REVIEW OF THE PUBLIC HEALTH GRADING FRAMEWORK FOR WATER SUPPLIES: ADEQUACY OF THE EXISTING FRAMEWORK

Prepared as part of a Ministry of Health
contract for scientific services

by

Chris Nokes

March 2008

Client Report
FW07100

REVIEW OF THE PUBLIC HEALTH GRADING FRAMEWORK FOR WATER SUPPLIES: ADEQUACY OF THE EXISTING FRAMEWORK

Alistair Sheat
Water Programme Manager

Chris Nokes
Project Leader

Alan Ferguson
Peer Reviewer

DISCLAIMER

This report or document ("the Report") is given by the Institute of Environmental Science and Research Limited ("ESR") solely for the benefit of the Ministry of Health, Public Health Services Providers and other Third Party Beneficiaries as defined in the Contract between ESR and the Ministry of Health, and is strictly subject to the conditions laid out in that Contract.

Neither ESR nor any of its employees makes any warranty, express or implied, or assumes any legal liability or responsibility for use of the Report or its contents by any other person or organisation.

ACKNOWLEDGMENTS
The authors are grateful to the Christopher Bergin, Maire Porter, Graham Morris, Graham Wood, and Steve Goodin, for their comments on the grading, to Paul Prendergast for his comments on the draft of the report, and to Alan Ferguson for discussions and his peer review of the report.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

SUMMARY

There are potential links between PHRMPs and the public health grading (PHG) for water supplies, the purpose of which is:

"to provide a public statement of the extent to which a public water supply achieves and can ensure, a consistently safe wholesome product".

Assurance of a "consistently safe wholesome product" can only be achieved through knowledge of the risks to supplies and how these are managed.

This report takes the first step in considering how PHRMPs might be introduced into the PHG framework by assessing the ability of the present grading framework to achieve its stated purpose. The linkage of PHRMPs with the grading system was considered during the last review of the grading, but it was decided that this step should be postponed until more experience with the preparation and implementation of PHRMPs had been gained. Experience in the preparation of PHRMPs has now been gained, and legislation makes them a requirement for water supplies.

This report has assessed the performance of the grading framework through:

- comparison with a model framework;
- examing data from supplies that have already been graded;
- canvassing the opinions of a small group of water suppliers and DWAs (drinking water assessors) who have been involved with grading

The conclusions reached are:

- The 2003 PHG framework works is simple and practicable, and compresses a potentially large and complex set of information into two letters. However, it sacrifices accurate (qualitative) assessment of the likelihood of contamination.
- An accurate assessment of the likelihood of contamination requires each hazardous event, and associated hazard levels, barriers and preventive measures to be assessed as a whole. This cannot be done when a set of generic questionnaires, constrained by concerns of simplicity and practicability, have to be used for the grading.
- The PHG 2003 framework places major emphasis on the barriers to hazards, and to preventive measures, with little consideration of the levels of hazards the barriers and preventive measures are controlling.
- Distribution zone grading achieves its purpose better than the source/plant grading. This is because the use of generic questionnaires makes capturing information about the wide range of hazardous events that may affect sources, and the risk management associated with these events, more difficult..
- It is difficult to justify scientifically some of the assignments of demerit points for the distribution zone. If this system were to be retained as the basis of grading, the assignments should be revisited.
- The "D" and "E" and "d" and "e" grades assigned to supplies that have already been graded are justifiable given the information collected about these supplies.

Higher source/plant and distribution zone grades may not provide an accurate indication of the likelihood of contamination in some circumstances.

- Water suppliers and DWAs have different preferred approaches to the way grading is undertaken. Water suppliers wish the system to be more flexible for reasons of fairness, and the belief that a generic framework does not allow an accurate assessment of the likelihood of contamination. DWAs wish to have objective guidelines for determining responses to the questionnaire to make grade determination more clear cut.
- Water suppliers support the linkage of PHRMPs to the grading. This may help to address their concerns over the use of generic questionnaires. (DWAs may also support this linkage, but it was not explicitly mentioned in the limited survey.)
- The grading notes play a key role in the grading process. Their improvement to better meet the needs of the practitioners will be fundamental to producing an acceptable revised grading framework.
- The improved level of training of DWAs has better equipped them to undertake the grading process and in some areas has made a substantial contribution to the improvement in the 2003 PHG system over the 1993 PHG system.

CONSIDERATIONS

The following may assist the Ministry with respect to the revision of the public health grading system:

1. That the analysis of the existing grading framework undertaken in this report be considered when options for revision of the grading are being developed.

2. That the possibility of incorporating PHRMPs or the information collected in preparing PHRMPs, into a revised grading framework be investigated. The desirable characteristics of a grading system, identified in Table 1 of this report, should be borne in mind in developing the grading.

3. .That as part of the consultation process when revising the grading, the needs of DWAs, water suppliers and other stakeholders with respect to the grading notes be addressed.

1 INTRODUCTION

1.1 The purpose of this report

Since the Ministry of Health introduced its initiative to encourage water suppliers to develop public health risk management plans (PHRMPs) for their water supplies over 6 years ago, the water supply industry has become more familiar with risk management concepts and their use. Many water suppliers have already prepared and implemented PHRMPs. Water suppliers who have not already taken these steps will be required to do so by the recently enacted Health [Drinking water] Amendment Act. Although a revision to the 2003 public health grading framework is not imminent, in view of the requirements of legislation and the experience with the preparation and use of PHRMPs that has been gained since 2001, it is an appropriate time to consider how PHRMPs might be introduced into the public health grading framework.

As the first step in this process, this report examines the 2003 grading to assess how well it achieves its purpose. The incorporation of PHRMPs, or the information gathered in their preparation, into a grading framework could be accomplished in several ways. This report provides an understanding of the required attributes of a public health grading system by reviewing the present grading; it does not attempt to pre-empt decisions about the use of PHRMPs in the grading of water supplies. The development and consideration of options for PHRMP incorporation are the tasks of a later report.

1.2 Brief history of the development of the 2003 grading framework

The public health grading framework produced in 1993 (PHG 1993) was one of the first components of a set of tools the Ministry has assembled to encourage the improvement of drinking water quality and water supply management through New Zealand by making information about water supplies available to, and understandable, by the public.

The purpose of the PHG 1993 was:

> "to provide a public statement of the extent to which a public water supply achieves and can ensure, a consistently safe wholesome product".

The grading produced 2 grades: a grade based on information about the source and treatment plant in combination which was represented by grades from A1 to E; and a grade for the distribution network represented by grades from a to e. The readily understood a-e grading hierarchy has contributed to the public's easy grasp of what the grades indicate about a water supply. As a result, the effect of public pressure to improve water supplies became evident in some districts to the point of the water supply becoming a significant issue in local body elections.

The PHG 1993 was not without controversy. The basis for the grades was challenged by some local authorities, and there was also concern over the ability of the grading framework to provide national consistency in the grading.

In 2001, the Ministry of Health started work in the related area of public health risk management plans (PHRMPs) for water supplies. The aim of this initiative was to shift the

emphasis of water supply management from one based on water quality monitoring to one of risk management. Developing a PHRMP should give water suppliers a better understanding of the risks to the water quality in their supplies and how well the risks are being managed - both are necessary for water supply grading. PHRMP development therefore presented an opportunity to review the public health grading to address concerns about the 1993 framework and consider how PHRMPs, or the information gathered by them, might be incorporated into the grading.

A suite of four outline options for a revised grading system incorporating PHRMPs was prepared for public consultation in 2001. After considering feedback from the consultation[1], the Ministry decided that the introduction of PHRMPs into the grading process was too large a step until more familiarity with PHRMPs had been gained. The basis of the 1993 PHG framework was therefore retained, but modified to incorporate improvements that experience over the years indicated were necessary. This framework was promulgated for use in 2003.

1.3 Characteristics of the grading important to water suppliers

As part of the public consultation on the grading revision undertaken in 2001, attendees at the public meetings were asked to complete a questionnaire to help guide the direction the revision should take. Part of the questionnaire sought guidance on the importance of a set of characteristics the grading should embody. The findings of this set of questions are presented here to provide an understanding of the factors that need to be considered when developing a revised grading.

The data in Table 1 were obtained from 125 responses to the questionnaire. The respondents placed a high importance on the grading reasonably evaluating public health risk, and low importance on maintaining links with existing grading frameworks. Simplicity of the grading framework is also regarded as being of relatively high importance. Achieving simplicity, in conjunction with a reasonable evaluation of public health risk, will be challenging and will influence the way in which information from the implementation of PHRMPs can be utilised.

[1] C Nokes, 2001, *Public Health Grading of Drinking-water Supplies Review 2001: Public Consultation Report*, ESR Report to the Ministry of Health FW0180.

Table 1 Grading characteristics and their relative importance as judged by stakeholders in the grading process

	Relative Importance				
	Most Important				Least Important
	1	2	3	4	5
Characteristic	**Percentage of responses**				
Simplicity	24%	51%	15%	7%	2%
Reasonable representation of public health risk	74%	21%	5%	0%	0%
Practicality	29%	52%	15%	3%	1%
Fairness	24%	39%	24%	12%	1%
Traceable evolution from the existing grading procedures	5%	13%	28%	27%	27%

2 EVALUATION OF THE BASIS OF THE 2003 PUBLIC HEALTH GRADING FRAMEWORK

2.1 Introduction

As a starting point for assessing how well the PHG 2003 framework achieves its purpose (stated in s.1.2), this section establishes a "model" framework to act as a yardstick against which the PHG 2003 framework can be compared. The model is an idealised system, unhampered by the practical considerations that have shaped the PHG 2003 framework. By comparing the PHG 2003 framework against it, deficiencies of the 2003 system with respect to risk assessment that should be considered in developing a revised grading can be identified. The need to consider the desired characteristics of a grading system (listed in Table 1) is likely to limit how closely a practical framework can approach the model framework.

