National Environment Protection (Assessment of Site Contamination) Measure April 2011 National Environment Protection (Assessment of Site Contamination) Measure April 2011 National Environment Protection (Assessment of Site Contamination) Measure April 2011 National Environment Protection (Assessment of Site Contamination) Measure April 2011 National Environment Protection (Assessment of Site Contamination) Measure April 2011 National Environment Protection (Assessment of Site Contamination) Measure April 2011 National Environment Protection (Assessment of Site Contamination) Measure April 2011 National Environment Protection (Assessment of Site Contamination) Measure April 2011 National Environment Protection (Assessment of Site Contamination) Measure April 2011 National Environment Protection (Assessment of Site Contamination) Measure April 2011 National Environment Protection (Assessment of Site Contamination) Measure April

Schedule B6

GUIDELINE ON

Risk-Based Assessment of Groundwater Contamination

The following guideline provides general guidance in relation to risk-based assessment of groundwater contamination in the assessment of site contamination.

This Schedule forms part of the National Environment Protection (Assessment of Site Contamination) Measure as varied 2011 and should be read in conjunction with that document, which includes a policy framework and assessment of site contamination flowchart.

This Schedule replaces Schedule B6 to the National Environment Protection (Assessment of Site Contamination) Measure 1999.

The National Environment Protection Council (NEPC) acknowledges the contribution of the Western Australian Department of Conservation and the New South Wales Department of Environment, Climate Change and Water to the development of this Schedule.

Contents

Risk based assessment on groundwater contamination

1 Purpose

The purpose of this Schedule is to provide a framework for the risk-based assessment of groundwater that may have been affected by site contamination. The general processes outlined for the assessment of contaminated groundwater are compatible with the policy framework and the site assessment process shown in Schedule A. The aim of this process is to minimise the risk of adverse human health and environmental impacts arising from contaminated groundwater.

1.1 Scope

The framework outlined in this Schedule can be used specifically for the assessment of groundwater quality arising from point-source contamination (for example, leaks from fuel storage depots, sheep and cattle dips). This Schedule is not intended to address all aspects of the management of groundwater quality, or to replace the regulatory requirements of individual jurisdictions for the assessment and management of groundwater contamination. Nor is it generally applicable to other broad-scale groundwater issues associated with agriculture, catchment management or salinity. These resource management issues are administered by jurisdictions through various regulatory processes.

The framework recognises existing, nationally developed approaches, policies and water quality criteria developed to protect groundwater under the national water quality management strategy and the *Guidelines for managing risk in recreational water* (NHMRC 2008) and applies them to the specific issue of assessing the quality of groundwater impacted by site contamination.

When using this framework, Schedule B2 should also be referred to. This Schedule includes information on related issues such as monitoring well establishment, groundwater sampling and the application of fate and transport modelling.

1.2 Initiation of an assessment of groundwater contamination

Preliminary contaminated site investigations include a minimum of a desktop review of the geology and hydrogeology of the site. Regional information on these issues is usually available from geological maps and the relevant jurisdiction's water resource management authority. Initial site inspections, targeted soil sampling programs and logging of soil samples and test pits will provide site-specific information. The information is used for early appraisal of the potential for groundwater contamination. In addition to jurisdictions' legislative requirements, the main situations that may trigger a groundwater assessment are as follows:

- site usage and/or site history suggesting the potential for groundwater contamination
- assessment of soil contamination suggesting the potential for groundwater contamination.

Appraisal of the groundwater issues will also rely on the professional judgement of the site assessor who should obtain specialist groundwater advice where necessary. This advice should be sought early in the assessment process to help avoid re-mobilisation of assessment personnel and associated additional costs.

The issues which should be considered during the appraisal include:

- on-site sources (type of source)
- contaminant sources unrelated to the site
- whether the source(s) has(have) been removed
- permeability of the strata on the site
- known or expected depth to the local water table
- ambient groundwater quality
- quantity of the contaminant and its mobility characteristics
- identification of potential receptors
- any other site-specific issues.

Where the appraisal indicates the likelihood of groundwater contamination, the process outlined in this Schedule should be undertaken. Detailed groundwater investigations should only be undertaken by appropriately qualified and experienced groundwater professionals.

1.3 The basis for risk assessment

Groundwater is assessed on the basis of its suitability for current or realistic future use and the risk that use may pose to human health and/or the environment. This assessment should take into account factors relevant to the environmental value of the groundwater resource such as the proposed and realistic future uses, physicochemical and bioavailability characteristics of the particular contaminant(s) and the distribution of the contamination. In this approach, the potential receptor, either human or ecological, determines the level of protection required.

In the case of groundwater, consideration is given to current use and realistic future uses of the groundwater. This reflects the national approach to groundwater protection which is to protect it as a resource for future use as detailed in the *Guidelines for groundwater protection in Australia* (ARMCANZ & ANZECC 1995).

