



**A review of current groundwater  
management in Hawke's Bay and  
recommendations for protection of  
groundwater ecosystems**

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**NIWA Client Report: HAM2009-153  
September 2009**

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# **A review of current groundwater management in Hawke's Bay and recommendations for protection of groundwater ecosystems**

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*Prepared for*

**Hawke's Bay Regional Council**

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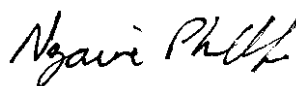
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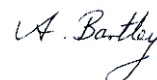
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## Executive Summary

Groundwater is an enormously valuable resource in New Zealand, particularly in regions such as Hawke's Bay where it is used for domestic supplies, industry, horticulture and agriculture. Nation-wide, groundwater is also associated with significant recreational, tourism and cultural values. The quality and quantity of surface water are often closely linked to those of groundwater, with many surface freshwater ecosystems dependent on replenishment from groundwater aquifers. These groundwater dependent ecosystems, as well as the groundwater ecosystems themselves, have intrinsic value, sustaining high biological diversity and providing important ecosystem functions, such as water purification and flood control. Despite the wide range of values associated with groundwater, little is known about the structure or function of these ecosystems. Presently, resource managers are unlikely to have the knowledge and tools required to protect groundwater ecosystems effectively. This knowledge gap is particularly critical in regions such as Hawke's Bay, where there is the potential for increasing pressure on groundwater from elevated exchange of contaminants (e.g., pesticides and nutrients) and increased takes, due to intensification of landuse.

Our goal, through research on groundwater ecosystems, is to raise the awareness of the intrinsic values of groundwater ecosystems and to seek a greater level of explicit protection of these systems in regional policies and plans. This report provides a summary of current approaches to managing groundwater resources in the Hawke's Bay region, and identifies where groundwater ecosystems are given implicit and/or explicit recognition and protection. In addition, we highlight limitations of existing policy in protecting these systems from potential anthropogenic stressors (e.g., water abstraction, contaminant disposal), and make recommendations for areas where groundwater ecosystems can be given a higher profile in management policies and plans.

Internationally, there is a move towards greater recognition of the interconnectedness of surface and groundwaters, and of the intrinsic values of groundwater ecosystems, in management plans. Although New Zealand's Resource Management Act rarely mentions groundwater, it is an enabling Act under which Regional Councils set region-specific objectives for the protection of natural and physical resources in Resource Management Plans. A growing number of regional councils are including explicit protection of groundwater in their plans. Recognition of the value of groundwater in Hawke's Bay compares favourably with that occurring in other regions of New Zealand, based on the number of times that the word groundwater appears in the Regional Resource Management Plan. However, present management of groundwater resources in Hawke's Bay is heavily biased towards protection of supplies for human use, with no mention of groundwater as an ecosystem with intrinsic biodiversity values. The absence of explicit protection for groundwater ecosystems is in contrast to significant protection of biodiversity values in surface water habitats. More research is required to guide management of groundwaters and we provide a number of specific questions relating to groundwater ecosystems that warrant priority investigation.

## 1. Introduction

Groundwater is an enormously valuable resource in New Zealand. Most of New Zealand's available freshwater resource is stored as groundwater and many of our surface freshwater ecosystems are almost entirely dependent on replenishment from groundwater aquifers (Fenwick et al. 2004). Over 50% of our population uses groundwater for their daily domestic supplies, and several major industries rely on ready access to high quality groundwater (Fenwick et al. 2004). Indeed, several regional economies (e.g., Nelson, Hawke's Bay) are becoming increasingly dependent upon groundwater to facilitate economic growth through horticulture and agriculture (HBRC 2006). In addition, groundwater resources are associated with significant recreation, tourism and cultural values (e.g., Waitomo Caves, Waikoropupu Springs).

Despite the economic, social and cultural values associated with groundwater we know almost nothing about the structure and functioning of groundwater ecosystems, and our knowledge of groundwater biodiversity lags far behind that of all other freshwater ecosystems. As a result, we consider that resource managers are unlikely to have the knowledge and tools required to identify and protect groundwater biodiversity values and ecosystem processes effectively. This knowledge gap is critical, because groundwater ecosystems are under threat from a number of direct and indirect human impacts, including unsustainable consumption of groundwater resources, intensification of land use and exchange of contaminants (e.g., pesticides and nutrients) between land and aquifers. There is also a risk that increasing demand for water will result in consumption of groundwater being prioritised over the less tangible, but very important, ecosystem services that groundwaters provide (Tomlinson & Boulton 2008). The increasing pressures facing groundwater resources from pollution and abstraction were recently highlighted in the Parliamentary Commissioner for the Environment's report *Growing for Good* (PCE 2005, available through [www.pce.govt.nz](http://www.pce.govt.nz)).

The current state of scientific knowledge, generated through previous PGS&T funding of taxonomic and basic ecological work (e.g., *Biodiversity of NZ Aquatic Environments* C01X0219), indicates a treasure-trove of biological diversity in groundwater ecosystems throughout New Zealand (Scarsbrook et al. 2003). We also know from overseas literature that intact, functioning groundwater ecosystems can make significant contributions to maintaining and enhancing groundwater quality and quantity, with significant flow-on benefits to groundwater-dependent surface ecosystems and the myriad users of groundwater resources (Boulton 2000; Danielopol et al. 2003; Tomlinson & Boulton 2008). In Australia, realisation of the critical importance of maintaining and protecting groundwater ecosystems has led to the

development and implementation of state and federal management policies for groundwater ecosystems and the range of inter-linked ecosystems they support (e.g., springs, lowland streams, wetlands) (Tomlinson & Boulton 2008). Given that 80% of our nation's available freshwater resources are in aquifers (Fenwick et al. 2004), and that these resources are coming under increasing anthropogenic pressure, it is time for New Zealand to give similar management priority to the protection of groundwater ecosystems and the goods and services that they provide.

In July 2005, NIWA received funding from the Foundation for Research Science & Technology (FRST) through the Natural Ecosystems Portfolio to carry out research on groundwater ecosystems in New Zealand. The goals of this project include an overview of groundwater management policies and procedures in place within key management agencies, with particular attention to the extent to which the ecosystems in porous and karstic groundwater are recognised and explicitly managed. This review is intended to provide a baseline description of the level to which current regional plans and other management documents explicitly account for the protection of groundwater ecosystems in the Hawke's Bay region. Our ultimate goal, through research on groundwater ecosystems, is to ensure that groundwaters are managed sustainably by achieving a shift in regional policies and plans to explicitly protect groundwater biodiversity and ecosystems, and the ecosystem services that groundwaters provide.

