisdiction or Australia as a whole. The percentage change in each of these grand indexes (relative to their initial values) would provide **appropriate estimates of progress made towards achieving the safety component of Target 9b** that need to be reported in the Annual Closing the Gap Report. (To data, no such estimates have been reported for either water safety or reliability.) The precise specification of these grand indexes is given in Appendix A.

For this reason, the Initial Strategy requires adding the population served by every water supply already included in the jurisdictional standards table.

Prioritization of safety improvement projects

There is another substantial reason for this requirement.The Initial Strategy also includes the adoption of an overarching criterion for *prioritization of safety improvement projects* proposed for NWGF (and any subsequent) funding. This is to ensure transparent and equitable allocation of the limited

funds available. *The criterion proposed is the ratio of the reduction in combined acute HRI to total cost per consumer.* Only the reduction in acute HRI is considered initially because this is the clear priority strongly recommended by the ADWGs (NHMRC 2022).

Projects should be funded in order of decreasing ratio until the limited funds are exhausted or further funds are made available (Fisher et al. 2024). Projects with similar forecast reductions in combined acute HRI should be prioritized in decreasing order of their *forecast ratios of reductions in combined chronic HRIs to total cost per person*. When all supplies have zero combined acute HRIs (i.e. all meet the microbial Guidelines), then the same criterion for chronic (lifetime) HRIs should be applied to obtain the greatest reductions for the funds available (Fisher et al. 2024).

National or jurisdictional prioritization?

The calculation of HRIs for prioritization involves the jurisdictional monitored data, the jurisdictional standards table, as well as the total costs and forecast reductions in HRIs of safety improvement projects. These calculations would therefore be best carried out at Federal Government level; for example, within the NWGA. However, the Federal group responsible would need access to the standards tables and monitored databases owned by each jurisdiction. Total costs and forecast reductions would be available to the same group as they would be contained within applications submitted for each safety improvement project for funding from the NWGF.

the proposed prioritization procedure must be applied at Federal Government level, rather than at jurisdictional level, to achieve a transparent and equitable allocation of funds among all First Nations communities across Australia.

Jurisdictional review and revision of monitoring programs

For this prioritization procedure to be viable, all proposed safety improvement projects need to include forecast reductions in acute and chronic HRIs due to the project, as well as the total cost of the project. By definition, the combined HRIs can only be calculated from measured data obtained by appropriate sampling (monitoring) as recommended in the ADWGs document (NHMRC 2022). Consequently, the Initial Strategy must include a review of current monitoring programs to *identify all those water supplies in the jurisdictional standards database that have the necessary and sufficient data* from which the current HRIs can be calculated and reductions due to proposed improvement projects can be forecast.

This is firstly to enable the prioritization procedure to commence with those supplies that have the necessary data. Secondly, the review would feed into a revision of existing monitoring programs to enable sufficient data to be obtained as soon as possible. The adequacy of such monitoring on *currently monitored supplies* will be assessed for its compliance with the microbial ADWG, in terms of sampling frequency and spatial distribution within the supply system. This is required to ensure that the microbial risk index values are calculated from consistent datasets from all community supplies.

This requirement poses a particular problem for either calculating current HRIs or estimating the total cost of proposed safety improvement projects in NSW. Of all State/Territory jurisdictions, NSW is the only one that does not require annual publication of monitoring data (Wyrwoll et al. 2022). The NSW Government regards indivdual water suppliers to be the owners of such data and to have the right to determine what data (if any) is to be released to the public. Indeed, the public is not even entitled to know what data is being collected. How then can any community know whether the safety of their water supply needs improvement, let alone make an application to the NWGF to do so?

REVISION CYCLE FOR THE STRATEGY

The annual proportion of positive samples (of *E. coli* and possibly *Naegleria*) is proposed as the acute health index. The ADWGs document recommends that the annual maximum value of any other substance should be compared with its respective ADWG, as is proposed for the chronic health index. This suggests a minimum annual revision cycle (Figure 1), which would also be compatible with the biannual NWGF application cycle. However, any applications for improving safety in each NWGF round would need to provide forecast reductions in HRIs along with the associated total cost, so that the proposed allocation criterion could be used to include new applications in the previously established prioritization.

