WORKSHOP NOTES

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Held in the Gisborne District Council Chambers on 7 May 2010

PRESENT:
Dennis Crone (GDC); Greg Hall (GDC); Helen Rouse (NIWA); Keriana Wilcox (GDC); Mandy Merino (NIWA); Ned Norton (NIWA); Paul Murphy (GDC); Trevor Freeman (GDC); Yvette Kinsella (GDC);

Record of Gisborne Groundwater Workshop

1. Overview of all NIWA water research projects underway

- **Waipaoa – Mean Annual Low Flow ($5k)**

The first NIWA report (SAGs 539-GCDC52 and 540-GSDC53; Norton 2009) identified the implications of the proposed NES Ecological Flows for GDC. Given that GDC has no water allocation limits formally established in plans, MALF would be the basis of mandatory interim limits for Gisborne rivers under the NES (i.e., 80% of MALF for the Waipaoa and 90% of MALF for the Te Arai). GDC has limits that guide resource consent processes but they are not based on MALF. The original report identified the need to calculate MALF to determine if Gisborne would be within those limits.

MALF is a statistic that can be used as a 'rule-of-thumb' for identifying minimum flows in the absence of more detailed assessment.

There are both NIWA and GDC records for flows on the Waipaoa River. They measure flows differently. GDC measures flood flows and low flows at the Kanakanaia Bridge and at Matawhero but the equipment is better suited to measuring flood flows – this focus on flood flows is due to historical periodic flooding and the potential impacts this has on surrounding land use on the Poverty Bay Flats. NIWA's equipment measures low flows and high flows but is better suited to low flows. The recorders used differ and there are benefits and risks of both types of measuring techniques. The GDC record does not account well for bed load movement and changes in river beds that are so common with braided rivers. This is particularly the case at the Kanakanaia Bridge site. Changes in rating account for this.

The NIWA record is seen as a more accurate record of low flows. It compares well with the rating curves and with spot gauging from GDC records. The first GDC MALF was calculated at 4.226 m^3/s compared with the NIWA calculation of 2.008 m^3/s and the second GDC calculation of 2.6 m^3/s. The first GDC calculation does not compare well to the rating curves or spot gauging. Given the issues with the difficult Kanakanaia monitoring site and the differences in the calculations, there is an approximate 20% margin of error in these calculations.

Under existing management practice, Council has a current shut-off limit on the river of 1.3m^3/s. There is also a trigger point at 1.5m^3/s where more intensive monitoring of water levels kicks in. As water demand increases in the future, especially where there is high demand or competition for water resources or where people are heavily reliant on water use, then it may be worth doing more work to reduce the uncertainties around low flow measurements in order to justify these water restrictions.

It is important to note that the accuracy of the measures and the resultant MALF calculations is not vital at this stage, because the work currently being done to determine ecological flow requirements (see below) will, when incorporated into a regional water plan, supersede the Proposed NES interim limits based on MALF.

- **Waipaoa – Ecological Flows (part of $20k)**

Interim results from the RHYHABSIM work show that a minimum flow to maintain a "high" amount of habitat for ecological values is predicted at around 2.0 m^3/s. This is very similar to the MALF calculation completed by NIWA.

The key species that NIWA have identified as being important will be eel (tuna), but they note that the values would ideally be identified via a community process.

The report will help with quantifying the percentage changes in habitat at different flows, which will inform planning.

It is useful to keep at least periodically gauging flow at Matawhero Bridge, in addition to the permanent flow recorders at Kanakanaia. This is useful because it provides a relationship between flows at these two sites. In other words it allows us to know what the flow is likely to be at Matawhero, for any given instant that we know the flow at Kanakanaia.

Current management practice is that once flows read around 1.5 l/s monitoring increases and once flows hit 1.3 l/s, at Kanakanaia, takes are at the discretion of the District Conservator.

- **Te Arai – Mean Annual Low Flow ($5k)**

There is one continuous flow record for Te Arai – at Pyke's Weir. This is a concrete weir and has less difficulty in measurements readings from this site as the river bed is less subject to change in the weir. However, gauging flow at other locations in the upper Te Arai (for example in the vicinity of the Water Works) is challenging because of the bouldery bed material that makes accurate gauging difficult.