S.2.2 analyses the public health grading purpose statement and determines the nature of the information required for the public health grading and clarifies terminology. The information required for a grading framework is one of the factors that determines its structure.

S.2.3 presents the model framework and explains how its components can be assessed. The remaining sections consider the information gathered by the PHG 2003 framework and how it is used, compared with the information requirements of the model framework and its use of the information.

2.2 Information required for public health grading

Part of the rationale for this review is to provide the basis for considering how information obtained through the PHRMP preparation process could be used by the public health grading. Terminology and concepts used in the MoH's document *How to Prepare and Develop Public Health Risk Management Plans for Drinking-Water Supplies* are used here in the development of the model to help in conceptually aligning PHRMPs with the PHG.

Fundamental terms used in this report include:

> *Hazard*: a microbiological or chemical determinand that may cause sickness
>
> *Event or hazardous event*: an incident or situation that may introduce a hazard (or hazards) into the water
>
> *Preventive measure*: an action taken, or process, designed to reduce the likelihood of an event happening.

The public health grading statement of purpose contains two key components:

a) Achieving a "safe wholesome product"

b) Ensuring a consistently "safe wholesome product"

Component a) requires the grading to take account of water quality data to show that the water quality is satisfactory. Compliance with respect to *E. coli* and chemical

determinands (P2 determinands) is the primary means by which the quality of a supply's water can be established. Compliance monitoring, however, can only provide "snapshots" of water quality not continuous water quality information. When the snapshots reveal poor quality water, it is clear that the water is not consistently safe and wholesome. In contrast, monitoring results are of limited value in showing the production of consistently safe wholesome water (Component b) when monitoring shows good quality water. This is because of the gaps in information between "snapshots".

The MoH document *Public Health Grading of Community Drinking-water Supplies 2003 – Explanatory Notes and Grading Forms* (page ix), provides insight into what the grading needs to take into account to establish that the water is *consistently* safe, i.e., at times when there are no monitoring "snapshots" to check on the water quality. It states that "The grading is a measure of the confidence that the water supply will not become contaminated,…". Use of the word "confidence" implies that it is the <u>likelihood</u> of contamination of the water that is the other information to be communicated by the public health grading.

For us to consider a water to be contaminated, the concentration of hazards in the water must be sufficient to be (at least) detectable. The likelihood of a water supply being contaminated therefore requires account to be taken of two factors:

i) the likelihood of the barriers to hazards, or the preventive measures, failing;

ii) the concentration of hazards being controlled by barriers or preventive measures (this concentration is one of the factors that will determine the hazard concentration entering the water supply should a barrier or preventive measure fail).

A water is more likely to be contaminated (i.e., a hazard being detected) following the failure of a barrier (or preventive measures) if the hazard concentration being controlled by the barrier (or preventive measures) is high, than if the controlled hazard concentration is low.

In summary, to evaluate the likelihood of consumers being provided with contaminated water, the grading must collect information about the barriers (or preventive measures), the factors influencing their likelihood of failure, and the levels of contaminants challenging the barriers (or preventive measures).

2.3 Evaluating likelihood

Of the two components (a and b) identified as being required for grading, i.e., evaluation of water quality, and assessment of the likelihood of contamination, the latter is the more difficult task. This section is mainly concerned with describing the conceptual framework that can be used to determine how well the grading system achieves this task.

A model framework, which identifies the process steps and information needed to assess the likelihood of supply contamination, is depicted in Figure 1. The information needs from each supply component (catchment or recharge zone; treatment plant; distribution zone) are identified separately. Although quantitative information could be provided to meet some information needs, in most instances only qualitative information is available.

Incomplete knowledge of the natural processes in the catchment and their effectiveness in reducing hazard levels between the contamination source and the abstraction point also limit our ability to quantify hazard levels. As a consequence, the framework is expected to produce qualitative outputs.

Figure 1 shows that contamination likelihoods are evaluated at the two points in the system where grades are presently determined: after the treatment plant, and in the distribution zone. The likelihood of the consumer receiving contaminated water depends on the likelihood of contaminated water leaving the treatment plant and the likelihood of the ingress of hazards from other sources into the distribution zone. These are two separate considerations - preventive measures in the distribution zone are not designed to protect against hazards entering the distribution zone from the treatment plant, (a chlorine residual may do this to some degree but its purpose is not to protect against contaminants entering from the treatment plant).

The following points should be noted with regard to the framework in Figure 1:

i) Preventive measures and barriers are both designed to protect water quality, but they act in different ways. Preventive measures are actions taken to reduce the likelihood of a hazardous event occurring, e.g., having a stand-by cylinder of chlorine at the treatment plant to avoid unchlorinated water leaving the treatment plant. Barriers, on the other hand, are processes, or measures taken, to reduce hazard levels entering a source water or the distribution zone (e.g., riparian wetlands; backflow preventers), or to reduce hazard levels in a source water (e.g., coagulation/flocculation/clarification/filtration).

ii) For a rigorous determination of the likelihood of contamination of a supply, all possible barriers, hazardous events and the preventive measures used to minimise the likelihood of an event occurring need to be identified. The present grading, to keep the system simple, uses a generic form to try to understand a myriad of water supply situations, and consequently cannot collect this level of detail.

iii) There is a linkage between catchment/recharge zone and treatment plant, because the "output" from the catchment/recharge zone is the "input" to the treatment plant. The hazard levels carried in the source water at the point of abstraction determine the nature of the barriers required in the treatment plant and the minimum level of hazard removal they must be able to provide.

iv) Happenings in the catchment can only be considered as hazardous events if there is a pathway capable of carrying hazards from the point of contamination to the source water. E.g. leaching of hazards from a landfill is not a hazardous event if the landfill is downstream of the water supply's abstraction point; stock defecating directly into the source water is not a hazardous event if the water is fenced so that the stock are unable to get access to the stream.

v) The barriers referred to in the catchment/recharge zone include such things as riparian vegetation strips planted to reduce the microbial hazards in pasture run-off into a stream or river. There are also natural processes, such as adsorption, filtration, die-off and inactivation by sunlight, which will act between the site of

contamination and the abstraction point to reduce the hazard levels reaching the treatment plant. These are also noted in the framework.

Estimating the degree to which hazard levels are affected by these processes is complex and it would be unrealistic to expect a team carrying out a water supply grading to work through this detail. However, some account needs to be taken of them for estimating the likely hazard concentration entering the treatment plant. As a rule of thumb, the greater the distance between the hazard source and the receiving water, and the longer the period of travel, the greater will be the reduction in the hazard level.

vi) The likely hazard concentration reaching the treatment plant will depend on the quantity of the hazard released into the environment, the efficacy of any barriers constructed to reduce the hazard level, and the effect of natural processes on the hazard levels. A large amount of a hazard may be released into the environment, but if this occurs a substantial distance from the source water, for instance, the concentration reaching the abstraction point may still be low.

vii) The framework requires all possible hazardous events to be identified and each considered individually with respect to factors influencing the likelihood of the event occurring and factors affecting the resulting hazard levels. From the abstraction point onwards, the actual source of a particular hazard is unimportant. E.g., bacterial hazards, whether from a defecating animal or sewer outfall, will all experience the same processes in the treatment plant.

viii) Compliance monitoring of the water leaving the treatment plant, and that in the distribution zone, serves to assess the effectiveness of the barriers and preventive measures in reducing the likelihood of contamination of the supply.

When evaluating the grading system in the following sections, the information sought by the grading system and the way in which it is used is compared with the information needs, and the use of the information, shown in Figure 1.