This report provides a summary of current approaches to managing groundwater resources in the Hawke's Bay region, identifies where groundwater ecosystems are given implicit and/or explicit recognition and protection, highlights limitations of existing policy in protecting these systems from potential anthropogenic stressors (e.g., water abstraction, contaminant disposal), and makes recommendations for areas where groundwater ecosystems can be given a higher profile in management policies and plans.

## 2. Groundwater Dependent Ecosystems and their values

### 2.1 What is a Groundwater Dependent Ecosystem?

Groundwater Dependent Ecosystems (GDEs) are those ecosystems which need inputs of groundwater to maintain their current structure and functions (Hatton & Evans 1998; Murray et al. 2003). GDEs include terrestrial vegetation communities, river base flow systems, aquifer and cave ecosystems, wetlands, and springs (Hatton & Evans 1998). Changes in the timing, quantity, quality or distribution of groundwater influence these ecosystems to varying degrees (Murray et al. 2003). Hatton & Evans (1998) recognised five classes of ecosystem dependency on the attributes (e.g., flux, level, pressure, quality) of groundwater: entirely dependent, highly dependent, proportionally dependent, opportunistically dependent and not dependent. The degree of dependency on groundwater for a particular ecosystem may also vary seasonally, and so key issues for management are both the degree of dependency and the timing of this dependency (Murray et al. 2003).

It is now widely accepted that ecosystems within catchments, including those within and those dependent on groundwater, should be treated as interconnected units for effective management (Baron et al. 2002; Danielopol et al. 2003). In Australia, management of GDEs is a state and federal issue, and several management recommendations have been identified to protect these ecosystems from a range of anthropogenic threats. We believe that a GDE management framework (Hatton & Evans 1998) is directly applicable to and beneficial for New Zealand aquatic ecosystems, although it will form only part of a complete management framework. Recognition of springs as GDEs is essential to their management and protection, because groundwater abstraction and consumptive use, as well as land-use practices impacting aquifer quality, are key threats to the integrity of spring habitats.

There are four key steps to developing GDE management strategies:

- 1) Identify potential GDEs.
- 2) Determine the degree of ecosystem dependency on groundwater.
- 3) Assess the water regime in which dependency operates.
- 4) Determine the environmental water requirement.

With regard to the management of springs, Steps 1 and 2 are implicit, whereas Steps 3 and 4 require assessments of the full range of existing groundwater uses and the effects different uses have on ecosystem integrity. As is the case with freshwater ecosystems throughout the world, determining a spring's environmental water requirements is a challenging task. The complete loss of flow from springs would be devastating for these systems, whereas some GDEs may be able to maintain their functioning at reduced levels of groundwater flux, pressure or quality. However, there is little information about threshold values for these variables, below which groundwater dependent ecosystems are likely to be degraded.

## **2.2 Groundwater resources and their values in Hawke's Bay**

The Hawke's Bay region's groundwater resources are increasingly essential for safe and dependable supply of water for domestic, industrial and irrigation purposes (HBRC 2006). There are approximately 9000 groundwater bores on the Hawke's Bay Regional Council database (Fenwick et al. 2004), and the quantity and quality of groundwater are regularly monitored across the Hawke's Bay region for State of the Environment reporting (see <http://www.hbrc.govt.nz/>). The primary aim of this monitoring is to ensure on-going supply of groundwater that meets health and aesthetic-based standards, as opposed to protecting biodiversity values of groundwater dependent ecosystems. The two main groundwater systems in Hawke's Bay are under the Heretaunga and Ruataniwha Plains, but many smaller systems are currently utilised (Fig. 1).