Annual revision of the Strategy should include additions or deletions of supplies from the jurisdictional standards database and updates of all First Nations community populations, any changes to substances included in the definition of safety and any corresponding Guideline values. Only then should combined acute and chronic HRIs be calculated for all First Nations supplies, from which corresponding grand community HRIs for each jurisdiction and Australia-wide can be calculated and reported in the next Closing the Gap Report.

Annual revision should also include any new information from the scientific literature on the rate at which adverse health effects increase with

increasing dose of any of the substances included in the jurisdictional standards table.

Commence monitoring unmonitored supplies

This Initial Strategy assumes that the substances for which indexes are to be constructed are monitored adequately; i.e., data are available from samples collected with the frequency and spatial distribution advised by the ADWGs or corresponding jurisdictional standards. Wyrwoll et al. (2023) found that there were many supplies in regional/ remote communities for which no data are available at all. *Commencing to monitor these unmonitored supplies* for at least the substances causing acute health risks is considered the *top monitoring priority for a Revised Strategy* because indexes can already be calculated in an Initial Strategy for any supply from which any data relating to acute health risks is available.

A necessary prerequisite decision is the size of the community population below which State/Territory/Local Government jurisdictions will not undertake any monitoring. Only those communities above this threshold will be included in the monitoring component of this Strategy.

For supplies serving less than 5000 people, the microbial ADWG requires a sample for E. coli to be taken weekly from each supply zone. However, it recognizes that a balance may be needed with the logistics of taking samples in remote locations and transporting them to analytical facilities for supplies serving less than 1000 people (Table 9.4, NHMRC 2023). The jurisdictional standards already make this balance for supplies in general, by lowering the sampling frequency below the ADWG. This Strategy assumes that an explicit statement of this reduction will be made for small communities.

Add newly monitored supplies to prioritization procedure

Regardless of the sampling frequency and spatial distribution, at least one year of *E. coli* data is required before compliance with the microbial Guideline (or related jurisdictional standards) can be assessed. Consequently, *it will be at least a year after monitoring commences* on a currently unmonitored supply before the related community microbial risk index values can be calculated for this Strategy.

Establish water safety networks and train water rangers and community workforce

This Strategy recognizes the *major resources and logistics required* to bring the monitoring, initially of *E. coli,* in First Nations regional/remote water supplies, up to jurisdictional standards. It must address the difficult issues of training and retaining people with sufficient skills to take samples, transport them and conduct the appropriate analysis under suitable clean conditions. Chemical substances that constitute chronic health risks can be readily added to a revised *E. coli* monitoring program because the one sample can be subdivided prior to analysis (and the chemical analyses are required at lower frequency/spatial distribution).

Key recommendations from the first Voices from the Bush Forum (Cromar and Ross 2023) included the establishment of the Community Water Ranger role to liaise with utilities and governments, and Building a Community Workforce for Operation and Maintenance of Water Infrastructure. The Workforce positions should include the role of sampling, transport and analysis at the most local centre possible. Establishing networks based on regional hubs may be as localised as logistics and staffing allows. Even making suitable training available to community members is challenging but is required for long-term viability of monitoring and safety improvements. Water Rangers could play a major role in feeding community preferences regarding treatment/disinfection into funding applications for safety improvement measures.

The ADWGs set limits on the concentrations of more than 200 other chemical substances *to ensure that their consumption in drinking water over a lifetime is safe.* The community total chronic health index is a measure of the health risk from a given supply for the community population, relative to all of these ADWGs. However, many of these substances are not monitored in water supplies in general. Consequently, for a Revised Strategy, each jurisdiction will need to define those substances which will be added to the monitoring program for each community supply.