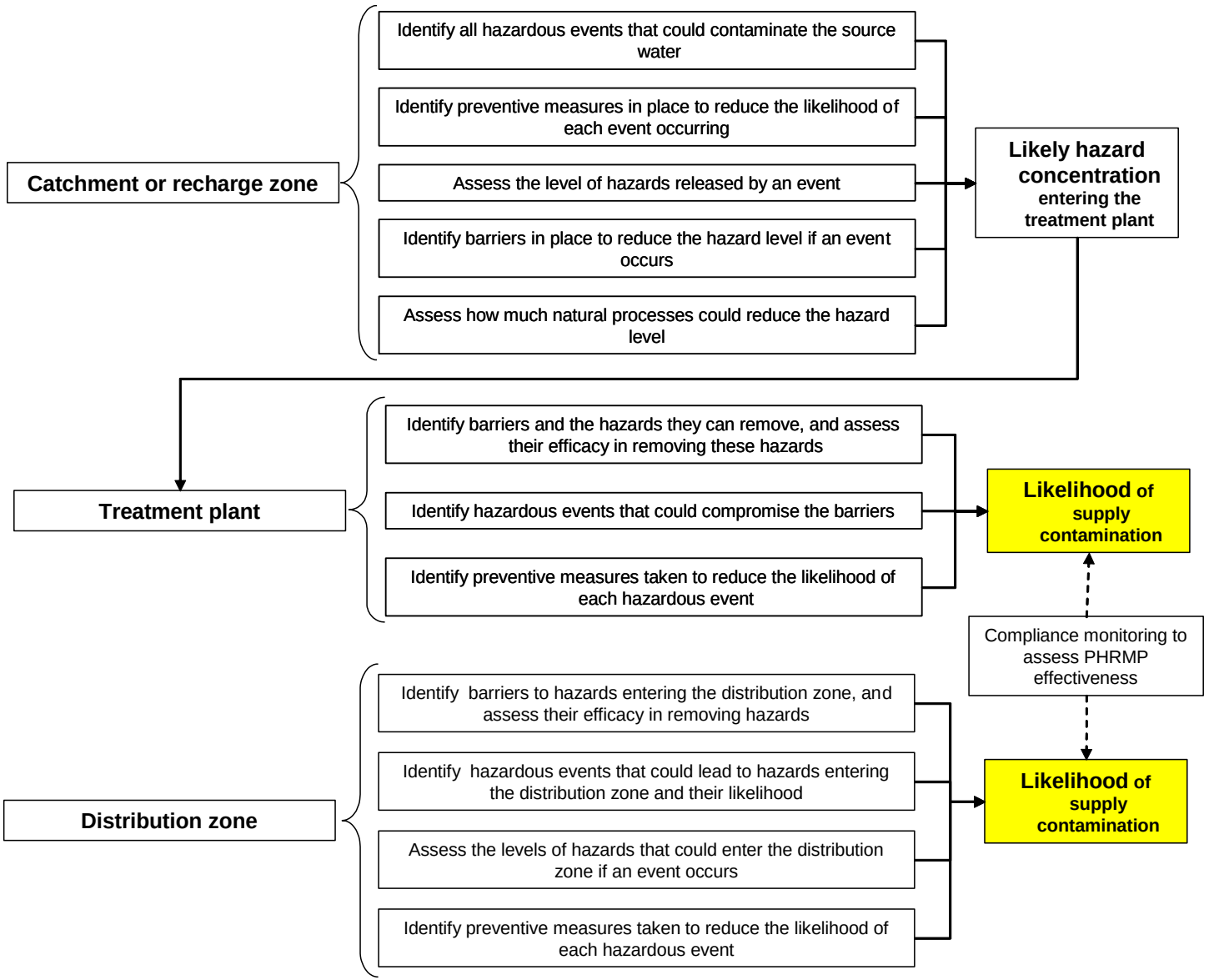

Figure 1 Model for the assessment of the likelihood of contaminated water reaching consumers

2.4 Source/plant grading

2.4.1 Identification of barriers, hazardous events and preventive measures

Information about hazardous events in the catchment, measures to prevent these events, barriers in the catchment to hazards from these events entering the source water, and the barriers and their operation at the treatment plant is collected through the source and plant questionnaires. The predominant factors that determine the source/plant grade, however, are the treatment barriers in the plant and their operation. The quality of the source water and the likelihood of contamination of the source water are only considered when the performance of the treatment plant is classed as unsatisfactory.

Source questionnaire

Within the source questionnaire, questions Q10-Q12 collect information about factors likely to affect water quality[2]. Q10 provides information about the type of source, which influences water quality variability and therefore treatability. This information is not explicitly used in determining the source/plant grade. Q11 determines whether the source is a secure groundwater, which establishes the table to be used in determining the grade.

For supplies drawing from surface waters or non-secure groundwaters Q12 gathers the key information about factors influencing source water quality. This question does not collect information about specific potentially hazardous events and associated preventive measures. It requires the DWA and water supplier to provide an overall assessment of the "level" of different types of pollution[3]. To do this the grading team should have identified all significant potentially hazardous events in the catchment (e.g. stock grazing near source sources; stock having direct access to water sources; etc), and for each event determined how preventive measures might reduce its likelihood, and what level of hazard attenuation any barriers might be expected to provide. For some supplies, an existing PHRMP may be used to assess the level of contamination.

Responses to Q12 cannot be quantitative. Information needed to estimate the degree of natural attenuation of the hazard before it reaches a source water is unavailable and the process of doing such calculations is, anyway, too complex to be carried out within the public health grading. The notes for Q12 set out some criteria for deciding how to respond, but the criteria are generic and may result in the same response being given for situations in which the likelihood of source contamination is different.

Q10-Q12 do not directly feed into the evaluation of the source/plant grade. Q13 summarises information from Q12 to evaluate the "risk of contamination" and this is only used in determining the grade ("D" or "E"), if plant performance is unsatisfactory.

Plant questionnaire

The plant questionnaire collects information about treatment processes in use (Q11), but only those linked to protozoal compliance, plus chlorination. The outcome of the source/plant grading hinges predominantly on the responses to Q13. Q13 contains

[2] The Grading provides a mechanism by which information needed for statistical purposes can be collected, hence the inclusion of Q9 in the Source Questionnaire, Q8 in the Plant Questionnaire, and Q8-Q11 in the Distribution Zone Questionnaire.

[3] It is understood that the DWA's handbook requires the information taken into account in arriving at the responses for Q12 to be recorded in the DWA's records of the grading, but this more detailed information is not submitted with the responses to the grading questionnaire.

questions concerning compliance and barriers to hazards. The barriers identified in Q13 are: the inclusion of a properly operating disinfection process; the use of a disinfectant providing a satisfactory residual, and protozoal compliance (which is based on barriers and associated preventive measures). The maintenance of a disinfection residual (also considered in Q13) is a post-treatment barrier to microbial hazards, and is not linked to the likelihood of hazards being in the water leaving the treatment plant.

Hazardous events at the treatment plant that may adversely affect operation of the treatment processes, e.g., chlorine dosing malfunction, increase the likelihood of the contamination of the treated water. Existing questions do not identify specific preventive measures for specific hazardous events. More general preventive measures are identified and evaluated by Q14 (Standard of Control), Q15/Q16 (qualifications of supervisors) and Q17 (record keeping). Care is needed in accepting these indirect indicators as confirmation that adequate preventive measures are in place. For example, a treatment plant might have a satisfactory record for maintaining continuous chlorination, but preventive measures to guard against a break in chlorination may not be in place. In this situation, the satisfactory chlorination record is a matter of good fortune rather than satisfactory risk management.

It could be argued that information about the preventive measures for some hazardous events is implicit in existing questions because of reference to the requirements of the DWSNZ (e.g. continuous chlorine monitoring, which provides a check for dosing malfunction, is required for a system to be regarded as "disinfected").

2.4.2 Shortcomings of the source/plant grading

The following concerns about the source/plant grading are evident from an analysis of the Source and Plant questionnaires:

i) The potential number and diversity of hazardous events associated with a catchment makes identification of each event difficult, if not impossible, in a generic questionnaire. The existing grading framework therefore requests summary information, but the supporting information, although recorded by DWAs in their records of the grading, is not recorded by the questionnaire. As a result, there is a lack of transparency with respect to the derivation of the summary response in the questionnaire, which makes assessment of national consistency difficult. National consistency relies on all DWAs making the same evaluation of the importance of hazardous events identified in the catchment.

ii) To establish an estimation of the likely hazard concentration in the water entering the treatment plant requires an understanding of the influence of several factors on contamination levels. In the case of animal pollution, for example, these include: animal type, animal numbers, topography, distance from the receiving water, ground cover and soil properties. Taking account of all these in a simple grading is unrealistic, but is what would be needed to provide a reliable assessment of the likelihood of source water contamination.

iii) The notes for Q16 (plant questionnaire) provide a generic basis for evaluating the appropriateness of treatment plant supervision based on the qualifications of the managers and operators. Suitable qualifications are key to minimising the likelihood of treatment failure, but a generic evaluation is unable to take account of other factors, such as experience, or the ability of an individual, that will also contribute to satisfactory risk management.

iv) The 2003 grading framework makes the treatment plant the major means by which risks to the quality of the water leaving the treatment plant are managed. Once there is overall compliance with the DWSNZ at the treatment plant, disinfection, and adequate maintenance of records, no account is taken of the quality of the source water and degree to which it might deteriorate. Thus, two treatment plants with the same treatment processes in place and the same level of risk management can be given the same grade even if one has highly polluted source water and the other is virtually pristine.

With the increasing sophistication of treatment processes and their control, the likelihood of treatment barrier failure is decreasing. However, to remove the quality of the source water from consideration for the better treatment plants ("C" grade and above) does not encourage the "multi-barrier" philosophy which is supported by the DWSNZ and which includes management of risks in the catchment where this is possible. The management of hazardous events in the catchment may be difficult, but the risk they present should be taken into account by the grading if the grading is to indicate accurately the likelihood of water contamination.

The development of the National Environmental Standard for sources of human drinking water (NES), by the Ministry for the Environment, should assist in better management of potential sources of contamination in the catchment. The NES, however, applies only to source waters used serve communities of more than 500 people.

v) The adequacy of records plays an important role in determining the source/plant grade because it allows compliance with the DWSNZ to be shown. Records also help to determine when barriers have failed and to identify necessary corrective actions. They therefore aid the management of risk. However, their relative importance in determining the likelihood of consumers receiving contaminated water, compared with other factors that influence the grade, is uncertain.

vi) For each hazardous event, there should be preventive measures to reduce the likelihood of it happening, or there should be barriers in place to remove hazards resulting from the event, or both. The source questionnaire determines whether a source has been subject to algal blooms, but this information is not considered in the grading if the treatment plant meets the criteria to receive a grade in the range "C"-"A1". None of the criteria that must be met to achieve these grades shows that the plant has the treatment processes in place to remove or destroy cyanotoxins.