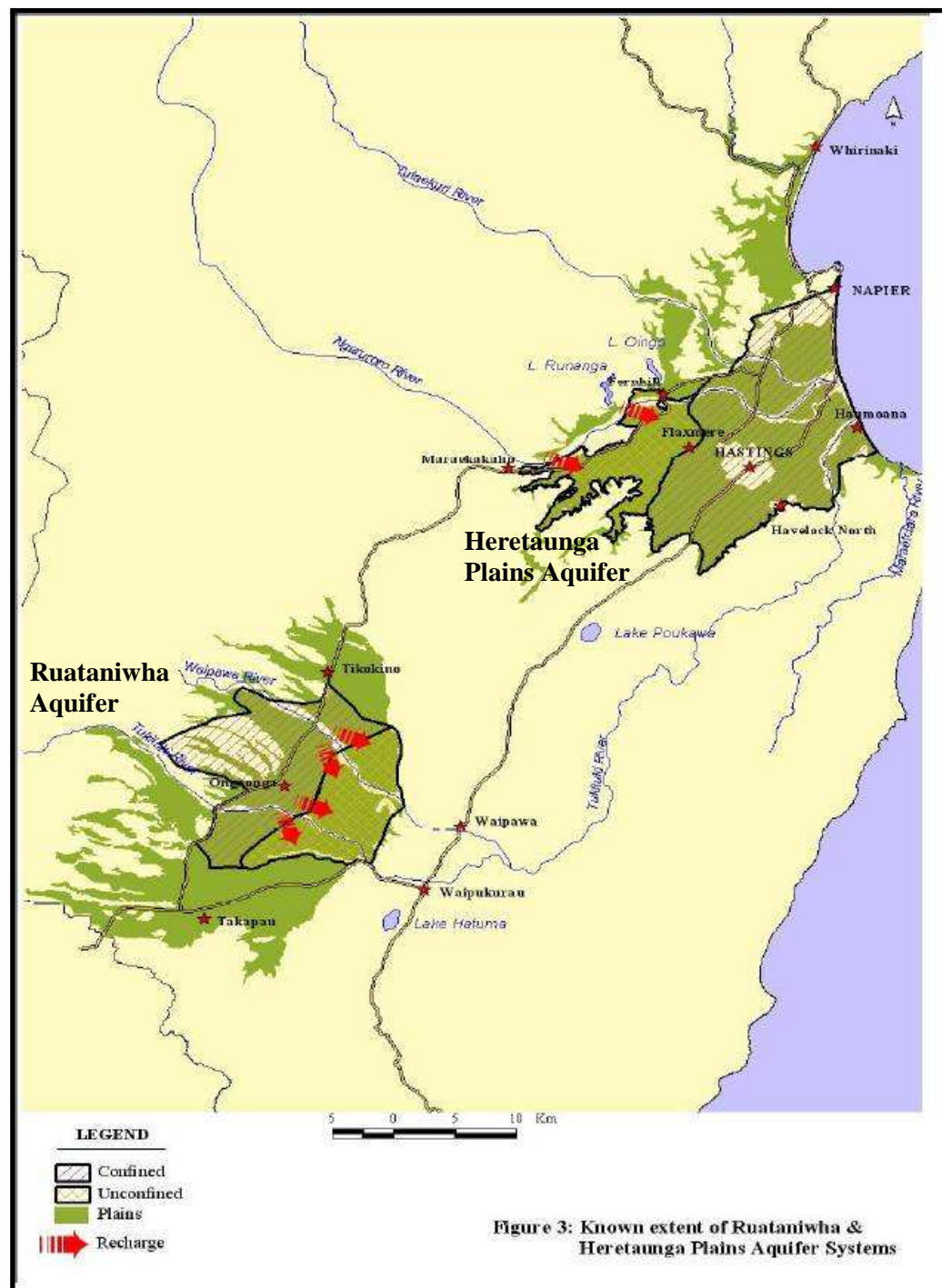


Figure 3: Known extent of Ruataniwha & Heretaunga Plains Aquifer Systems

Figure 1: Location of major aquifers in the Hawke's Bay region (from Hawke's Bay Regional Resource Management Plan 2006).

The Heretaunga Plains aquifer system is a critical resource for the Hawke's Bay region, providing untreated domestic water supply for Napier and Hastings, as well as supporting extensive horticulture, viticulture and industry (HBRC 2006). Annually, 60 - 70 million cubic metres is abstracted from the main aquifer system (Brown et al. 1999; HBRC 2006). Major recharge sources are the Ngaruroro River and rainfall entry through highly permeable gravels on the plains. Studies indicate that abstraction volumes do not exceed recharge, although some seasonal fluctuation occurs in the resource (Dravid & Brown 1997), with most abstraction occurring during summer and recharge in winter.

Generally, groundwater quality in the region is very good, but intensive agriculture, domestic waste, agrichemicals, landfills, underground storage tanks, accidental spillages and industrial activities pose risks for its future quality (HBRC 2006). Unconfined aquifers, and the shallow confined aquifers that these flow into, are more susceptible to contamination than deeper confined aquifers. Minor groundwater contamination from the Roys Hill landfill, septic tanks and diffuse nitrate pollution from intense landuse activities has been identified in unconfined aquifers in the past. Recommendations that urban development and the storage of hazardous substances be prohibited from the unconfined aquifer area, and that a precautionary approach should be taken with respect to future developments, occurred as early as 1974 (HBRC 2006).

The Ruataniwha Plains aquifer system comprises a relatively shallow, unconfined aquifer fed from the Tukituki and Waipawa Rivers, and several deeper, confined aquifers fed from the Ruahine Ranges. Groundwater volume in the Ruataniwha Plains aquifer is considerably less than that under the Heretaunga Plains, but more than 60% of the water utilised in this productive agricultural basin is groundwater (HBRC 1999) with about 26 million cubic metres abstracted annually from this aquifer system (HBRC 1999; Fenwick et al. 2004). Water quality in this aquifer system is presently high, but much of the Ruataniwha Plains consists of shallow, unconfined aquifers which are highly vulnerable to groundwater contamination (HBRC 1999). The major threats to this aquifer system arise from intensification of agriculture and meat processing industries (HBRC 2006). Specific sources of potential contamination to aquifers in this system include land disposal of wastes, septic tanks, irrigation, pesticides, fertilisers and animal feed (HBRC 2006).

### 3. Threats & lessons from past failures

#### 3.1 Growing international recognition of the need to protect Groundwater Dependent Ecosystems

Internationally, most conservation efforts in aquatic ecosystems have focused on surface waters, which is understandable given their visibility and accessibility. Conversely, programmes to protect out of sight and inaccessible groundwaters have been far less common (Boulton 2005). The limited awareness and poor understanding of how groundwater ecosystems function has certainly contributed to the decline in their condition in some continents, with numerous documented examples of these systems becoming severely degraded due to over-extraction (e.g., Fensham & Fairfax, 2003; Weinthal et al. 2005; Reddy et al. 2009), saline intrusion (e.g., Ergil 2000; Peck & Hatton 2003; Milnes & Renard 2004; Khan et al. 2007), and contamination (e.g., Nickson et al. 1998; Al-Hogarty et al. 2008; Schipper et al. 2008; Levison & Novakowski 2009). There are also likely to be many undocumented cases of groundwater degradation. Fortunately, there is some movement towards more explicit protection of groundwaters and GDEs, including in Europe and Australia, although this is still hindered by the very limited awareness of groundwater biodiversity and ecosystems services, as well as the small base of knowledge about how these ecosystems function.

In Europe, the Water Framework Directive 2000 (WFD) includes a holistic, catchment-scale approach to the maintenance of 'good status' of coastal, surface and groundwaters (Krause et al. 2007). This includes both chemical and ecological measures, which are recognised as interdependent functions. This represents a move away from defining water quality based on critical thresholds. These changes in the definition of the status of waterbodies and in the scale of measurement have led to significant changes in the requirements for monitoring and assessment (Krause et al. 2007). The WFD also specifies the assessment of damage to groundwater dependent terrestrial ecosystems as a component of assessing groundwater status.

In Australia, there is federal and state legislation covering water resources allocation and protection or conservation. Federal legislation provides a high-level, overarching policy framework that leaves state legislation to implement the details. However, implementation of the federal legislation, and even the terminology used, appears to vary from state to state.

Environmental Water Requirements (EWRs) have figured in Australian government water policy since 1994. However, despite the mention of groundwater health in

policy framework there has been an emphasis on rivers and wetlands and a lack of attention to groundwater in subsequent guidelines. Tomlinson and Boulton (2008) provided a useful summary of the policy context for groundwater legislation in Australia. They concluded that recent water reforms in Australia provided a mandate for environmental allocations in water plans, but there was little guidance for groundwater planners and managers. This was primarily a consequence of the substantial technical, conceptual and knowledge gaps associated with the environmental requirements for groundwater ecosystems.

Likewise, there is a focus on surface water in Australia's Intergovernmental Agreement on a National Water Initiative, although four of the ten objectives are concerned most directly with environmental management of groundwater (Tomlinson & Boulton 2008). The identification of EWRs is seen as a key process in defining the needs of GDEs. However, Australian research effort on GDEs has focussed on assessing the dependence of terrestrial ecosystems on groundwater, rather than the intrinsic values of groundwater ecosystems. Investigations of aquifer ecology in Australia have been undertaken only very recently and have been mostly uncoordinated, short-term faunal surveys to answer immediate resource use questions driven by requirements of environmental impact assessment legislation. Few such surveys have involved the collection of water quality data, were designed to assess the environmental water requirements of the aquifer ecosystem, or identified the thresholds for acceptable change in key ecosystem characteristics (Tomlinson & Boulton 2008).