It differs from the assessment process for land contamination in that there is greater emphasis on suitability for current and realistic future uses with the groundwater assessment and emphasis on current and intended uses with soil assessment. The focus on the protection of realistic future uses (based on the inherent capacity of the aquifer to support those uses) is derived from the following considerations:

- groundwater contamination is often persistent and difficult to contain
- some groundwater contamination may persist beyond current planning horizons, affecting future uses which today are not considered likely
- the stress on Australia's water resources is expected to increase, highlighting the importance of protecting groundwater resources for the future
- groundwater contamination may readily spread and is expensive and time consuming to remediate.

An assessment of the risk posed to human health and the environment from current and realistic future uses of the groundwater resource can be used to determine an appropriate response to groundwater contamination, and the nature and urgency of that response.

In the context of a contaminated site, groundwater can be considered to be contaminated when it is not suitable for its current or realistic future use or presents the likelihood of causing an unacceptable environmental or human health impact in the discharge environment. This differs from the national water quality management strategy (ARMCANZ & ANZECC 1995) definition which considers groundwater to be contaminated whenever there is a change in water quality that produces a noticeable or detectable change in its characteristics. This latter definition should be the one adopted by jurisdictions in managing and protecting groundwater resources. Therefore, if any change in groundwater is detected, relevant jurisdictional policy should also be taken into account regarding groundwater protection.

The risk assessment process must consider any impact from site contamination on groundwater quality which causes groundwater parameters to differ from ambient quality.

As with contaminated soil, this approach recognises that the appropriate level of groundwater quality will be based on its impact on the receptor. With soil assessment, land use and the level of contact between the most sensitive human or ecological receptor and the contaminated soil primarily determine the level of protection required. In the case of groundwater, there may be several different exposure scenarios and several potential receptors, for example, groundwater may be used for irrigation purposes, pass beneath a freshwater lake and then go on to discharge into the marine environment. Potential receptors will differ in each scenario and acceptable contaminant levels may well be different for each receptor. An assessment of groundwater contamination must consider the most sensitive receptor in each exposure scenario.

2 Framework for the application of the Australian water quality guidelines for fresh and marine waters and the guidelines for managing risk in recreational water

2.1 Background

This section provides a methodology for the use of the following guidelines in the assessment of contaminated groundwater:

- Australian water quality guidelines for fresh and marine water (AWQG) (ANZECC & ARMCANZ 2000)
- Australian drinking water guidelines (ADWG) (NHMRC & NRMMC 2004)
- Guidelines for managing risk in recreational water (GMRRW) (NHMRC 2008).

The process involves building on existing criteria to provide a system that responds appropriately as knowledge about the levels of protection required becomes available.

The following assessment framework is based on identifying the receptors (human and/or ecological) for groundwater that is contaminated and determining the level of protection required by referring to the appropriate set of guidelines within the AWQG, the ADWG and the GMRRW.

This framework is intended to be consistent with the goals promoted in the *Guidelines for groundwater protection in Australia* (ARMCANZ & ANZECC 1995). It is not intended to imply that contaminated groundwater from a contaminated site, which is transported off site, is acceptable if the AWQG criteria are not exceeded at the point of use. The process is risk-based and deals only with contamination associated with a contaminated site. Generally, any contamination of groundwater, both on site and off site, is considered unacceptable and the responsibility of the polluter. Its administration is a jurisdictional matter.

2.2 Framework

The AWQG, ADWG and GMRRW set out criteria for water quality relating to a number of environmental values. Environmental values are values or uses of the environment which are conducive to public benefit, welfare, safety or health and which require protection from the effects of pollution, waste discharge and deposits. Six environmental values are presented in the AWQG, ADWG and GMRRW:

- aquatic ecosystems
- aquaculture and human consumers of food
- agricultural water
- recreation and aesthetics
- drinking water
- industrial water.

For each environmental value, a set of guideline criteria is presented for potential contaminants of concern (toxicants) and these criteria form the basis, in this Schedule, for the assessment of contaminated groundwater and associated risks. The recreational and aesthetics sections of the AWQG have been superseded by the GMRRW (NHMRC 2008).