The situation is similar for some P2 determinands. The only contribution P2 determinands make to the grade is through their compliance status at the treatment plant. Some determinands can vary considerably in concentration, e.g., disinfection by-products. The test results from 12 samples taken over a year, do not show that the treatment processes are appropriate and being adequately managed. As indicated by the earlier discussion in s.2.2, the samples provide only "snapshots" of water quality, not evidence of a <u>consistently</u> safe wholesome water.

vii) The response options for much of Q13 are a mix of levels of pollution, e.g. "considerable" and the likelihood of pollution, e.g., "very unlikely". This makes it unclear whether concentration or likelihood is being estimated.

2.4.3 Strengths of the source/plant grading

S.2.4.2 identifies several deficiencies in the source/plant grading, but it's primary strength is managing to compress into a single letter, a large amount of risk information concerning the source and treatment plant. Whatever modifications to the grading framework are undertaken in the future, managing to retain a system that is practicable to implement from the point of view of the DWAs and water suppliers, and simple to understand for the public will be the greatest challenge.

2.4.4 Summary - evaluation of the 2003 source/plant grading against the model framework

Table 2 summarises the comparison between the 2003 source/plant grading and the model framework.

Table 2 Evaluation of the 2003 source/plant grading against the model framework of Figure 1.

Model framework component	How well incorporated by the 2003 Grading framework
Source	
Identification of all hazardous that could contaminate the source water	• Not specifically identified, but they are expected to be taken into account in responding to Q12 (source questionnaire). • They only influence the grading, if treatment barriers are inadequate, to differentiate between a D and E grade.
Identification of preventive measures to reduce the likelihood of each hazardous event (catchment) occurring	• Not specifically identified, but they are expected to be taken into account in responding to Q12 (Source questionnaire). • They only influence the grading, if treatment barriers are inadequate, to differentiate between a D and E grade.

Model framework component	How well incorporated by the 2003 Grading framework
Assessment of the level of hazards released by an event	• Some monitoring data for *E. coli* is sought by Q12 (source questionnaire), but levels of other hazards are not specifically determined. • *E. coli* data only influence the grading: to differentiate between a D and E grade, or when direct filtration is used for protozoal compliance, and there is direct discharge of human or animal waste into the source.
Identification of barriers to reduce hazard levels if an event occurs	• Not specifically identified, but they are expected to be taken into account in responding to Q12 (Source questionnaire). • They only influence the grading, if treatment barriers are inadequate, to differentiate between a D and E grade.
Assessment of the extent to which natural processes could reduce hazard levels	• Not considered in the existing framework
Plant	
Identification of barriers for each hazard and assessment of their efficacy	• Barriers to protozoa are specifically identified, which includes processes that will inactivate bacteria. Within the DWSNZ:2005 the efficacies of these processes for protozoa removal are defined if they comply with the Standards. • Barriers to specific chemicals that may cause aesthetic problems are not identified. Whether the aesthetic guidelines overall are met is determined (Q12 Plant Questionnaire). • Barriers to specific health-significant chemical hazards are not identified.
Identification of hazardous events that may compromise the barriers	• Possible events are not identified

Model framework component	How well incorporated by the 2003 Grading framework
Identification of measures to prevent the hazardous events (to barriers) occurring	• Specific measures are not identified, but more generic measures, eg, control and supervision, that should indirectly prevent events are determined

2.5 Distribution zone grading

2.5.1 Identification of barriers, hazardous events and preventive measures

Questions Q13 to Q21 are the basis for the distribution network grade. Q22 and Q23 seek information that is only used to promote an "a"-graded supply to an "a1" grade. Q22 (ISO accreditation) does have a bearing on risk management of the supply, but it is at a high level and is not critical to determining how well the grading achieves its purpose. Q23 relates to the acceptability (taste, odour, appearance) of the water. The aesthetic properties of the water are not considered important enough to be fundamental to determining the grade (until the "a" –"a1" transition is reached) otherwise the response to Q23 would be used differently in the 2003 framework. (Determinands influencing the aesthetic properties of the water are just regarded as another group of "hazards" by the model framework.)

Q20 and Q21 seek information about compliance and are primarily concerned with water quality and how well this has been determined.

Q13 to Q19 gather information about barriers, hazardous events and preventive measures. The questions cover the key hazardous events identified in the appropriate Ministry of Heath's PHRMP Guide. (The PHRMP guides list the use of a satisfactory code of practice for maintenance and repair operations on the distribution network as an important preventive measure. The distribution zone questionnaire does not contain a specific question to determine whether such a measure is in place, but a code of practice of this type is mentioned in the notes to Q14).

The model framework requires:

a) Identification of barriers to hazards entering the distribution zone, and assessment of their efficacy;

b) Identification of hazardous events and assessment of their likelihood;

c) Assessment of the levels of hazards that may enter the distribution zone should a hazardous event occur;

d) Identification of preventive measures to reduce the likelihood of hazardous events occurring.

Table 3 shows how information for a) b) and d) is captured by Q13 to Q19. No information is gathered for c). Often the likelihood of a hazardous event occurring can be qualitatively judged from information obtained by a question about the extent to which preventive measures are in place.

Table 3 Analysis of the nature of the information gathered by Questions Q13-Q19 in the plant questionnaire

Question	Hazardous event	Deals with			Comment
		Barrier	Likelihood of hazardous event	Preventive measures in place	
Q13a	Leaks (indirect through network condition)	No	Yes	No	The likelihood of an event is qualitatively estimated by the age of the pipes.
Q13b	Leaks	No	Yes	Yes	Demerit points are assigned on the basis of the likelihood of an event (% water lost) and the preventive measures (frequency of surveys) combined.
Q13c	Ball hydrants (ingress of hazards)	Yes	Yes	Yes	The installation of new approved-design hydrants provides a barrier against hazards. The presence/absence of ball hydrants simultaneously identifies the likelihood of an event and extent to which preventive measures (replacement of ball hydrants) are being taken.
Q13d	Corrosion	No	Yes	No	Likelihood of event is estimated through the degree of corrosion and the water quality. No information is sought about the preventive measures that have been put in place to control corrosion.

Question	Hazardous event	Deals with			Comment
		Barrier	Likelihood of hazardous event	Preventive measures in place	
Q13e	Biofilm and sediment formation	No	Yes	Yes	The extent to which the problems of the development of biofilm and sediment deposition are managed are estimated from the regularity of mains flushing and cleaning (preventive measures). A qualitative estimate of the likelihood of biofilm formation and sediment accumulation can be made from the frequency of flushing and cleaning.
Q14	Leaks and contamination during maintenance	No	Yes	Yes	The extent to which maintenance programmes are implemented is the means by which the likelihood of an event is assessed. PHRMPs are noted as the means of assessing whether preventive measures are in place.
Q15	Backflow	Yes	No	Yes	Neither the nature of operations in the distribution zone for which backflow would be appropriate nor the number of such operations are identified to help in establishing the hazard level. The presence of preventive measures is estimated on the degree to which legislative requirements are met. Meeting the legislative requirements implies the installation of a barrier to hazards.

Question	Hazardous event	Deals with			Comment
		Barrier	Likelihood of hazardous event	Preventive measures in place	
Q16	Uncovered and unsecured reservoirs Storage capacity	Yes	No	Yes	A reservoir cover provides a barrier to the ingress of contaminants. The number of uncovered/unsecure reservoirs, or the volume of water held by such reservoirs, is not determined, which limits assessment of the hazard levels. The likelihood of an event is assessed as "presence/absence" of the risk, but little more. This question seeks information simultaneously about, cover, security and stored capacity, which makes teasing out the likelihood associated with the various components difficult.
Q17	Hazard ingress through leaks	No	Yes	Yes	Maintenance of a pressurised network is a preventive measure to protect against the ingress of contaminants through leaks. The question assesses the extent to which this preventive measure is implemented. Some indication of the likelihood of a leak event is obtained from consideration of Q13a in conjunction with Q17.
Q18	Poor operation of the distribution system, failure of preventive measures	No	No	Yes	No specific risks are addressed. This question evaluates how well the preventive measures that have been put in place will operate based on the qualifications of those supervising and operating the network. An estimate of likelihood cannot be readily gained from the information gathered.

Question	Hazardous event	Deals with			Comment
		Barrier	Likelihood of hazardous event	Preventive measures in place	
Q19	Microbial hazards in the network	No	No	Yes	The maintenance of a free chlorine residual is a preventive measure that will assist in mitigating the level of contamination arising from other hazardous events. Although a free chlorine residual is a barrier to the hazard reaching the consumer, it is not a barrier to the entry of hazards into the distribution system. Information about monitoring of the FAC residual does not provide a satisfactory basis for evaluating the likelihood of the hazardous event.