Current management practice is that once flows read around 160 l/s, monitoring increases and once flows hit 140 l/s at Pyke's Weir, takes are at the discretion of the District Conservator. When they reach 15 l/s no takes permitted at all.

Estimates of MALF by NIWA calculations are around 0.068m^3/s (90% = 0.06m^3/s). NIWA believe this to be a reliable number with approximately 6-8% margin of error.

Current shut-off levels for GDC are set at 0.015m3/s, significantly lower than NIWA's MALF calculation. Council is already forcing shut offs in low flow times – irrigation season in summer particularly. So water management is already an issue for this catchment.

Te Arai catchment is already modified as the Gisborne city water supply is taken from the upper reaches – city supply virtually drains the headwaters and any other water in the river's lower reaches comes from tributaries lower down the catchment and groundwater and precipitation. The NIWA calculation is based on the modified river environment and does not include the water that is diverted to town supply. If MALF is calculated including the town supply, Council would never be able to meet those limits.

- **Te Arai – Ecological Flows (part of $20k)**

Interim results from the RHYABSIM work is that a minimum flow to sustain a "high" amount of habitat for ecological values is predicted at around 0.10 m^3/s for the upper reaches of the river (above the water works) and 0.15m^3/s for the lower reaches (Reay's bridge). These numbers are clearly about 10 times greater than the current management regime. This again highlights the types of issues that will need to be considered and consulted over when formalising water management tools for this catchment.

- **Groundwater Information ($5k)**

There are five different aquifers on Poverty Bay Flats ("PBF"): two shallow ones (Te Hapara Sands shallow fluvial deposits); Waipaoa gravel; Makauri gravel; and Matokitoki gravel.

Makauri aquifer is not too deep (50-80m) so it's not expensive to tap and pump water from and it has a good pressure head. More than half of the annual yield is from the Makauri aquifer. Use of Makauri groundwater has changed over the past 10 years. In 1997, Makauri yielded 17,000 m^3/s. In 2007, Makauri yielded 31,000 m^3/s. In 2009/10, Makauri yielded 22,600 m^3/s.

The Makauri aquifer is about 14,000 years old. Tectonic uplift has cut off the lower aquifers from the coast (these are called blind aquifers) so water pops up to the surface so it can get out. The Makauri is a confined aquifer, i.e. it is overlain by a confining layer. The oldest water in the Makauri aquifer is about 100 years old, compared with the water in the deeper Matokitoki aquifer, which is about 3000 years old. Generally, quality of water gets worse in the deeper parts of the aquifer where groundwater has had much longer flow paths and residence times hence making it unsuitable for human consumption.

- **Water Planning Framework ($20k)**

NIWA have had an internal review of the report and have added some material. For example, the need to consider reliability of supply in the weighing process between instream and out-of-stream uses has been factored in more explicitly. Clarification has been made of the purpose of the River Environment Classification system and how it could be used in a planning framework as it is primarily based on the physical characteristics of rivers rather than their values, sensitivity or risk. In the final section of the report, NIWA have included a conceptual matrix for the levels of protection of rivers as an example of the type of tool that can be used to weigh values and hence make decisions on river policy.

- **Reports**

Three reports on the above topics have now been finalised with GDC:

732-GSDC58 - MAG
Rouse, H.L.; Norton, N. 2010. Towards a framework for regional freshwater planning for the Gisborne District Council. NIWA Client Report: CHC2009-184, Prepared for Gisborne District Council, May 2010.

745-GSDC59 and 746-GSDC60 - 2 SAGs
Norton, N.; Flanagan, M.; Walter, K.; McGrath, W. 2010. Review of flow records and estimates for the mean annual seven day low flow (MALF) for the Waipaoa and Te Arai Rivers. NIWA Client Report: CHC2010-014, Prepared for Gisborne District Council, April 2010.

835-GSDC74 – SAG
Meriano, M.; Schmidt, J.; Rouse, H.L. 2010. Review of groundwater information for the Poverty Bay Aquifers. NIWA Client Report: CHC2010-022, Prepared for Gisborne District Council, April 2010.