Australia's overarching federal legislation provides poor guidance to state legislation for water planning. This is similar to New Zealand's two-stage situation, in which the Resource Management Act 1991 (RMA) provides overarching legislation to water allocation plans of regional councils. Whereas federal policies provide poorly defined guidance in Australia, New Zealand's RMA provides a sound framework for managing groundwater resources, although it fails to recognise fully the importance of groundwater as a component of the aquatic environment. In both countries, recognition of the intrinsic value of groundwater ecosystems is very recent, and this recognition is being reflected in an increasing number of New Zealand regional councils' natural resources plans. The same level of recognition has not yet been achieved in Australia, but the publication of Tomlinson & Boulton's (2008) report identifies research that would provide information and tools to assist environmental managers to make informed contributions to water planning with respect to groundwater ecosystems. The key issues in both countries are to ensure that groundwater issues are better understood and that groundwater dependent ecosystems are recognised consistently nation-wide.

## **4. Current management and plan effectiveness in New Zealand**

### **4.1 Legislative framework**

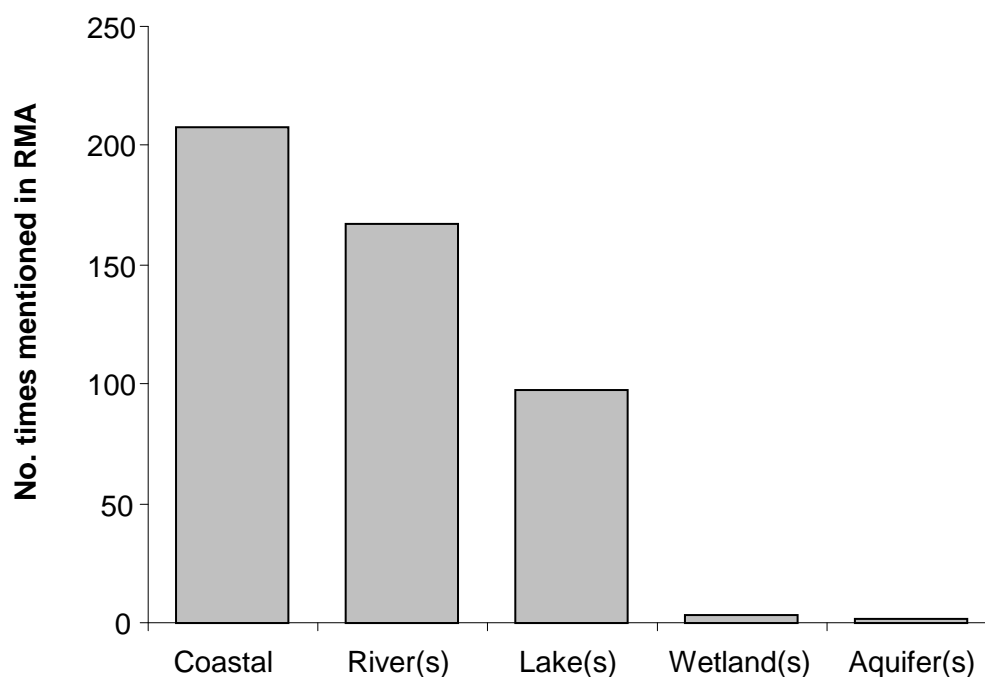
#### **4.1.1 The Resource Management Act 1991**

The Resource Management Act (RMA) is the most important piece of environmental legislation in New Zealand (other legislation that is potentially relevant to the management and conservation of groundwater biodiversity includes the Fisheries Act 1996 and the Conservation Act 1987). The purpose of the RMA is to promote the sustainable management of natural and physical resources. In essence, the RMA controls the use of natural and physical resources through a prescribed, hierarchical framework of policies, plans, rules and consents. Regional councils must develop Regional Policy Statements and Regional Plans and Rules that take account of this national framework.

#### **4.1.2 Groundwater ecosystems and the Resource Management Act**

The term “groundwater” does not appear in the RMA, although the term “aquifer” appears in two places (Fig. 2). Note that the definitions of “water” and “water body” (see Appendix) include specific mention of water below ground and water in aquifers. It is also important to note that the RMA uses the Fisheries Act 1996’s definition of aquatic life, so that any species of plant or animal life that must inhabit any waterbody (fresh, brackish or marine) for part of its life is included. The definition, therefore, includes all groundwater invertebrates. Bacteria and fungi, both free-living and components of biofilms, are presumably included as plants.

A simple search of the text of the RMA shows a striking pattern of relative prominence of different aquatic ecosystems in the Act (Fig. 2). “Coastal marine”, “river(s)” and “lake(s)” appear commonly throughout the Act, whereas “wetland(s)” and “aquifer(s)” occur only 3 and 2 times, respectively. This pattern appears to highlight a lack of consciousness of groundwater (and wetland) habitats within the New Zealand legislation.



**Figure 2:** Results of keyword search of Resource Management Act 1991 (RMA) for different aquatic ecosystem terms.

There are several instances in the RMA where the term “aquifer” is excluded from listings of the other habitats within the definition of “water body”. In this way, the RMA appears to imply that aquifers do not have equal standing with coastal marine areas, wetlands, rivers and lakes. For example, Section 6 requires that all persons exercising functions and powers under the RMA, shall recognise and provide for the following matters of national importance: “a) The preservation of the natural character of the coastal environment (including the coastal marine area), wetlands, and lakes and rivers and their margins, and the protection of them from inappropriate subdivision, use and development”. This omission of groundwater, deliberate or unintended, implies that protection of the natural character of groundwater is not a matter of national importance, despite the reliance of a large proportion of New Zealanders on groundwater for domestic, agricultural and industrial water supply.

Further, most activities (e.g., discharges of contaminants, and water abstractions) that affect public resources in coasts, air, water, rivers and lakes are restricted under the Act. This means that resource consent must be obtained before these types of activities can be undertaken in these surface waterbodies, unless there are rules in a plan stating otherwise. By contrast, most land is a private resource and land use activities are generally not restricted under the RMA, unless a council writes a specific rule. As land

use activities remain largely unregulated by the RMA, there is potential for contamination of underlying groundwater resources.