Table 3 shows that the grade is dependent predominantly on knowing whether preventive measures are in place. For some hazardous events (leaks; hazard ingress through ball hydrants), information is gathered to assess the likelihood of the event in the absence of preventive measures. This likelihood is reduced by having appropriate preventive measures in place, but this is not reflected in the assignment of demerit points in the grading: e.g. undertaking surveys to detect leaks and so reduce the likelihood of contamination does not achieve a reduction in demerits points, only the avoidance of receiving more demerit points.

In summary, the present grading framework for the distribution zone is primarily concerned with only two of the four factors identified in the model shown in Figure 1 for evaluating the likelihood of contamination: the use of appropriate preventive measures and the estimation of the likelihood of an event.

2.5.2 Shortcomings of the distribution network grading

Despite identification of appropriate preventive measures being well handled by the grading framework, some concerns remain.

i) Little, if any, information is collected to assess the level to which hazards might enter the pipe network should barriers or preventive measures fail and a hazardous event occur (item b) above). For example, preventive measures are identified for biofilm formation and sediment deposition, and for backflow, but no account is taken of the levels of hazards that may develop in the water should the barriers or preventive measures stopping one of these hazardous events fail. Having some estimate (qualitative would be sufficient) of the hazard level is important for being able to draw sensible conclusions about the likelihood of contamination.

ii) The questionnaire seeks information about the primary measures for preventing each event it identifies. The establishment of these measures is probably the most effective means for limiting the likelihood of events occurring, but suppliers may have taken additional preventive measures. The grading takes no account of how these additional actions will reduce the likelihood of contaminated water reaching consumers.

iii) Inconsistency with the way hazard levels are handled.

For some hazardous events, such as backflow, demerit points can accrue from not having barriers or adequate preventive measures in place, but there are no demerit points linked to the hazard level that these measures may be protecting against. For example, no information is collected about the number or size of installations within the network that may require backflow prevention. These factors will influence the levels of hazards entering the distribution zone in the event of a failure in backflow prevention.

In contrast, with respect to the ingress of hazards through leaks, some attempt is made to evaluate the hazard levels through information about the conditions of the pipes (Q13a) and to assign corresponding demerit points. Evaluation is also made of appropriate preventive measures through Q13b and Q17.

iv) The defensibility of various weightings used in deriving the grade

Any scoring system that relies on the arbitrary assignment of scores suffers from concerns over unintentional distortion of the relative importance of risk factors the grading tries to take into account.

Some decisions on scoring are based on MoH policy or a judgement of what would be acceptable to the community. An example is the decision that a supply that is non-compliant with respect to *E. coli* is capable of receiving a "c" – probably regarded by the public as "a pass", if only just.

Other arbitrary weightings given to scores cannot be scientifically justified because of the paucity of scientific information on which to base them. In these instances, the best expert guesses have been made in assigning demerit points, but a more defensible basis for the scores would be desirable, if it is possible. There are three situations in which the fairness of the assigned demerit points might be questioned:

- Comparison of weightings to the responses within a particular question

  For example, is there a defensible basis for the demerit points of 0, 4, and 9 given to the possible responses to Q15 – backflow prevention?

- Comparison of weightings to responses from different questions

  Table 4 lists the maximum demerit points associated with not implementing certain preventive measures.

Table 4 Maximum demerit points that can accrue by not implementing preventive measures in the network

Preventive Measure	Maximum Demerit Points
Leak Detection	2
Mains flushing and cleaning	2
Distribution Operation	3
Inspection and Maintenance	6
Water Pressure	6
Backflow prevention	9
Secure Reservoirs	9
Distribution Management	10
FAC residual	12

Greater demerit points imply a greater importance of the preventive measure in preventing the consumer receiving contaminated water. An FAC residual has a limited ability to deal with substantial contamination and is limited with respect to the types of hazard it is effective against (bacteria and viruses). Given these limitations, should an FAC residual be considered of greater importance than maintenance of pressure or backflow prevention both of which can protect against substantial contamination by a wide range of hazards?

v) Inability of generic questionnaires and a generic scoring system to accurately reflect the likelihood of contamination of individual supplies

Having a generic questionnaire with set demerit points assumes that a particular preventive measure carries the same level of importance in all supplies. The importance of a particular preventive measure will depend, *inter alia*, on the levels of hazards that may enter the system should the measure fail. (see s.2.5.2 i)).

2.5.3 Positive aspects of the distribution network grading

Comparison with the information contained in the appropriate PHRMP guides shows that the distribution network questionnaire captures information about all the major hazardous events identified in the PHRMP guides that might befall a distribution system[4].

The primary hazardous events that have been identified are:

A) Ingress of contaminants from outside the network through:

a Leaks in pipes coupled with pressure fluctuations drawing hazards into the reticulation system

b The absence, or inadequate maintenance, of backflow prevention systems to avoid pressure drops siphoning contaminated water back into the reticulation system

c Use of uncovered, unsecured service reservoirs, or reservoirs that are susceptible to intentional or unintentional contamination

d Poor network repair and maintenance practices

e The presence of ball hydrants in the network

B) Release into the water of contaminants derived from inside the network through

f Corrosion of materials used to construct the network

g Biofilm (which may contain pathogens) sloughing off the internal pipe surfaces

h Resuspension of sediment, and associated micro-organisms, that have accumulated within the network

Important (though not necessarily the only) barriers and preventive measures to minimise the likelihood of contamination from these events have also been identified, and information has been sought about them, albeit indirectly in some instances (the events to which the measures apply are identified in brackets):

- Leak detection surveys and maintenance of adequate supply pressure (a)
- Flushing and cleaning of mains (f, g, h)
- Performance of system maintenance in a sanitary manner (d)

[4] While the PHRMPs are not an exhaustive listing of all such events, they provide a starting point for making this evaluation.

- Adherence to legislative requirements for backflow protection, which includes maintenance of the devices (b)
- Covering and security of reservoirs (c)
- Replacement of ball hydrants (e)

In addition to these more specific preventive measures, there are more general measures that provide an over layer of protection, by reducing the likelihood of a preventive measure failing, or mitigating the effects of failure, namely:

- The adequacy of supervision and operation
- The maintenance of an adequate disinfecting residual.

3 EXAMINATION OF THE RESULTS OF THE 2003 PUBLIC HEALTH GRADING

3.1 Introduction

Section 2 has looked at the 2003 grading framework from a theoretical standpoint. Confirmation of some of the concerns identified in Section 2, and perhaps the identification of others, may be revealed by looking at the actual consequences of using this grading framework. This section therefore examines the results of the grading of water supplies using the 2003 PHG system.

At present, 115 zones, 81 plants and 123 sources have been graded. Some caution is required in drawing conclusions from the statistics presented. The number of zones for which gradings have been undertaken is only about one quarter of the total number of supplies serving a population of 500 or more, and the results arise from the early use of a new grading system. It is possible that the supplies selected for grading reflect a desire on the part of DWAs to start with easily graded supplies, namely those that will obviously receive a high or low grade; supplies with an intermediate status that might be more controversial are potentially more difficult to grade. This may be influencing the distribution of grades.

3.2 Source/Plant Grades

The distribution of Source/Plant grades between plants that have been graded is shown in Figure 2[5].

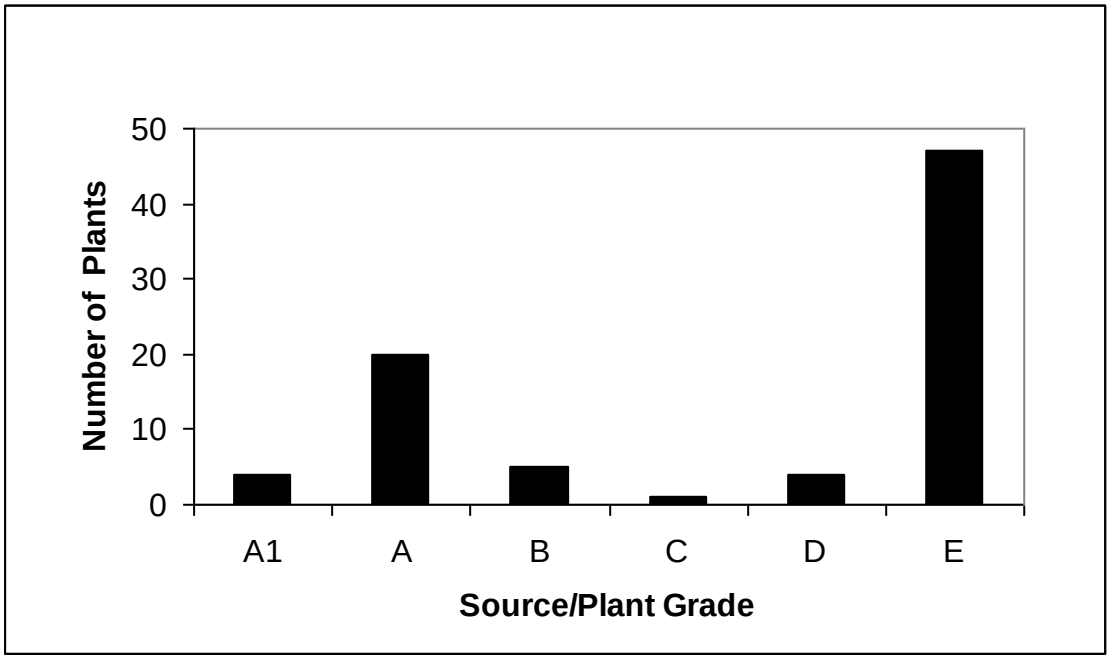

Figure 2 Distribution of 2003 source/plant grades

[5] Some treatment plants may have more than one source. In this event, the source/plant grade assigned to the plant is determined by the worst source/plant combination. To date, each plant with more than one source that has been graded using the 2003 grading framework, has the same source/plant grade irrespective of which source is considered. The statistics in this section are expressed in terms of numbers of treatment plants, because the source/plant grade is the same for each source/plant combination.