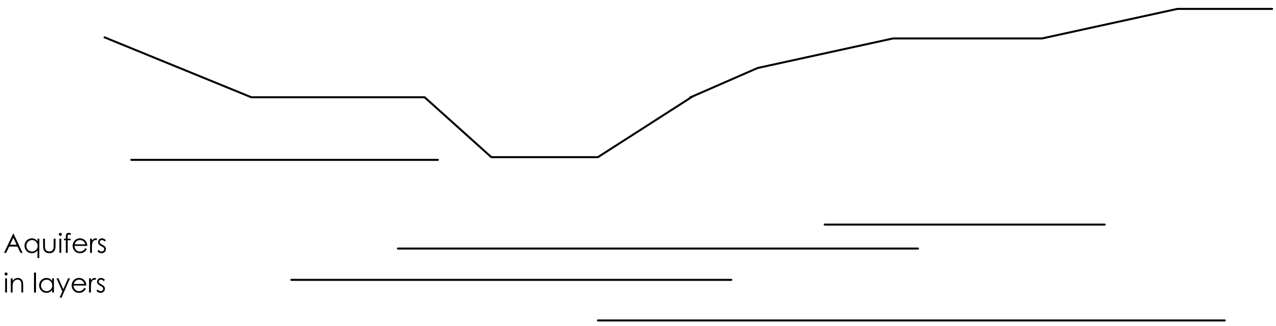
2. Background to groundwater science

The key question is "where is the Makauri Aquifer recharged from?"

Aquifers are recharged in three ways: indirectly from leakage from overlying aquifers or stream bed leakage; and directly from precipitation. Most Makauri recharge comes from stream bed leakage according to previous studies. Annual average recharge rates could be anywhere between 4.7 – 12.7 million litres/year (150 – 4700 litres/second). So there is a high degree of uncertainty about volumes. Some unquantified water sources are contributing to groundwater in PBF.

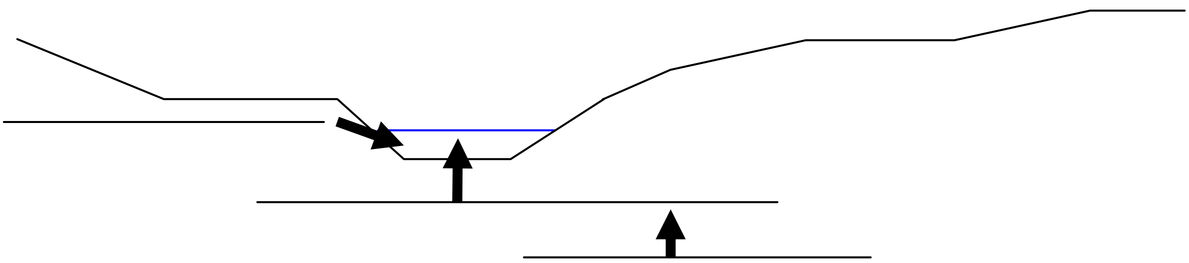
There is a high degree of uncertainty around how much streambed leakage, precipitation and inter-aquifer fluxes contribute to total aquifer recharge. We need to know how much water is in the catchment and we need to understand the dynamics of the system better so we can develop appropriate management responses.

Aquifer structure and dynamics



Groundwater travels along sub-surface pathways, which are more complex than surface water pathways (or rivers). In basic terms, aquifers get their water directly from precipitation, indirectly from inter-aquifer fluxes and from localised pockets of streambed leakage. Water leaves the aquifers either through groundwater discharge to surface waters or through allocation for human uses. Understanding this balance of recharge (water in) and discharge and allocation (water out) is the first step in a simple water balance understanding of the system.

When aquifers are recharged, some of this water travels close to the land surface and discharges into streambeds (i.e., at the bottom of the Makauri Aquifer). The water in the aquifer can move both vertically and horizontally and between different aquifers. The aquifers in the PBF are hydraulically connected so groundwater can move from one aquifer to the next in response to changes in groundwater levels.



Anecdotal evidence and some monitoring suggest that the PBF aquifers may be in quasi steady state, i.e. that water coming into the system is equal to water coming out of the system. Currently we don't know much about how much water is getting into the system (recharge) via which pathways. However, if the assumption that the aquifer system is in a steady state is correct, then we can reasonably accurately measure the system 'outs', and assume that these are equal to the system 'ins'. In other words, measuring the 'outs' would give us a reasonable estimate of the recharge rates.