The concept of a precautionary approach is implied in the RMA and requires an informed but cautious approach to decisions in those cases where full information on effects is not available at the time of the decision-making process, particularly where there is a high level of uncertainty and where decisions are effectively irreversible. A precautionary approach is particularly relevant to cases where effects are of low probability, but are of high potential impact. Section 32 of the RMA requires the evaluation of a plan provision to consider the risks of acting or not acting if there are uncertainties or inadequate information. This is directly relevant to groundwater ecosystems, where usually little information is available and impacts may be irreversible.

#### **4.1.3 Other legislation relevant to groundwater**

The RMA is not the only legislation to exclude explicit mention of groundwater. The Fisheries Act 1996, which is the principal Act governing the management of New Zealand's marine and freshwater fisheries, defines "Aquatic environment" as:

“(a) the natural and biological resources comprising any aquatic ecosystem; and

(b) includes all aquatic life and the oceans, seas, coastal areas, inter-tidal areas, estuaries, rivers, lakes, and other places where aquatic life exists.”

In this instance, groundwater is covered implicitly under “other places where aquatic life exists”, where “aquatic life” is defined as “any species of plant or animal life that, at any stage of its life history, must inhabit water...”. However, the Fisheries Act makes no reference to aquifer or groundwater at all. This is unsatisfactory for aquatic ecosystems that contain a significant proportion of our freshwaters and their own significant biodiversity.

The Conservation Act 1987 was promulgated to promote the conservation of New Zealand's natural and historic resources (DoC 2008a). The Department of Conservation's (DoC) mission is to “...conserve New Zealand's natural and historic heritage for all to enjoy now and in the future”. Seven intended outcomes were identified to achieve this mission from 2008-11, and three natural heritage outcomes are especially relevant to groundwater biodiversity management (DoC 2008b):

- “The ecological integrity of managed sites is maintained or restored: ...Restoring and maintaining ecological integrity on public conservation lands and waters is a key means to address the ongoing depletion of New Zealand’s natural heritage”.
- “The security of threatened species unique to New Zealand, and most at risk of extinction, is improved: ...Species are preserved for their own sake, for their role in indigenous ecosystems, and to help to maintain options for current and future New Zealanders. This work delivers economic, social, cultural and environmental benefits”.
- “Examples of the full range of New Zealand’s ecosystems are conserved: ...Conserving examples of the ranges of ecosystems is a key means to address the ongoing depletion of New Zealand’s natural heritage. This work is part of the Department’s contribution to the New Zealand Biodiversity Strategy. Ecosystems are preserved for the value of the life-forms they sustain and the value of the systems as a whole, and to help maintain options for current and future New Zealanders. Managing ecosystems will also deliver ecosystem services (such as flood protection, and water and soil quality protection), which are of economic, environmental, social and cultural benefit to the New Zealand public, and contribute to the Government themes as outlined above”.

Conservation and management of groundwater habitats, their biodiversity and the ecosystem services that they provide clearly fall within DoC’s desired outcomes. New Zealand’s groundwater ecosystems and their biodiversity are facing increasing threats from the on-going de-watering of our shallow soils and the perpetuation of increasingly intensive land-use activities. Based on its mandate and targeted outcomes, therefore, groundwater biodiversity management should receive high priority in DoC’s future management of ecosystems, habitats and biodiversity.

#### **4.2 Management of groundwater by regional councils**

Regional councils are given a number of functions under the RMA (Section 30). Key functions which are relevant to groundwater include:

- a) the establishment, implementation and review of objectives, policies, and methods to achieve integrated management of the natural and physical resources of the region; and



- b) the preparation of objectives and policies in relation to any actual or potential effects of the use, development, or protection of land which are of regional significance; and
- c) the control of the use of land for the purpose of:
  - i. soil conservation; and
  - ii. the maintenance and enhancement of the quality of water in water bodies and coastal water; and
  - iii. the maintenance of the quantity of water in water bodies and coastal water; and
  - iv. the avoidance or mitigation of natural hazards; and
  - v. the prevention or mitigation of any adverse effects of the storage, use, disposal, or transportation of hazardous substances; and
- d) the control of the taking, use, damming, and diversion of water, and the control of the quantity, level, and flow of water in any water body including-
  - i. the setting of any maximum or minimum levels or flows of water; and
  - ii. the control of the range, or rate of change, of levels or flows of water; and
  - iii. the control of the taking or use of geothermal energy; and
- e) the control of discharges of contaminants into, or onto land, air, or water and discharges of water into water.

Therefore, in relation to groundwater, regional councils are required to i) control the use of land for the purpose of maintaining and enhancing water quality and quantity; prevent or mitigate any adverse effects of the storage, use and disposal, or

transportation of hazardous substances; ii) control the taking, use, damming, and diversion of water, and control the quantity, level, and flow of water; and iii) control discharges of contaminants into or onto land, or water and discharges of water into water.

Based on Sections 6 and 7 of the RMA, regional councils must also recognise and provide for a range of matters of relevance to groundwater ecosystems:

- i. the protection of outstanding natural features and landscapes from inappropriate subdivision, use, and development; and
- ii. the protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna; and
- iii. facilitate the relationship of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga; and
- iv. the efficient use and development of natural and physical resources; and
- v. the maintenance and enhancement of amenity values; and
- vi. intrinsic values of ecosystems; and
- vii. maintenance and enhancement of the quality of the environment; and
- viii. any finite characteristics of natural and physical resources.

The primary documents for resource management at the regional level are the Regional Policy Statement and the Regional Resource Management Plan. The purpose of the Regional Policy Statement is to provide an overview of the resource management issues of the region and to provide a structure for the integration of resource management in the region and component districts. The purpose of the Regional Plan is to address the issues identified in the Regional Policy Statement, and to provide the detailed policies and guidelines that allow the regional council to carry out its functions to achieve the purpose of the RMA. A regionally significant issue is

one that requires a substantial, region-specific, response under the RMA. For example, within the Hawke's Bay Regional Resource Management Plan, a regionally significant issue is defined as one that satisfies one or more of the following criteria: a problem which is relevant throughout the region; the existence of a natural or physical resource that is scarce, rare or unique, and/or under threat; presence of, or potential for, significant conflicts in resource use; or the presence of, or potential for, significant cumulative impacts arising from resource use.

#### **4.2.1 Hawke's Bay**

The Hawke's Bay Regional Resource Management Plan (RRMP), which incorporates the Hawke's Bay Regional Policy Statement, became operative in August 2006. The over-arching objective of the RRMP is "To achieve the integrated sustainable management of the natural and physical resources of the Hawke's Bay region, while recognising the importance of resource use activity in Hawke's Bay, and its contribution to the development and prosperity of the region" (HBRC 2006: 22). We reviewed this plan within the context of this objective and the needs for protection and management of groundwater as a living ecosystem.

