greater WELLINGTON
REGIONAL COUNCIL
Te Pane Matua Taiao

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Wairarapa Valley groundwater resource investigation technical reports

1. Purpose

To summarise the technical outputs from the Wairarapa Valley groundwater resource investigation.

2. Background

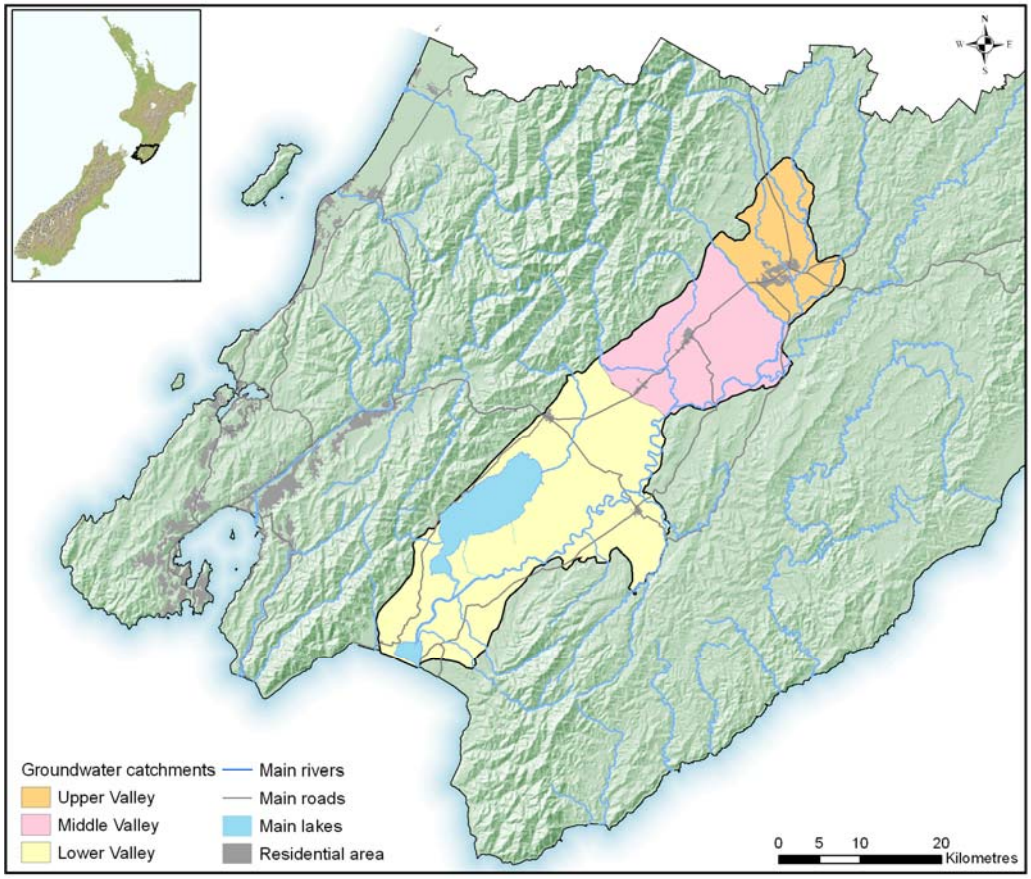
Groundwater is an important resource in the Wairarapa. It is intrinsically linked to many river and stream systems and supports numerous groundwater dependent ecosystems such as springs and wetlands. It is also important for public water supply, domestic use, stock water supply, irrigation and industry.

In 2005, steady increases each year in demand for groundwater in the Wairarapa, coupled with a decline in groundwater levels in some areas, raised concern regarding the potential adverse impacts of abstraction on groundwater dependent ecosystems and whether the present rates of abstraction were sustainable in the long term. This concern led to the launch of a comprehensive investigation of the Wairarapa Valley groundwater system with the primary purpose of providing a sound scientific platform to re-assess the groundwater allocation limits and management objectives of Wairarapa Valley aquifers.