We need to assess the ground water resources both seasonally and over long periods of time to track both (allocation) use and recharge.

Sustainable allocation

The NIWA review (Meriano et al. 2010) has identified that based on our current understanding, allocation of water from the Makauri aquifer lies somewhere in the range between 30 – 200% of the average annual recharge for the aquifer. We need to narrow down that range to see whether this level of allocation is sustainable, and potentially to enable better management responses. It may be possible to allocate a large amount of a groundwater resource for a short period of time, but this is unlikely to be sustainable as the aquifer would need time to recover. The order of magnitude of the allocation (as a % of average annual recharge) indicates that, according to the proposed NES for ecological flows and water levels, Gisborne's groundwater resources need to be understood using relatively detailed methods.

These calculations have been done using paper allocation of water, i.e. how much people are allowed to take, not necessarily how much they actually do take. This is a good rule of thumb as we have, in essence, granted them permission to use the full amount. There may be some work we need to do around ensuring we only issue permits for amount of water actually needed – this would be essential should we get into greater competition for water resources.

There are lots of ambiguities in past research that further research will assist in clarifying.

3. Options for Identifying Groundwater Recharge Rates

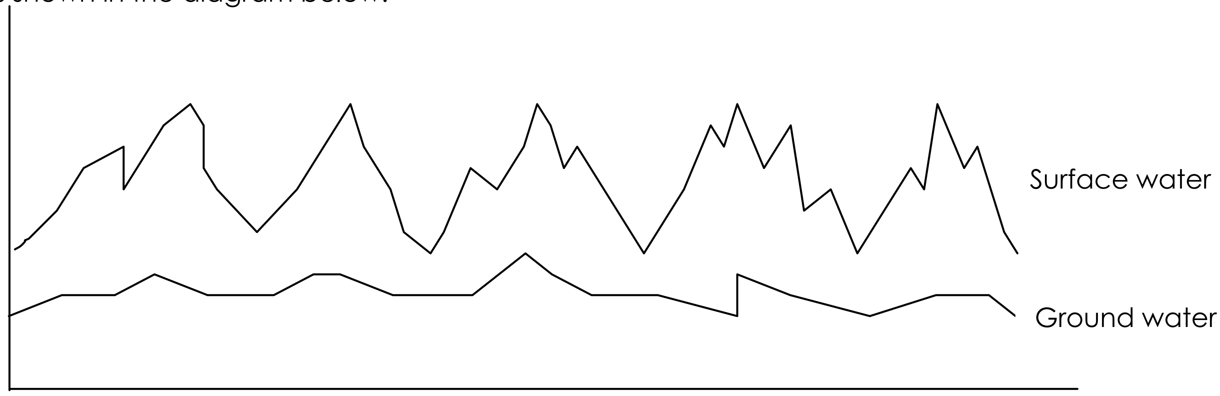
NIWA proposed a four-stage plan of action that would gradually build up a greater understanding of our PBF groundwater resources.

1. Annual average recharge calculations using a hydrograph separation technique
2. Longitudinal survey
3. Three dimensional conceptual model
4. Numerical model

<u>Annual average recharge rates</u>

NIWA identified a simple first step in order to refine our estimate of average annual recharge. The first step is to complete a hydrograph separation analysis using stream hydrographs and groundwater levels to quantify the groundwater discharge from the system, i.e. to calculate part of the 'out' values from the aquifer. GDC records of water use for water permits (which are all metered) can easily be pulled together with these values. Then we have a sum for the average annual 'outs' for the PBF aquifers. If our assumption that the system is in a quasi steady state is correct, then that sum will also equal what is coming into the system and provide a ballpark of total recharge rate.

Based on historical data, we would need to look at a couple of examples that show base flow – i.e. groundwater seepage into stream – for example the water we see flowing in the stream when there has been no rain for some time. This approach looks at the whole system of aquifers (not just the Makauri) and will show how much water is discharged from the groundwater system compared with surface water and will enable us to separate the groundwater component of the streamflow as shown in the diagram below.