Within the RRMP the words "groundwater(s)" and "aquifer(s)" occur 265 and 136 times, respectively. This compares favourably to the number of times that the words "coastal" (115), "river(s)" (287), "lake(s)" (132), and "wetland(s)" (29) appear, and is a reflection of the recognised value of the groundwater resource in the Hawke's Bay region. The Regional Council has set a number of key objectives in the RRMP to enable it to carry out its functions in relation to groundwater quality and quantity:

Specific Objectives contained in the Regional Policy Statement include:

"OBJ 21 No degradation of existing water quality in aquifers in the Heretaunga Plains and Ruataniwha Plains aquifer systems."

"OBJ 22 The maintenance or enhancement of groundwater quality in unconfined or semi-confined productive aquifers in order that it is suitable for human consumption and irrigation without treatment, or after treatment if this is necessary because of the natural water quality."

"OBJ 23 The avoidance of any significant adverse effects of water takes on the long-term quantity of groundwater in aquifers and on surface water resources."

“OBJ 24 The avoidance or remedy of any significant adverse effects of water takes on the operation of existing lawful efficient groundwater takes.”

Specific Objectives contained in the Regional Plan include:

“OBJ 41 The maintenance of the water quantity of specific rivers in order that the existing aquatic species and the natural character are sustained, while providing for resource availability for a variety of purposes, including groundwater recharge.”

“OBJ 42 No degradation of existing groundwater quality in aquifers in the Heretaunga Plains and Ruataniwha Plains aquifer systems.”

“OBJ 43 The maintenance or enhancement of groundwater quality in unconfined or semi-confined productive aquifers in order that it is suitable for human consumption and irrigation without treatment, or after treatment where this is necessary because of the natural water quality.”

“OBJ 44 The maintenance of a sustainable groundwater resource.”

Therefore, in relation to groundwater quality, the RRMP emphasises maintaining high quality water in the Heretaunga and Ruataniwha Plains unconfined aquifers, and provides a number of specific rules to regulate the discharge of contaminants over the recharge areas of these aquifers. The activities that are regulated include: the storage of stock feed; the use of compost, biosolids, and other soil conditioners; animal effluent discharge; management of solid waste; domestic sewage disposal systems; stormwater discharges; and, discharges to land that may enter water. Discharges to land in areas other than the Heretaunga Plains and Ruataniwha Plains unconfined aquifers are permitted in the RRMP, subject to compliance with relevant standards and conditions. Other productive aquifers in the region are managed to provide water suitable for human consumption and irrigation, with quality assessed relative to existing drinking water (MoH 2005) and ANZECC (2000) guidelines. The key environmental indicators of groundwater quality used and monitored by the council are concentrations of nitrate, pesticides and herbicides.

The RRMP also has rules which consider the effects of the taking of groundwater on the quality of groundwater, including the potential for salt water intrusion. There are also rules to minimise the leaching of nutrients to groundwater in sensitive catchments, by ensuring that the combined hydraulic loading rates from agricultural effluent disposal and freshwater pasture irrigation do not exceed the capacity of the

soil. Further, the Regional Council requires that bores are drilled, constructed and maintained in a manner which avoids any contamination of aquifers.

When assessing the risks to environmental and public health through the effects of contaminated sites on groundwater quality, the following factors are taken into account under the RRMP:

- (i) the level of contamination in soil and water at the site and the characteristics of the contaminants, such as their mobility;
- (ii) any numerical standards provided by relevant national guidelines;
- (iii) in the absence of relevant national guidelines, numerical standards determined in other internationally recognised guidelines;
- (iv) the current or proposed land use and any restrictions on future land uses of the site;
- (v) the proximity of the site to sensitive ecosystems\* and the sensitivity of those ecosystems to the contaminants;
- (vi) the possible exposure pathways;
- (vii) the degree and nature of the discharges from the site; and
- (viii) the geological nature and history of the site.

Further, the RRMP specifies that remediation and/or containment of any existing contaminated site will be required to ensure that the final level of contamination is appropriate for the current, proposed or any permitted use of that land.

The goals of the groundwater quantity objectives are to avoid any adverse effects “on the long-term quantity of groundwater in aquifers and on surface water resources”, and to avoid or remedy “any significant adverse effects of water takes on the operation of existing lawful efficient groundwater takes” (HBRC 2006: 55). The plan also notes that the use of groundwater is likely to increase in the future, especially during summer, with the result that summer and autumn aquifer levels are expected to

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\* However, particularly sensitive groundwater ecosystems are more difficult to discover and delineate than those ecosystems above ground.

decrease, conflict between groundwater users is expected to increase, possibly resulting in a “...reduction in spring flows (i.e., less groundwater would emerge as springs) and consequential potential reduction in water quantities within wetlands, rivers and lake” (HBRC 2006: 55).

The central theme of groundwater management within the RRMP is protection of groundwater supplies (quality and quantity) for human use. There is no mention of groundwater as an ecosystem with intrinsic biodiversity values. Indeed, the groundwater quantity objective specifically provides for the protection of GDEs (e.g., springs, wetlands), but offers no explicit protection for ecosystems in groundwater. However, it is likely that careful management of groundwater levels to maintain spring and stream flow is also likely to offer a level of protection to groundwater ecosystems. At this stage, there is little scientific knowledge available to address the question of how changes in groundwater level affect groundwater ecosystems.

The absence of explicit protection for groundwater ecosystems is in contrast to significant protection offered to surface water habitats. For example, Objective 40 (surface water quality) of the RRMP is the “maintenance of the water quality of specific rivers in order that the existing species and natural character are sustained, while providing for resource availability for a variety of purposes, including groundwater recharge” (HBRC 2006: 99). Objective 41 seeks “maintenance of the water quantity of specific rivers in order that the existing aquatic species and the natural character are sustained, while providing for resource availability for a variety of purposes, including groundwater recharge”, where natural character is defined as “a range of qualities and features, which have been created and sustained by nature as distinct from those which have been constructed by people. The degree or level of natural character within an area depends to an extent to which natural elements, patterns and processes have occurred and the nature and extent of modifications to the natural environment” (HBRC 2006: 104). Aquatic ecosystem protection is the central focus of these two surface water objectives, which is entirely appropriate given the purpose of the RMA.