The investigation involved three phases: Phase 1 involved a general regional evaluation of the entire Wairarapa Valley and consolidated existing knowledge of Wairarapa hydrogeology, culminating in the production of a snapshot ('steady-state') computer-based groundwater model for the valley and a technical report[1], completed in December 2006 (see Report 07.136 for a summary). Phase 1 highlighted that the groundwater and surface water system are essentially **one resource** and should be investigated as such; it also identified three sub-catchments (Upper, Middle and Lower Valley, Figure 1) that essentially set the scene for the comprehensive Phase 2 stage of the investigation.

[1] Jones A.; Gyopari M. 2006. *Regional conceptual and numerical modelling of the Wairarapa groundwater basin.* Greater Wellington Regional Council Technical Publication GW/EMI-T-06/293.

The recently completed Phases 2 and 3 are outlined in more detail in Sections 3 and 4 of this report below.



(Source: Gyopari & McAlister 2010a)

Figure 1: Location of the Wairarapa Valley groundwater investigation study area, highlighting the three sub-catchment modelling areas as defined during Phase 1 of the investigation

3. Phase 2 – Detailed sub-regional groundwater resource analysis and modelling

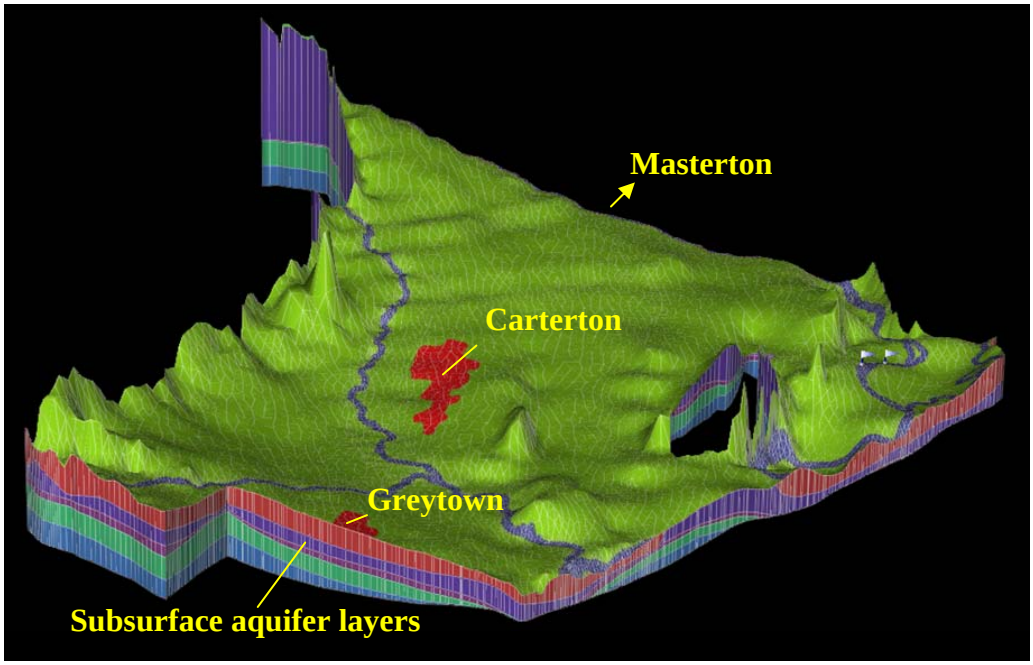
The purpose of Phase 2 of the investigation was to provide a robust technical analysis of the groundwater environments of the Wairarapa Valley leading to the development of transient groundwater flow models for the Upper, Middle and Lower Valley sub-catchments suitable for evaluating the allocation of the Wairarapa's groundwater and surface water resources. During this phase the geological characteristics and hydrogeological functioning of the valley were extensively reviewed.