The distribution is bimodal: peaks in numbers of source/plant with high or low grades. This could be explained by a preference for grading supplies that are at the "risk extremes" because they are easier to grade as explained in s.3.1. Alternatively, it may be an indication that the criteria for achieving a "C" grade are sufficiently onerous that the majority of would-be "C" grade source/plant combinations are relegated to unsatisfactory "D" and "E" grades. A grading system that in practice results in only extreme grades is essentially a "Pass/Fail" grading system. This is not what the grading is intended to produce.

3.2.1 Failing source/plant grades

A "D" or "E" grade can result from failure to meet any of a number of requirements. The reasons for failure in the 51 treatment plants with failing grades are listed in Table 5.

Table 5 Reasons for treatment plants receiving a D or E grade

Potential reason for failing grade	Number of Treatment plants
Did not comply with DWSNZ with respect to *E. coli*	24
Did not comply with DWSNZ with respect to protozoa	51
Did no comply with DWSNZ with respect to P2 monitoring	5
Did not meet criteria to be regarded as disinfecting	41
Did not keep adequate records	35

The failing grade ("D" or "E") for these plants indicates that they were not adequately managing the risk to the finished water quality. Many of the treatment plants received a failing grade for multiple reasons, but most importantly all were unable to show compliance with respect to protozoa, and only about 20% were regarded as adequately disinfecting their water.

The distinction between the "D" and "E" reflects the lower likelihood of contamination at "D"-graded plants because the source water has met the requirements for classification as a "low risk" source. It could be argued that the likelihood of contaminated treated water being produced by the "D"-graded treatment plants was low, and therefore a higher grade should have been obtained, because of the "low risk" water entering the treatment plant. The median source water concentrations of *E. coli* are reported as "0/100ml" for all the "D"-graded plants. All sources are springs or groundwaters from unconfined aquifers, and therefore are not secure. Despite the expected low likelihood of contamination of the source waters and the low *E. coli* concentrations in monitoring samples, the inadequate treatment for protozoa and inadequate disinfection provide no protection against microbial hazards that may enter the source water as the result of unforeseen circumstances. *E. coli* monitoring is insufficient warning of such an event, and the "fail" grade is justified.

Of the 47 "E"-graded treatment plants 37 are inadequately disinfecting. The barriers they have against microbial hazards are therefore no better than those for the "D"-graded plants. Hazard levels in the source water, however, are expected to be higher. A lower grade is

therefore justified. Although 10 of the treatment plants are adequately disinfecting, their lack of barriers to protozoa and the poorer quality source water can be expected to lead to a greater likelihood of contamination of the treated water. A lower grade is again justified.

The split between the "D" and "E" grade is the only example in the present grading system where the hazard level is taken into account in determining the grade, which is consistent with the model framework of Figure 1. The "D" and "E" grades to date are justifiable because of the lack of barriers to protozoa, inadequate disinfection, or both.

3.2.2 High source/plant grades

The high-graded source/plant combinations ("A1" and "A") also need to be considered to establish whether the potential events associated with the hazards in their source waters are being adequately managed.

Of the 47 sources that have an "A" or "A1" grade, 17 are classed as "low risk". Eight of these are secure groundwaters. The remaining 11 sources come from protected catchments.

Seven of the 30 "A" or "A1" sources that are not "low risk" are subject to algal blooms. These treatment plants may operate treatment processes that can remove or destroy cyanotoxins, but this information is not captured by the grading questionnaires, and therefore their high grade may give a misleading indication of the likelihood of treated water contamination.

Twenty-four source/plant combinations have an "A" or "A1" grade. To attain this grade compliance for P2 determinands is needed, which implies all P2 determinands are monitored and none exceed their MAV in the 12 or more samples taken during the year. The absence of a MAV exceedance during monitoring is not an indication that the determinand is being adequately managed. No information to assess the adequacy of treatment processes removing P2 determinands (or precursors to P2 determinands, e.g. natural organic matter which is a precursor to disinfection by-products) is collected by the grading questionnaire (apart from the monitoring results).

Although there are gaps in the information collected with regard to chemical hazards, the grading collects adequate information on which to assess the ability of the "A" or "A1" treatment plants to provide barriers against microbiological hazards.

There is only one plant with a "C" grade. It misses a "B" grade because of supervision. There is an experienced professional manager, but it appears that the absence of an adequately qualified operator results in the drop in grade, despite continuous monitoring of the plant. This situation is perhaps an example of the grading acting as a tool to encourage a water supplier to further train their staff to make them better able to manage risks to water quality.

In summary, the source/plant gradings undertaken to date show some areas of concern in the assessment of grades when the grades are "C" or above.

3.3 Distribution zone grades

The occurrence of distribution zone grades is shown in Figure 3. The distribution is similar to that for the source/plant grades showing a tendency for extremes of grade. As with the source/plant grade, this may result from the nature of supplies that have been initially selected for grading.

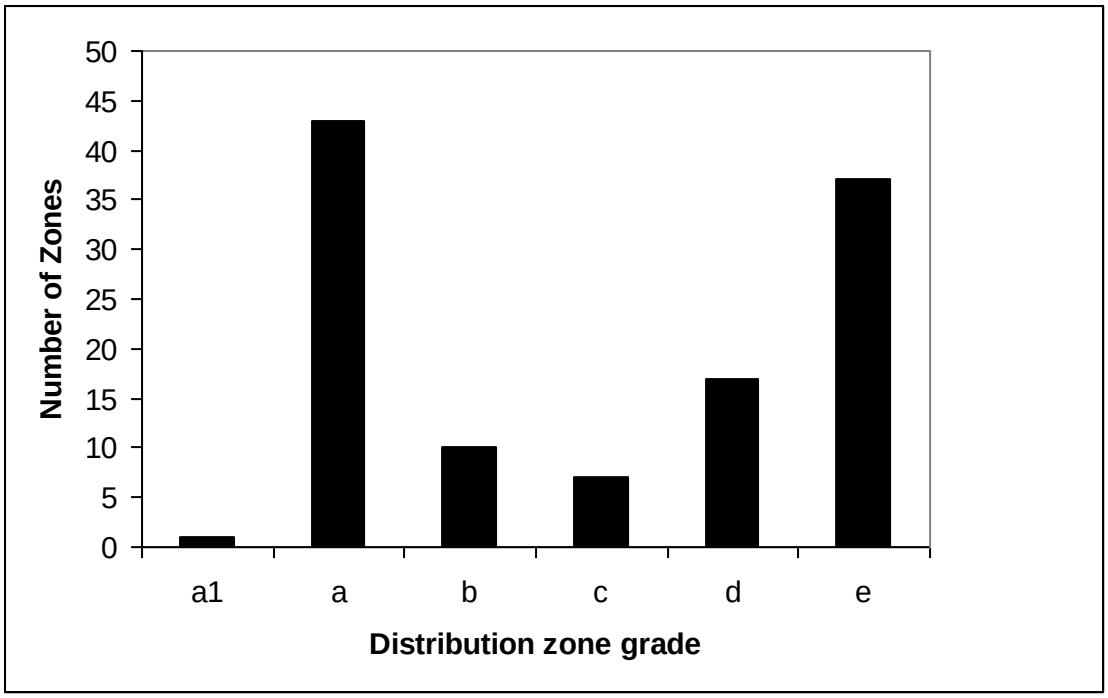

Figure 3 Distribution of 2003 grades for distribution zones

Compliance with the DWSNZ has a major effect on the distribution zone grade that can be obtained. The large number of demerit points linked to *E. coli* non-compliance has the potential to make non-compliance a major factor in determining the distribution network grade.

Table 6 shows how questions associated with risk (those evaluating either the likelihood of hazardous event or the effectiveness of preventive measures (Q13-Q19) – see Table 3, rather than questions gathering water quality (compliance) information) affect the grade. For the top grades most of the demerit points arise from questions associated with risk. This is expected as non-compliance has sufficient demerit points linked to it that a top grade cannot be obtained when a supply is non-compliant. With decreasing grade the average number of risk-associated demerit points increases sharply, but there is a trend for them to constitute a decreasing fraction of the total demerit points accrued.

Table 6 Relationships between distribution zone grades and the number of the demerit points received, and the frequency of *E. coli* detection

Grade	Average number of demerit points resulting from questions associated with risk	Average percentage of total demerit points from questions associated with risk	Percentage of zones in the grade that received all demerit points from questions associated with risk	Percentage of total samples taken that were positive for *E. coli*
a1 + a	4.7	98%	93%	0.005%
b	13.9	82%	60%	0.026%
c	22.6	85%	43%	0.00%
d	30.1	79%	47%	5.9%
e	34.9	58%	2.7%	20.4%

It is also clear from Table 6 that as the number of risk-based demerit points accrued increases, the likelihood of detecting *E. coli* in monitoring samples increases.