The RRMP has specific rules to manage the effects of groundwater takes from aquifers on nearby surface water bodies. Any taking of shallow groundwater within 400 m of a river, lake or wetland is treated as if it were a direct take. Further, any taking of shallow groundwater beyond 400 m may require an assessment of effects in the river, lake or wetland depending on the scale of the take. If interaction is deemed likely to occur, it may be treated as if it were a direct take.

## 5. Recommendations for changes to Hawke's Bay Regional Resource Management Plan

There are a few districts and regions in New Zealand where groundwater fauna and/or ecosystems are explicitly mentioned in regional plans. Tasman District Council recognises the valuable resources associated with extensive karst systems in the district and mentions the aquatic invertebrate fauna that is associated with these systems (Tasman District Council 2008). The Tasman District Council's Regional Management Plan (2008) stands out because it explicitly recognises groundwater biota, as well as accepting the connectivity between groundwater and surface waters (TDC 2008). More recently, Environment Waikato recognised biological diversity and ecosystems services performed by groundwater ecosystems in their consent application assessment criteria. These additions to the plans were a direct result of NIWA's FRST-funded research on groundwater biodiversity and ecosystems since 1998.

The HBRC's RRMP compares favourably with those of other regions, based on the number of times that the words groundwater or aquifer appear in the plan. However, present management of groundwater resources within the Hawke's Bay RRMP is heavily biased towards the physical resource, with little attention paid to sustaining their life supporting capacity. This is in contrast to the protection of intrinsic values of surface waters. The present limited knowledge of the structure and functioning of groundwater ecosystems is a major impediment to their effective management (Tomlinson & Boulton 2008). We still lack adequate information to assess the potential effects of groundwater takes and contaminants on groundwater ecosystems. These should be developed as full research investigations. Further, regular assessments of groundwater ecosystem condition are required so that adaptive management can be guided by up-to-date information.

Hawke's Bay Regional Council could incorporate more explicit protection of groundwater ecosystems and biodiversity in its plan's objectives for managing contaminated sites on land, where contaminants are likely to enter groundwater. There is a dearth of information about the effects of contaminants in groundwater ecosystems, and a precautionary approach is advisable. In contrast, we know that land-based sewage effluent disposal can have significant adverse effects on groundwater ecosystems (Sinton 1984). As a result, the management of sewage effluent disposal to land, or into land, should incorporate the means to protect the life-supporting capacity of groundwater ecosystems.

Specific questions relating to groundwater ecosystems that warrant priority investigation include:

- Does groundwater biota respond to fluctuations in groundwater level?
- Do septic tanks have adverse effects on groundwater ecosystems and, if so, what is the extent (zone of impact) associated with septic tanks of differing effectiveness?
- What key parameters should be measured to improve our understanding of groundwater-surface water linkages, and what are the main aquifer processes driving the quality and quantity of groundwater discharges to dependent ecosystems?
- What parameters define ecosystem health of groundwaters, and what limits of acceptable change in these indicators may act as triggers for management actions?
- What are the priority areas for the protection or restoration of specific groundwater ecosystems?



## 6. Conclusions

Presently, the focus of groundwater management in Hawke's Bay is on the protection of groundwater supplies for human use, with no mention in the RRMP of groundwater as an ecosystem with intrinsic biodiversity values. Although there is increasing recognition of the interconnectedness of surface and groundwaters and of the intrinsic values of groundwater ecosystems internationally, this recognition is slow in Hawke's Bay and other regions within New Zealand. The limited knowledge of the structure and functioning of these ecosystems is the main reason for this lag and this, in turn, hinders effective management to identify and protect the biodiversity and ecosystem values of groundwaters. Overcoming this knowledge gap is critical, because groundwater ecosystems are subject to increasingly intense pressures and threats. Research is required to determine the impacts of abstraction, intensification of land use and discharge of contaminants on the structure and functioning of groundwater ecosystems. In turn, this will guide more effective management in the future. In the interim, a precautionary approach is advisable, given that impacts on groundwaters may be difficult to detect and potentially irreversible.

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## 8. References

- Al-Hogaraty, E.A.; Rizk, Z.S. & Garamoon, H.K. (2008). Groundwater pollution of the quarternary aquifer in northern United Arab Emirates. *Water, Air and Soil Pollution 190*: 323-341.
- Australian and New Zealand Environment and Conservation Council (ANZECC) (2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality.
- Baron, J.S.; Poff, N.L.; Angermeier, P.L.; Dahm, C.N.; Gleick, P.H.; Hairston, N.G. Jnr; Jackson, R.G.; Johnston, C.A.; Richter, B.D. & Steinman, A.D. (2002). Meeting ecological and societal needs for freshwater. *Ecological Applications 12*: 1247-1260.
- Boulton, A.J. (2000). River ecosystem health down under: assessing ecological condition in riverine groundwater zones in Australia. *Ecosystem Health 6*: 108-118.
- Boulton, A.J. (2005). Chances and challenges in the conservation of groundwaters and their dependent ecosystems. *Aquatic Conservation: Marine and Freshwater Ecosystems 15*: 319-323.
- Brown, L.J.; Dravid, P.N.; Hudson, N.A. & Taylor, C.B. (1999). Sustainable groundwater resources, Heretaunga Plains, Hawke's Bay, New Zealand. *Hydrogeology Journal 7*: 440-453.
- Danielopol, D.L.; Griebler, C.; Gunatilaka, A. & Notenboom, J. (2003). Present state and future prospects for groundwater ecosystems. *Environmental Conservation 30*: 1-27.
- Department of Conservation (DoC) (2008a). Legislation: Conservation Act 1987 (<http://www.doc.govt.nz/templates/page.aspx?id=41967>).
- Department of Conservation (DoC) (2008b). Department of Conservation statement of intent 2008-11. Department of Conservation, Wellington. pp. 64.