Phase 2 included a field investigation programme to address critical information gaps identified during Phase 1. This programme incorporated the drilling of monitoring bores, a seismic geophysics survey, isotope chemistry sampling to determine groundwater age, a springs survey and the reading of meters on consented water takes. Phase 2 also involved analysis and quantification of rainfall recharge processes, groundwater abstraction and groundwater chemistry. A range of external experts were utilised during Phase

2, including a geologist, soil scientist, hydrologist, hydrogeochemist, hydrogeologists, and a computer modeller.

Using all of this information a numerical model (based on the FEFLOW computer package) was constructed and calibrated, initially for the Middle Valley sub-catchment (simulating the period 1992 to 2007)[2] and subsequently the Upper and Middle Valley sub-catchments. These three sub-catchment models better represent the very complex geological environment and associated aquifer system of the Wairarapa Valley than the initial (Phase 1) model.

The three sub-catchment modelling studies were completed in June 2010 and have been documented in three separate technical reports, completed in late 2010[3] following peer review by an independent expert. The computer-based groundwater models documented in these reports are three-dimensional (Figure 2) and take into account groundwater inputs (rainfall leakage through the soil zone and river bed leakage) and outputs (groundwater discharging to rivers, springs and wetlands) through time[4]. Despite some limitations and assumptions, the calibration outputs provide confidence that the models provide



(Source: Report 08.626)

Figure 2: Three-dimensional visualisation of the computer model showing the "layer cake" of aquifers present in the Middle Valley sub-catchment

[2] A progress report on Phase 2 was presented to Council in October 2008 (see Report 08.626), documenting the completion of the Middle Valley subcatchment groundwater model.

[3] Gyopari, M.; McAlister, D. 2010a. *Wairarapa Valley groundwater resource investigation: Lower Valley catchment hydrogeology and modelling.* Greater Wellington Regional Council, Technical Publication No.GW/EMI-T-10/75.
Gyopari, M.; McAlister, D. 2010b. *Wairarapa Valley groundwater resource investigation: Middle Valley catchment hydrogeology and modelling.* Greater Wellington Regional Council, Technical Publication No.GW/EMI-T-10/73.
Gyopari, M.; McAlister, D. 2010c. *Wairarapa Valley groundwater resource investigation: Upper Valley catchment hydrogeology and modelling.* Greater Wellington Regional Council, Technical Publication No.GW/EMI-T-10/74.

[4] Using Mike-11 computer software, a surface water model was also developed for each of the three sub-catchments during Phase 2 of the investigation, providing important information on surface water and groundwater interactions. It was hoped to integrate the developed groundwater and surface water models to create a highly accurate simulation of the interaction between groundwater and surface water. However, technical difficulties with the software prevented this (coupling groundwater and surface water models in a project like the Wairarapa Valley groundwater resource investigation is a very complex task and represents new modelling territory in New Zealand).

a good representation of the Wairarapa Valley groundwater system and can be used as a tool to test various water abstraction scenarios (for example, by adjusting the groundwater abstraction rate in a model we can simulate the effects on groundwater levels or river flows through time) and climate change scenarios (for example, a predicted decrease in precipitation can be taken into account by adjusting the model's rainfall input thereby simulating the effects reduced rainfall on groundwater levels or river flows through time).

4. Phase 3 – Groundwater resource sustainability assessment

The third and final phase of the Wairarapa Valley groundwater resource investigation, undertaken in the second half of 2010, involved modelling different water abstraction and climatic scenarios using the transient groundwater models developed during Phase 2 of the investigation. For example, the Middle Valley sub-catchment model was used to run four different abstraction scenarios to test the appropriateness of current allocation limits in the existing Regional Freshwater Plan. The four scenarios were:

1. No groundwater pumping – simulation of the natural state (i.e., no water abstraction).

2. Current groundwater use – our best estimate of current and historical consented groundwater usage 1992–2007 (15% to 40% of consented volume depending on how wet each year was).
3. 100% consented use – as if all consented abstraction was actually withdrawn from aquifers.
4. 100% safe yield – testing what would happen if all groundwater volumes quoted in the Regional Freshwater Plan were actually consented and abstracted from the ground (i.e., the worst-case scenario).