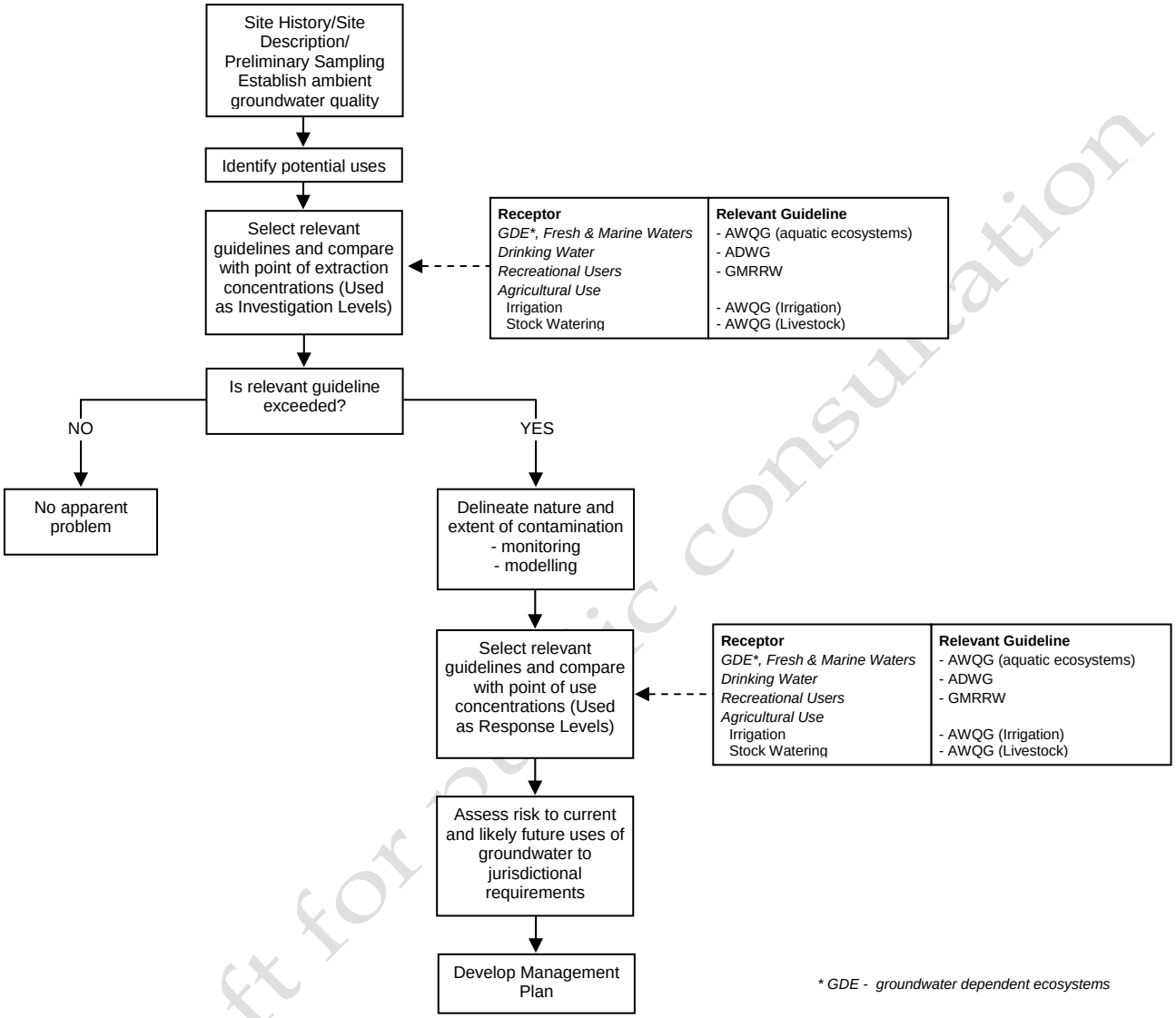
The criteria defined within the AWQG, ADWG and GMRRW define acceptable water quality at the point of use. In this Schedule, they are used as investigation levels at the point of extraction and as response levels at the point of use (unless a site-specific risk assessment has been carried out and an alternative, more appropriate response level has been determined).

These criteria are referred to as groundwater investigation levels (GILs) in Schedule B1 of this Measure.

The structure of the assessment framework is outlined in Figure 1, which demonstrates use of the AWQG, ADWG and GMRRW in the assessment of groundwater contamination. In all situations, the AWQG, ADWG and GMRRW GILs should only be applied with reference to the policy framework which includes consideration of ambient groundwater quality. The assessment of ambient water quality should include the analysis of major ions to enable differentiation between contaminated and non-contaminated groundwater.

The assessment framework is an iterative process that has two levels of assessment. The level of assessment depends upon the point of application of the relevant criteria. A preliminary assessment is a comparison of the groundwater contaminant concentrations at the point of extraction with existing generic GILs. Detailed investigations require the assessment of contaminant concentrations over time at the point of current and realistic future use and may require the use of sophisticated modelling programs. The investigations leading to a detailed assessment should cover all relevant site-specific issues; for example, appraisal of the attenuation capacity of vadose zone soils or the removal of hydrocarbon sources. Further information about groundwater investigations can be found in Schedule B2 of this Measure. Detailed assessments compare groundwater contaminant concentrations at the point of use with existing generic GILs or can incorporate additional information such as ecosystem/ environmental variability and exposure to derive modified, site-specific response levels.