- Dravid, P.N. & Brown, L.J. (1997). Heretaunga Plains groundwater study. *Hawke's Bay Regional Council and Institute of Geological and Nuclear Sciences, Vol 1: Findings*. pp. 254.
- Ergil, M.E. (2000). The salination problem of the Guzelyurt aquifer, Cyprus. *Water Research 34*: 1201-1214.
- Fensham, R.J. & Fairfax, R.J. (2003). Spring wetlands of the Great Artesian Basin, Queensland, Australia. *Wetlands Ecology and Management 11*: 343-362.
- Fenwick, G.; Thorpe, H. & White, P. (2004). Groundwater Systems *In: Freshwaters of New Zealand*. Harding, J.; Mosley, P.; Pearson, C. & Sorrell, B. (eds). pp. 29.1-29.18.
- Hatton, T. & Evans, R. (1998). Dependence of ecosystems on groundwater and its significance to Australia. Land and Water Resources Occasional Paper No. 12/98. pp. 81.
- Hawke's Bay Regional Council (HBRC) (1999). Ruataniwha Pains: conceptual hydrogeological model. Environmental Management Group Technical Report. pp. 50.
- Hawke's Bay Regional Council (HBRC) (2006). Hawke's Bay Regional Resource Management Plan. pp. 246.
- Khan, S.; Asghar, M.N. & Rana, T. (2007). Characterizing groundwater dynamics based on impact of pulp and paper mill effluent, irrigation and climate variability. *Water and Air Pollution 185*: 131-148.
- Krause, S.; Heathwaite, A.L.; Miller, F.; Hulme, P. & Crowe, A. (2007). Groundwater-dependent wetlands in the UK and Ireland: controls, functioning and assessing the likelihood of damage from human activities. *Water Resources Management 21*: 2015-2025.
- Levison, J. & Novakowski, K. (2009). The impact of cattle pasturing on groundwater quality in bedrock aquifers having minimal overburden. *Hydrogeology Journal 17*: 559-569.

- Milnes, E. & Renard, P. (2004). The problem of salt recycling and seawater intrusion in coastal plains: an example from the Kiti aquifer (Southern Cyprus). *Journal of Hydrology* 288: 327-343.
- Ministry of Health (MoH) (2005). Drinking-water standards for New Zealand. Ministry of Health, Wellington. pp. 175.
- Murray, B.R.; Zeppel, M.B.; Hose, G.C. & Eamus, D. (2003). Groundwater-dependent ecosystems in Australia: it's more than just water for rivers. *Ecological Management and Restoration* 4: 110-113.
- Nickson, R.; McArthur, J.; Burgess, W.; Matin Ahmed, K.; Ravenscroft, P. & Rahman, M. (1998). Arsenic poisoning of Bangladesh groundwater. *Nature* 395: 338.
- Parliamentary Commissioner for the Environment (PCE) (2005). Growing for Good: Intensive farming, sustainability and New Zealand's environment. Parliamentary Commissioner for the Environment, Wellington. pp. 238.
- Peck, A.J. & Hatton, T. (2003). Salinity and the discharge of salts from catchments in Australia. *Journal of Hydrology* 272: 191-202.
- Reddy, D.V.; Nagabhushanam, P.; Sukhija, B.S. & Reddy, A.G.S. (2009). Understanding hydrological processes in a highly stressed granitic aquifer in southern India. *Hydrological Processes* 23: 1282-1294.
- Scarsbrook, M.R.; Fenwick, G.D.; Duggan, I.D. & Haase, M. (2003). A guide to the groundwater invertebrates of New Zealand. NIWA Science and Technology Series No. 51, Wellington. pp. 59.
- Schipper, P.N.M.; Vissers, M.J.M. & van der Linden, A.M.A. (2008). Pesticides in groundwater and drinking wells: overview of the situation in the Netherlands. *Water Science and Technology* 57: 1277-1286.
- Sinton, L.W. (1984). The macroinvertebrates of a sewage polluted aquifer. *Hydrobiologia* 119: 161-169.
- Tasman District Council (TDC) (2008). Tasman Resource Management Plan.

Tomlinson, M. & Boulton, A. (2008). Subsurface groundwater dependent ecosystems: a review of their biodiversity, ecological processes and ecosystem services. Waterlines Occasional Paper No.8, National Water Commission, ACT, Australia. pp. 77.

Weinthal, E.; Vengosh, A.; Marei, A.; Gutierrez, A. & Kloppmann, W. (2005). The water crisis in the Gaza strip: prospects for resolution. *Groundwater* 43: 653-660.

## 9. Appendix: Definition of terms

These definitions are from the Resource Management Act 1991 unless indicated otherwise.

**Aquatic life** (definition from Fisheries Act 1996):

(a) any species of plant or animal life that, at any stage in its life history, must inhabit water, whether living or dead; and

(b) Includes seabirds (whether or not in the aquatic environment).

**Biological diversity:** the variability among living organisms, and the ecological complexes of which they are a part, including diversity within species, between species, and of ecosystems

**Contaminant:** includes any substance (including gases, odorous compounds, liquids, solids, and microorganisms) or energy (excluding noise) or heat, that either by itself or in combination with the same, similar, or other substances, energy, or heat -

(a) when discharged into water, changes or is likely to change the physical, chemical, or biological condition of water; or

(b) when discharged onto or into land or into air, changes or is likely to change the physical, chemical, or biological condition of the land or air onto or into which it is discharged

**Effect:**

(a) any positive or adverse effect; and

(b) any temporary or permanent effect; and

(c) any past, present, or future effect; and

(d) any cumulative effect which arises over time or in combination with other effects -

regardless of the scale, intensity, duration, or frequency of the effect, and also includes-

(e) any potential effect of high probability; and

(f) any potential effect of low probability which has a high potential impact.

**Environment:**

(a) ecosystems and their constituent parts, including people and communities; and

(b) all natural and physical resources; and

(c) amenity values; and

(d) the social, economic, aesthetic, and cultural conditions which affect the matters stated in paragraphs (a) to (c) of this definition or which are affected by those matters

**Fresh water:** all water except coastal water and geothermal water

**Intrinsic values**, in relation to ecosystems, means: those aspects of ecosystems and their constituent parts which have value in their own right, including -

(a) their biological and genetic diversity; and

(b) the essential characteristics that determine an ecosystem's integrity, form, functioning, and resilience.

**Productive aquifers** (definition from Hawke's Bay Regional Resource Management Plan 2006): an aquifer that has a sufficient quality, quantity and flow of water that it can be used for water supply purposes.

**Regional plan:** an operative plan (including a regional coastal plan) approved by a regional council or the Minister of Conservation under Schedule 1; and includes all operative changes to such a plan (whether arising from a review or otherwise).

**Regional policy statement:** an operative regional policy statement approved by a regional council under Schedule 1; and includes all operative changes to such a policy statement (whether arising from a review or otherwise).

Water:

- (a) means water in all its physical forms whether flowing or not and whether over or under the ground;
- (b) includes fresh water, coastal water, and geothermal water;
- (c) does not include water in any form while in any pipe, tank, or cistern.

Water body: fresh water or geothermal water in a river, lake, stream, pond, wetland, or aquifer, or any part thereof, that is not located within the coastal marine area

Wetland: permanently or intermittently wet areas, shallow water, and land water margins that support a natural ecosystem of plants and animals that are adapted to wet conditions