Screening process for unmonitored supplies

For *previously unmonitored supplies, a screening process is needed* to identify those substances which are likely to exceed their respective ADWGs before committing resources to regular monitoring. However, at least a year's monitoring (quarterly) is recommended for substances that are likely to vary seasonally, in source waters such as surface water or shallow groundwater. Many of these substances are pesticides, which can be quantified by analysis of a single sample, which greatly reduces the initial analytical screening burden. Furthermore, if the source catchment has no history of pesticide use, then the screening could be eliminated on these grounds.

A similar screening process is needed for those substances that are usually monitored in other general supplies, but have not yet been monitored in First Nations supplies.

STRATEGY TIMEFRAME

The Closing the Gap Target for achieving safe water (9b) was introduced in August 2022. If the Target is to be achieved by (August) 2031, the Strategy timeframe is only nine years, of which two years has already elapsed. This leaves only seven years to complete the enormous amount of planning, monitoring, training and infrastructure design and construction outlined in this paper, a herculean effort even if the necessary funds are made available to prevent delay of critical tasks.

CONCLUSION

A National Strategy is needed to focus on achieving the Closing the Gap Agreement Target of providing safe drinking water to all First Nations communities by 2031.

The Target is defined in terms of bringing First Nations supplies up to "jurisdictional standards" and these standards vary within and between jurisdictions. Consequently, the specific group of substances that are to meet health-related Australian Drinking Water Guidelines (ADWGs) must first be agreed.

A novel method of scoring health risks (health risk indexes – HRIs) is proposed, based on the severity of water supplied exceeding any of the agreed ADWGs. The magnitude of health risks at supply, jurisdictional or national level can then be calculated. Reductions in HRIs at national level relative to an initial national score can then be used to report progress on achieving the safety Target in the Annual Reports on Closing the Gap.

In an Initial Strategy, safety improvement projects would be prioritized in decreasing order of the ratio of combined acute HRI, relative to total (capital and discounted operating) cost per consumer. This is to maximize the reduction in acute health risks for the limited funds available (as recommended by the ADWGs). Project applications would need to include forecasts of these reductions as well as the total cost to obtain them.

After funding all projects to reduce acute health risks below their respective ADWGs, a similar prioritization of reductions in chronic (lifetime) health risks would be made.

Existing monitoring programs would be reviewed to ensure that measured data required to calculate the HRIs are available from as many supplies as possible for an Initial Strategy.

Monitoring programs for currently unmonitored supplies would be designed and initiated in subsequent Revised Strategies, so that they could be included in the safety improvement prioritization process as soon as possible.

A network of Water Rangers and Community Workforces would be established to ensure long-term viability of monitoring programs and operation of safety improvement infrastructure.

A Revised Strategy would be produced annually to suit the cycle of Closing the Gap reporting and NWGF project funding.

There are only seven years remaining to carry out the enormous amount of work involved in achieving the Closing the Gap Target for water safety, even assuming that the necessary funds are made available when required.

APPENDIX A: MATHEMATICAL SPECIFICATION OF HEALTH RISK INDEXES

A1 Acute(Microbial) Health Risk Indexes

If the weekly sampling frequency recommended in the microbial ADWG is adopted, then $n_1=52$ (for population<5000).
If *E. coli* is detected in f_1 of these samples, then the annual failure rate is f_1/n_1, which has a range of zero to one.

The **microbial risk index** for an individual consumer using this supply is also defined as the annual failure rate; i.e. $\mathbf{f_1/n_1}$.

If *Naegleria* is agreed to be a second microbial risk, its risk index is $\mathbf{f_2/n_2}$ and the **combined microbial health risk index for that water supply is then** $\mathbf{f_1/n_1+f_2/n_2}$.

A2 Chronic (Lifetime) Chemical Risk Index

Sampling frequencies recommended by the ADWGs for chemicals responsible for (chronic) lifetime health risks are generally either monthly or quarterly.