Figure 1. Assessment process for groundwater contamination



A preliminary assessment is a screening process and compares groundwater contaminant concentrations at the point of extraction with existing generic GILs. This means that a groundwater sample from a monitoring well with contaminant levels above the GILs will trigger further investigation rather than initiate remedial action. However, site-specific consideration must be given to water quality impacts which cause variations from ambient water quality even when GILs are not exceeded. This is because individual jurisdictions may operate protective strategies for groundwater that require action at levels below the GILs or whenever levels of contaminants above ambient are detected. Such issues are the responsibility of jurisdictions.

If further investigation is required, a detailed investigation is conducted which entails devising a detailed sampling and analysis plan, in accordance with the iterative process of site-contamination assessment outlined in Schedule A of this Measure. Investigation should include determination of sources and receptors, as well as further delineation of the groundwater plume, as appropriate.

If receptors are identified, then a complete analysis of the potential impact of the plume should be undertaken considering a realistic range of aquifer conditions. With groundwater issues, this should involve the collection of sufficient data to determine the direction of groundwater flow, and to determine the vertical and lateral extent of contamination and its nature and severity. In many assessments, particularly of sites which are small in area, off-site wells will need to be established in the delineation process. Identification of contaminant sources should also be completed by this time.

This more detailed investigation and analysis should result in an estimation of the current and projected contaminant concentrations in the receiving environment at the points of existing and realistic future use. Fate and transport modelling may be required to estimate the contaminant concentrations at these points. The investigation process should consider the:

- exposure pathway
- persistence and bioaccessibility of the contaminant
- the physicochemical and biochemical transformations which occur as the contaminants pass from the ground source to the point of current or future realistic use.

For further details on modelling, refer to Schedule B2 of this Measure.

The GILs may then be used as response levels at the point of use, taking into account the following factors:

- economic, social and jurisdictional factors
- jurisdictional policy regarding protection of the groundwater resource.

Jurisdictional policy may allow for modification of GILs on a site-specific basis. For example, when determining criteria for groundwater discharging to a surface water body, these should be determined on a site-specific basis as some jurisdictions allow for a mixing zone or treatment, whereas others apply the GILs at the point of discharge without mixing in order to protect benthic organisms.

A management plan for unacceptable levels of contamination may include one or more of the following:

- work plan
- determination of site-specific clean-up criteria
- development of site management options
- determination of clean-up methods
- implementation plan of remedial actions
- water treatment at the point of use
- restriction on the use of the aquifer
- future monitoring and information provisions.

These steps are comparable to those employed for contaminated soil assessment and remediation, the major exception being that the GILs may also be used as response levels. These management issues are beyond the scope of this Measure and are matters administered by jurisdictions.

3 Bibliography

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NHMRC 2008, *National water quality management strategy. Guidelines for managing risk in recreational water*, National Health and Medical Research Council, Australia.

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4 Glossary

Aquifer is a rock or sediment in a geological formation, group of formations or part of a formation which is capable of being permeated permanently or intermittently and can thereby transmit water.

Contamination means the condition of land or water where any chemical substance or waste has been added at above background level and represents, or potentially represents, an adverse health or environmental impact.

Discharge area means an area in which there are upward components of hydraulic head in the aquifer. Groundwater flowing toward the land surface in a discharge area may escape as a spring, leading to a discharge, seep or baseflow, or by evaporation and transpiration.

Environmental value is a value or use of the environment which is conducive to public benefit, welfare, safety or health and which requires protection from the effects of pollution, waste discharge and deposits.

Groundwater investigation level is the concentration of a groundwater parameter at which further investigation (point of extraction) or a response (point of use) is required. Includes Australian water quality guidelines/drinking water guidelines/guidelines for managing risk in recreational water criteria and site-specific derived criteria.

Groundwater means all waters occurring below the land surface.

Point source means a source of contamination which comes from a contaminating activity at a particular site.

Receptor is the entity (organism, population, community, or set of ecological processes) that may be adversely affected by contact with, or exposure to, a contaminant of concern.

Risk assessment is the process for estimating the potential impact of a chemical, biological or physical agent on humans, plants, animals and ecosystems.

Risk means the probability in a certain timeframe that an adverse outcome will occur in a person, a group of people, plants, animals and/or the ecology of a specified area that is exposed to a particular dose or concentration of a hazardous agent; that is, it depends on both the level of toxicity of hazardous agent and the level of exposure.

Well is a hole drilled into an aquifer for the purpose of monitoring or extracting groundwater. This generic term includes bores, water wells and tubewells.