Results of the modelling showed that if the Regional Freshwater Plan aquifer safe yield volumes were consented and actually abstracted, significant effects would occur on flows in rivers in the Middle Valley during critical dry summer months, especially in the Mangatarere Stream near Carterton. As a consequence, a key component of Phase 3 of the investigation was to establish the rate of flow depletion that would be expected for rivers, streams, springs and wetlands under varying groundwater abstraction scenarios.

Phase 3 was run in conjunction with a separate but related technical project to define groundwater/surface water "interaction zones" for the Wairarapa Valley region. This work has been critical because the existing Regional Freshwater Plan provides limited guidance for the management of the potential effects of groundwater abstraction on river and stream flows. In addition, current policies make limited provision for the management of the cumulative effects of groundwater and surface water abstraction at a catchment scale to enable integrated water resource management.

A technical report has recently been completed documenting Phase 3 of the investigation and peer review comments are currently being considered. This report presents a sustainable groundwater allocation methodology approached from a conjunctive water management perspective that integrates both surface and groundwater resources so they can be managed as a single resource. This approach proposes that groundwater takes that have a direct or immediate "depletion" effect on water levels in surface water bodies be managed by making these takes subject to the environmental flow policies (e.g., minimum flows and core allocation) for the relevant river, stream, lake or wetland. In other situations where groundwater takes do not have an immediate depletion effect on rivers or streams, but may contribute to a cumulative reduction in stream baseflow, such takes may be managed by establishing fixed groundwater allocation volumes that recognise the linkages between groundwater and surface water bodies.

The Phase 3 report includes a series of appendices that set out proposed new groundwater management zones for the upper, middle and lower sub-catchments of the Wairarapa Valley (based on the revised geological hydrogeological understanding developed during Phase 2 of the groundwater investigation). Essentially there are fewer zones than those in the existing Regional Freshwater Plan, reflecting the enhanced understanding of the degree of interconnections between different groundwater aquifers and rivers and streams. The Phase 3 report also includes maps that set out varying degrees (described as "categories") of hydraulic connection between groundwater and rivers and streams that will be used to inform the regional plan review as well as technical assessments of the effects of groundwater takes on surface water bodies.

5. Comment

The Wairarapa Valley groundwater resource investigation represents a comprehensive piece of technical work undertaken over a period of more than six years. We now have calibrated groundwater models for the upper, middle and lower sub-sections of the valley that can be used to test different climatic and water abstraction scenarios. These models have been developed using the best available data; they can and should be refined in the future as new water use, soil moisture and other data become available.

Overall, the outputs from Phases 2 and 3 of the investigation have significantly advanced our technical understanding of groundwater resources in the Wairarapa Valley, especially the connections between rivers, streams, springs and groundwater systems. The recommended new groundwater zones and surface water interaction categories presented in the Phase 3 technical report represent the best-available scientific understanding and, as well as informing the review of current water allocation policy for the Wairarapa Valley, they should be used in technical evaluations of any new or replacement resource consent applications to abstract either surface or groundwater in the valley.

6. Additional work

Although the three phases of the Wairarapa Valley groundwater resource investigation are now complete, further investigations and refinement of the modelling outputs are likely to be undertaken over time, particularly in areas of the valley that are subject to significant allocation pressure or where limited information existed during the Phase 2 model development and calibration. One current piece of extension work that has run concurrent with Phase 3 of the investigation is an assessment of the likely uncertainty associated with the groundwater model predictive simulations. Uncertainty in model predictions is always expected and this work aims to quantify (as far as possible) the likely sources and scale of uncertainty. This will provide policy-makers and stakeholders with a degree of confidence when interpreting the model results. Findings of the uncertainty analysis work are expected before the end of the financial year.

7. Communication

Once the peer review process has been completed, the Phase 2 and 3 technical reports will be made available on Greater Wellington's website and a media release issued. The information contained in these reports will also form part of the ongoing consultation surrounding the regional plan review process.

8. Recommendations

That the Committee:

1. ***Receives*** *the report.*

2. ***Notes*** *the content of the report.*

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