The ADWGs recommend using the annual maximum concentration of a contaminant as the value to be compared with its Guideline G_i. Then the annual **chronic chemical risk index** for a single (ith) contaminant (i>2):

$$= \frac{(\max(x_i) / G_i) - 1}{n_i} \quad \text{for } \max(x_i)>G_i$$
$$= 0 \quad \text{otherwise}$$

A3 Combined Chronic Health Risk Index

The annual **combined chronic health risk** for a water supply is then the sum of these individual indexes, where they exceed the Guideline; i.e.,

$$\sum_i \frac{\{(\max(x_i) / G_i) - 1\}}{n_i} \quad \text{for } \max(x_i)>G_i \text{ only}$$

A4 Grand Combined Acute Health Risk Index

$$\sum_j [p_j \times (f_1/n_1+f_2/n_2)]$$

A5 Grand Combined Chronic Health Risk Index

$$\sum_{j} [p_j \times \sum_{i}^{n_i} \{(\max(x_i)/G_i) - 1\}] \quad \text{for } \max(x_i) > G_i \text{ only}$$

NOMENCLATURE

Name	Units	Description
n_i	-	Number of samples for the ith analyte taken annually (i=1 *E. coli*; i=2 *Naegleria*
f_i	-	Annual number of samples containing *E. coli* or *Naegleria*
x_i	mg/L	Concentration of ith analyte in a sample (i>2)
G_i	mg/L	ADWG for ith chemical substance (i>2)
p_j	person	Population supplied by j
j	-	Water supply identifier j=1,2,3….

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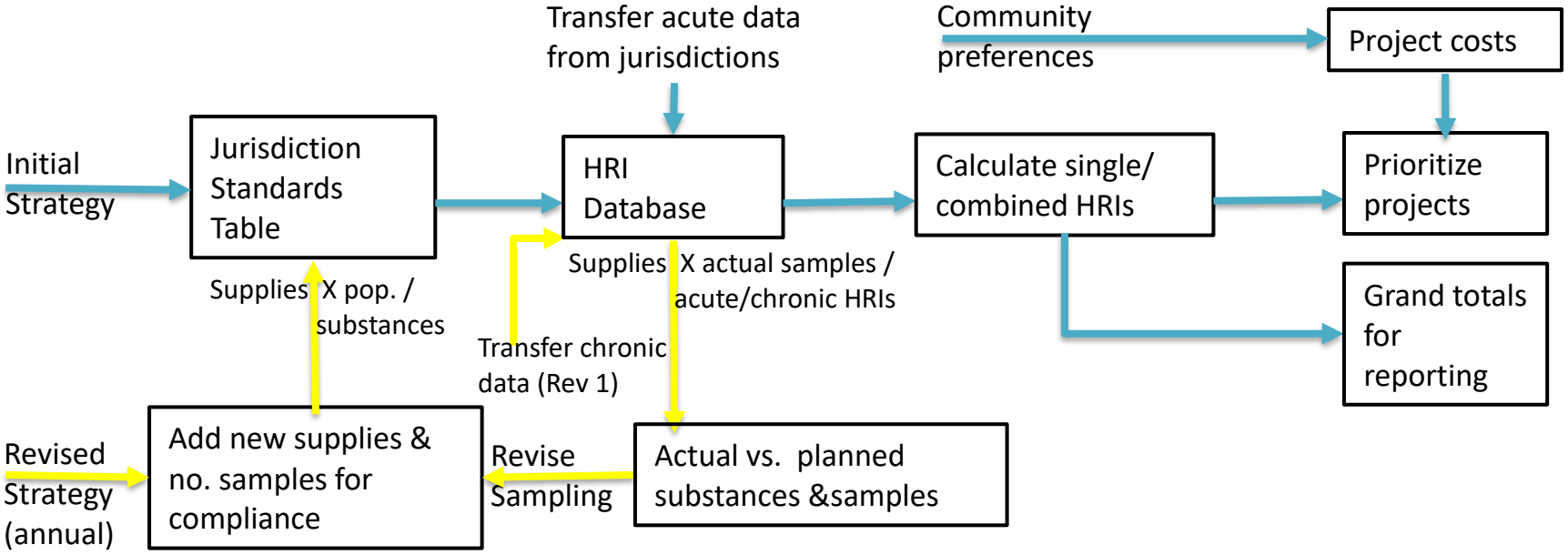

Figure 1: Overview of Initial and Revised Strategies