The discussion so far has rested on averaged data, which shows trends and how well the grading of the distribution zone works overall. The purpose of the grading, however, is to provide the public with information about individual supplies – people wish to know about their supply. The averaging of data can disguise anomalous results, and a search has been undertaken to try to identify examples of anomalous results for individual supplies.

The search for anomalous results targeted distribution zones with some evidence of poor water quality, but a good grade. Review of data for zones with more than one positive *E. coli* sample shows that all, except one, have 34 or more demerit points associated with factors influencing the likelihood of contamination. The exception has only 11 demerit points (and 3 samples positive for *E. coli*). This zone obtained a "b" grade because sufficient samples were taken to avoid non-compliance with respect to *E. coli*. At first glance this appears to be a case of a zone having several instances of contamination of the water despite a relatively low number of demerit points for risk factors and consequently a moderately good grade.

Discussion with the DWA who assessed this supply revealed that on two occasions when *E. coli* was detected, the samples were from the same, low demand (volume) area of the network. No chlorine was detectable at the sampling points, but a chlorine booster pump was afterwards installed in the line to prevent recurrence of the problem. The source of contamination was not discovered, but the entry of a bird into the reservoir was suspected.

The third occasion of *E. coli* detection followed mains repair and inadequate flushing of the line was suspected.

In classifying this zone as "b" rather than "a" the grading system does reflect a likelihood of contamination greater than would be expected of an "a" grade zone. Although hazardous events have occurred to lead to the detection of *E. coli*, steps were taken to improve the chlorine residual in the system. This action should also have been accompanied by preventive measures to reduce the likelihood of the hazardous events occurring: i.e., measures to prevent birds entering the reservoir, and instructions to maintenance crews to ensure repaired sections of the pipe are flushed and adequately disinfected before recommissioning.

Should similar recurrences of *E. coli* detection occur, showing ineffectiveness of preventive measures, the risk management of the supply should be closely scrutinised and deficiencies reflected in a lower grade, even if the large number of samples taken allow compliance with the DWSNZ with respect to *E. coli*.

In summary, consideration of the distribution zone grades reveals an interesting distinction between the low and high grades. The lower grades are defined mainly by demonstrable water quality, while the higher grades are defined by the actions to manage risk. For the lower graded supplies the likelihood of contamination is high enough that it can be confirmed by monitoring. The higher graded supplies, on the other hand, have a low enough likelihood of contamination that water quality monitoring shows an absence, or low incidence, of hazards in the treated water. In these situations, the factors that influence risk (e.g. preventive measures) must be taken account to estimate the likelihood of contamination.

The PHG 2003 framework provides a grade that reasonably accurately reflects the likelihood of contamination of the water supplied to the consumer. The framework performs better for the distribution zone than it does for the source/plant combination. This probably reflects the greater range of risks associated with the source that a grading framework has to try to assess compared with the moderately well defined risks, and the measures to address them, that are found in distribution zones.

4 PRACTITIONERS OPINIONS ON THE 2003 PUBLIC HEALTH GRADING FRAMEWORK.

4.1 Introduction

In preparing the foregoing sections of the report, only one view of the framework and how well it functions has been provided. Those who have experienced the grading from a users' viewpoint may be able to provide different insights into how well the grading does its job. The scope of the report allows for the opinions of only a very small group of stakeholders to be sought. However, as the Ministry of Health intends to distribute this document much more widely for further comment, all stakeholders will have an opportunity to provide comment later.

A group of 7 people, consisting of water suppliers and DWAs were approached for comment. The majority of this group was selected because of their having already been involved with grading supplies under the 2003 system. Responses were received from 5. They were asked for comment in response to the following:

a) Which aspects of the 2003 grading system are improvements on the 1993 grading system?

b) Which aspects of the grading, if any, do you think require improvement?

c) Do you think the notes attached to the questionnaires (both source/plant and distribution questionnaires) make the criteria required for answering the questions sufficiently clear that there will be consistent grading throughout NZ?

d) Please identify which aspects of the grading, if any, you think are good and would like to see retained in any future revisions?

The number of opinions sought, and the questions asked, provided only an initial evaluation of the 2003 PHG framework of how practitioners see the grading. An exhaustive assessment was not sought.

The condensed anonymous responses are provided in Appendix 1. S.4.2 identifies the key themes that run through the responses.

4.2 Key themes and general concerns identified in responses from grading practitioners

Despite the questions being asked of only a small number of practitioners, some consistent themes become apparent.

1. Flexibility

   Water suppliers voiced a need for greater flexibility which was associated with two concerns:

- Strict adherence to the grading criteria could result in grading outcomes that were regarded as unfair[6].

- The use of a "one-size-fits-all" grading framework was also seen as a potential source of unfairness because of its inability to take account of quite different circumstances arising in large and small systems. Differences between supplies even of the same size may also arise.

2. PHRMPs

   Water suppliers noted the need to link the PHRMPs (or their status) to the grading, and a DWA did note deficiencies with the way in which the existing grading system tried to establish the risk associated with the source water. Better use of the effort and resources expended in preparing PHRMPs and a more efficient and timely grading process are seen as two of the benefits that will flow from making use of the PHRMPs in establishing a supply grade. Because PHRMPs are supply specific, their greater use in the grading framework would address the "one-size-fits-all" concerns.

3. Increased objectivity

   While water suppliers may prefer a grading with flexibility to avoid "unfair" situations arising, for DWAs increased flexibility, greater subjectivity and blurred edges between acceptable and unacceptable, make their job more difficult. DWAs are assisted in grading supplies by having such things as numerical values as the basis for making decisions, and reviews of grading problems that provide nation-wide guidance for interpretation. A "one-size-fits-all" grading system is better aligned with their need to have clear cut criteria for making grading decisions.

   [Observation: DWAs and suppliers may have different preferred approaches to how the grading is undertaken, but there is a common desire for a fair and consistent system that accurately reflects the likelihood of supply contamination].

4. DWA training

   The training of HPOs to take on the more demanding role of being DWAs did occur about the same time that the 2003 grading system started to be used. As a result, the increased knowledge and skills of the DWAs undertaking the grading has been one of the factors leading to improvement in the grading process. This was noted by one water supplier who observed that DWAs were better equipped to make subjective assessments when objective criteria were unavailable, although, as a group, there was still a long way to go with respect to their technical knowledge.

   [Observation: The "One-size-fits-all" grading approach presently allows the peer review of a DWAs grading by other DWAs and ESR. Peer review of gradings will

[6] It has been suggested that grading outcomes may seem to be unfair because a good grade requires compliance with all aspects of the DWSNZ, while water suppliers may be more used to seeing the *Annual Review of Drinking-water Quality in New Zealand*, which has tended to place more emphasis on the bacteriological compliance.

be more difficult should a more flexible, supply-specific approach based more on PHRMPs be taken. The grading will rely more heavily on the knowledge and expertise of the DWA who undertakes the PHRMP approval, because the present checks do not review the detail on which the PHRMP is based.]

5. Grading notes

   The notes play an important part in helping both DWAs and water suppliers during the grading process. Overall, the existing notes are seen as being helpful, although comments indicate they are still in need of improvement. They are seen as a major factor in improving consistency, although problems with interpretation are identified as limiting the degree to which consistency can be achieved. DWAs are looking for objective guidelines in the notes, while some water suppliers are concerned that objective guidelines create inflexibility.

   Ideas for improving the notes were provided, and greater consultation in preparing the notes may be as important in producing a well-accepted grading system as consultation in developing the grading framework itself.

Further consultation with practitioners is necessary to try to identify ground common to both water suppliers and DWAs which can be used as the basis for developing options for a revised framework.

5 CONCLUSIONS

The ability of the 2003 grading framework to meet its purpose has been considered from three view points:

a) Comparison against a model framework, aligned with the framework developed by the MoH for preparing PHRMPs

b) Review of grading data from supplies that have already been graded using the 2003 PHG framework

c) Comment from grading practitioners (DWAs and water suppliers) who have been involved in the use of the 2003 PHG framework

The conclusions reached from these assessments are as follows:

a) Comparison with a model framework

The model framework provides an approach to assessing the likelihood of contamination of a water supply that assumes all necessary information is available and is unhindered by the restraints placed on the 2003 PHG framework that are needed to make it simple and workable.

- There are disparities between the model framework and the 2003 PHG framework. These are greater with the source/plant than the distribution zone grading. This is probably due to the wider range of hazardous events that may occur in a catchment compared with a distribution zone, and the difficulty in capturing this information using a generic questionnaire.

- The 2003 PHG framework places major emphasis on the barriers to hazards, and to preventive measures, with little consideration given to the levels of hazards that the barriers and prevent measures are controlling. This overlooks an important component in assessing the likelihood of contamination.

- An accurate assessment of the likelihood of contamination requires each hazardous event, and associated hazard levels, barriers and preventive measures to be assessed together. This cannot be done when a set of generic questionnaires, constrained by concerns of simplicity and practicability, have to be used for the grading. This deficiency limits the ability of the 2003 PHG framework to accurately assess the likelihood of contamination of a supply.

- It is difficult to justify scientifically some of the assignments of demerit points for the distribution zone. These have already been scrutinised in preparing the 2003 PHG framework, but if this system were to be retained as the basis of grading, the assignments should be revisited.

Summary: The 2003 PHG framework works under the constraints of needing to be simple and practicable, and compresses a potentially large and complex set of

information into two letters. To achieve this, it sacrifices the accurate (qualitative) assessment of the likelihood of contamination which is needed to achieve the purpose of the grading. The introduction of PHRMPs, or the information they collect, into the grading framework may help to address some of the difficulties identified by this comparison with the model framework.

b) Review of grading data

- The assignments of "D" and "E" grades to source/plant combinations are reasonable and justifiable given the information available about the supplies.

- The likelihood of contamination of treated water with cyanotoxins, and chemical determinands generally, is not necessarily accurately indicated by the grades of supplies with source/plant combinations graded "C" and above. The available grading data show that the higher grades adequately reflect the ability of treatment plants to provide barriers to microbial hazards.

- Distribution zones with failing grades ("d" or "e") have been accurately classified. These grades are more influenced by water quality data (i.e., the compliance status of the supply) than the existence of barriers and preventive measures and their implementation.

- High distribution zone grades are determined primarily by the way in which risks are managed, not on water quality (*E. coli* compliance). (Non-compliance with respect to *E. coli* would place them in a low grade by default). Large supplies have the potential to be able to mask the detection of *E. coli* in the distribution zone (which may mean poor risk management) by virtue of having taken large number of samples to achieve compliance with the DWSNZ.

Summary: The "D" and "E" and "d" and "e" grades already given are supported by the information collected about these supplies. For the higher grades, for both source/plant and distribution zone, the grade may not always give an accurate indication of how well risk is being managed for some determinands. The microbiologial quality of the water in these supplies is good, as shown by compliance with the DWSNZ.

c) Comment from practitioners

Comments from the practitioners about the grading addressed a wider range of concerns than did the other two view points (as a result of the questions posed).

- Water suppliers and DWAs both appear to want a system that produces grades that are fair, consistent and accurately reflect the likelihood of supply contamination. However, they have different preferences for how a framework should be designed to achieve this. Water suppliers wish the system to be more flexible for reasons of fairness, and the belief that a

generic framework does not allow an accurate assessment of the likelihood of contamination. DWAs wish to have objective guidelines for determining responses to the questionnaire to make determination of a defensible grade more clear cut.

- Water suppliers support the linkage of PHRMPs to the grading. This may go some way to addressing their concerns over the use of generic questionnaires. (DWAs may also support this linkage, but it was not explicitly mentioned in this limited survey).

- The grading notes play a key role in the grading process and their improvement to better meet the needs of the practitioners will be fundamental to producing an acceptable revised grading framework. Both DWAs and water suppliers acknowledge the need for improvement to the notes to assist in interpretation under different circumstances.

- The improved level of training of DWAs has better equipped them to undertake the grading process and in some areas, at least, has made a substantial contribution to improvement in the 2003 PHG system over the 1993 PHG system.

Summary: Whether the practitioner is a water supplier or a DWA has a marked influence on the aspects of the grading they wish to see developed. Consultation will be important to ensure that any new grading framework is designed in such a way as to best meet their needs as well as those of the Ministry.

APPENDIX SUMMARISED RESPONSES FROM A SMALL GROUP OF PRACTITIONERS TO QUESTIONS SEEKING THEIR VIEWS ON THE GRADING

S.4 contains further discussion about these questions and the numbers of practitioners to whom they were sent. The levels of responses ranged from discussion of detail of the grading questionnaires to be more generic concerns. All have been included below.

No attempts have been made to change the terminology (particularly that associated with risk) used by the respondents to align it with that used in the main body of the document.

a) Which aspects of the 2003 grading system are an improvement on the 1993 grading system?

{Responses to this question were limited by virtue of there being few respondents who have been involved with grading under the 1993 system}

- *E. coli* data from the raw water helps with risk assessment.
- Reviews of grading questions occur more freely which will help in making the system more robust and defensible.
- The decisions reached from the grading question reviews should be captured in a database and made readily available.
- Incorporating changes to the questions and notes into reprinted grading notes will help with consistency.
- 2003 system is more thorough and less prone to subjective decisions
- Biggest improvement has been the education and training of HPOs/DWAs that has occurred in conjunction with the revised grading
- HPOs/DWAs are better equipped to undertake grading and in some situations better equipped to make subjective assessments.

b) Which aspects of the grading, if any, do you think require improvement?

- Source questions need to gather more information about the "risks" rather than just the hazard identification. Hazards may be present but may present a low risk because their concentrations are low. This is not recognised in the grading. E.g., the risk presented by animals depends not only on the number of animals, but whether contaminants from their faeces will reach the water. This would require more information to be collected by the grading than is presently sought.
- Demerit points in the distribution zone grading are good because they allow differences in water supplies to be taken into account. The source/plant grade should be given a similar basis, because the current table source/plant tables are confusing.
- There should be a linkage between the grading and the PHRMP and the PHRMP's status (written, approved, implemented, etc). This would also provide motivation to complete the PHRMPs.

- Modifications are needed to those parts of the grading that refer to compliance. This will be difficult because of the choice suppliers presently have as to whether they are working for compliance with regard to the DWSNZ:2000 or the DWSNZ:2005. The suggestion is made that the grading document should generically refer to compliance with Bacterial compliance criteria, Protozoal compliance criteria etc, and as part of the process the DWA and water supplier list the specific criteria (reference to DWSNZ:2005 1c etc) the supply has to meet.
- DWAs don't have the time to properly grade supplies (as this is a massive task if done properly). If time and resources are limited the questionnaires become just a check list, rather than a prompt to investigate and validate a supplier's answer.
- The stringency with which "full compliance" with the DWSNZ is determined needs consideration. A supplier may suffer a one-off or series of events that make them non-compliant if the DWSNZ are strictly adhered to, but the DWA needs some discretion when grading. The most important factor is how the water supplier reacts to ensure there is not a recurrence of the problem.
- A list of recommendations for improvements could be issued with the grading and a timeframe set within which the improvements need to be shown to have been taken. Provided the improvements are made within the timeframe, the existing grading is retained, otherwise the grade is dropped.
- Source Questionnaire Q12a – suggest a better definition of terms, particularly for a bore, this could be done by providing a list of items that must have been undertaken to achieve a "secure" status for groundwaters, for example.
- Plant Questionnaire Q13 – explanations of the categories "Water is disinfected" and "Disinfected with residual".
- Plant Questionnaire Q15 - updating to take account of new qualifications
- Distribution zone Questionnaire Q13d – update to fit with plumbosolvency
- Distribution zone Questionnaire Q19 – good
- Distribution zone Questionnaire Q20 – microbiological compliance requires attention as it allows a minor failing, e.g., "days of the week", to result in the same demerit points as a supplier who takes no samples at all, which is unfair.
- A complete review of the grading is required to ensure it aligns with the DWSNZ:2005 and the proposed legislation. This alignment should also extend to: PHRMPs, catchment sanitary surveys, and The Annual Review of the Drinking-water Quality in New Zealand. Definitions, programmes and data format should be compatible.
- The present system is designed as a one size fits all, with a bias towards smaller systems, which has ramifications for large supplies, e.g., continuous data management through WINZ have not been thought through.
- Training and manning levels of treatment plants need to be reviewed in the light of new technologies. Industry experience and peer review of operator performance should be taken into consideration along with professional and technical qualifications, when assessing adequacy of supervision. Actions such as

"Grandfathering" of incumbent staff and workplace training would be beneficial to the industry

- The grading needs to be checked to ensure that there is no "double" counting of a single event, e.g., a few low chlorine results could have impacts through Q16 and Q19.

c) Do you think the notes attached to the questionnaires (both source/plant and distribution questionnaires) make the criteria required for answering the questions sufficiently clear that there will be consistent grading throughout NZ?

- The notes provide good guidance which will help in ensuring consistency. There will always be some degree of inconsistency because of interpretation. The need for interpretation is more in some questions than others. Local knowledge is often needed in answering questions which can influence interpretation. Other notes allow less room for interpretation, e.g. turbidity levels are set to help define categories of catchment protection.
- A review of the notes as part of a review of the grading would be helpful, especially where objective criteria can be provided.
- Notes encourage consistency, but can be a little too "black and white".
- Provided the DWA is well trained the grading notes are adequate
- Explanatory notes are very helpful. Cross referencing them to the appropriate sections of the DWSNZ would make them even more helpful.
- Suggest all DWAs have access to a file of common comments to allow standard comments to be appended to grading forms
- The notes still allow opportunities for inconsistency as some definitions are still too vague to be applicable for supplies of all sizes (problem with the "one-size-fits-all" approach).
- The notes are useful in providing interpretation to both suppliers and DWAs. The notes should be expanded to provide examples, and greater interpretation.

d) Please identify which aspects of the grading, if any, you think are good and would like to see retained in any future revisions?

- Interpretation notes
- Inclusion of *E. coli* sampling in source water
- Keep objective guidelines
- Demerit points are good because that allow flexibility
- Strong linkages to DWSNZ compliance are essential
- The grading and trial grading documents in WINZ are good.
- The linkage between Q15 and Q19 of the distribution zone questionnaire has been very helpful in persuading TLAs to chlorinate their water.

- Key issue is amalgamation with PHRMPs. Greater reliance on the work that has gone into the preparation of a PHRMP should make the grading a faster process.