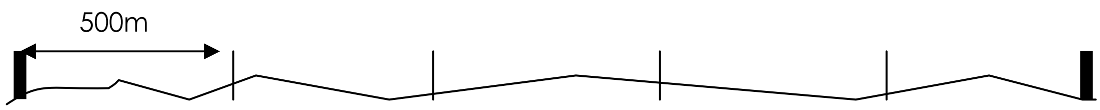


GDC needs to look at flow level records at Kanakanaia and Matawhero and pick groundwater bores at these locations that best represent the seasonal fluctuations in the groundwater levels. The approach can be used to model historical trends in the groundwater discharge rates - or in other words an estimate of catchment integrated groundwater recharge. Then we can quantify groundwater recharge into the system and, using meter readings, we know what is coming out. Need to do this for summer and winter due to fluctuations in water use between the seasons.

This is a desktop exercise using existing archived data, so there would be no need for collection of new data. There may be some issues around finding the data, but it is all available within GDC's own systems. It would also require us to identify two stream flow gauges (ideally one stream flow gauge needs to be near the bottom of the catchment) that have a monitoring well nearby. There are only Kanakanaia, Kaiteratahi and Matawhero at present and we would need to choose the two that have a monitoring well nearby.

<u>Longitudinal Survey</u>

This step would be an extension of Barber's work and would build on the first step above. A series of gauging would be carried out at defined intervals along the river, as simultaneously as possible. The difference between the gaugings would then enable us to spot leakages out of (or gains into) the system between gauging points. The survey involves identifying a line between two measuring points and, every 500 metres or so, measuring the actual stream flows.



It involves breaking up the river into segments and gauging as often as practical to identify gains and losses.

Two surveys would be required: during high water season (winter); and low water season (summer and irrigation season). Selecting transects and measuring spots would be a judgement call so someone with some expertise would need to do a reconnaissance (e.g. Paul). The closer the sites are to each other the better. Using a stream pro gauge could speed the surveying up a lot and there is a possibility of hiring one for the week long work. There is a possibility we could change the current HTL contract to measure low flows and adjust what we are measuring and from where without incurring additional costs.

The surveying would generate new data and GDC staff would be able to calculate leakages from surface to groundwater or gains from groundwater to surface water. This helps with understanding the dynamics of surface and groundwater interactions, and will help develop an estimate of localised recharge from river leakage.

<u>Three Dimensional Conceptual Model</u>

Developing a 3D conceptual model would use all of our current information to identify the location and size of the PBF aquifers. We would define where the aquifers are and their breadth as well as their depth (the top and bottom of each one). The GDC groundwater database could then be sub-divided by aquifer and their corresponding water level data, to enable better groundwater data management. This would then lead to initial steps that need to be taken in the development of a conceptual model. They include: contouring of water levels (potentiometric surfaces) and groundwater flow directions, mapping of the tops and bottoms of the aquifers and creating isopach maps (i.e., thickness maps) of the aquifers. In short, we would have a rough estimate of the volume of water in the aquifers. The building of the conceptual model is a necessary step towards developing a numerical model.

We have some relevant data already including information on our database from well records (bore logs) and paper records, which have more detailed information.

This step could be completed by a tertiary student with some understanding of hydrodynamics but would require specialist expertise to guide. Council would look at options including offering the project to Masters/PhD students or reconfiguring water resources work to free up some of Paul's time.

Numerical Model

The Rolls Royce version is to develop a transient numerical model to quantify ground water recharge. This would be the ideal as it would take account of current rainfall etc. and an in-depth knowledge of the aquifer dynamics and provide up-to-the-minute information about aquifer levels. This would need specialist skills to build and would be very complex work. The level of allocation of Gisborne's groundwater resources would suggest this would be the ideal end point for understanding the groundwater systems, but the previous steps are prerequisites and extremely useful steps along a pathway.

Other points

It is possible to ask other users to assist with costs of developing the information as it would be in their interests to have certainty e.g. Leaderbrand and some of the big farms.

We could use students and interns for some of the earlier work in stages 1 and 2. We have a German intern coming this year and Yvette will find out her skills and background.

Other ways to fund the work include: a targeted rate on those with water permits to fund ongoing water research; and/or using section 36 of the Resource Management Act to impose monitoring charges on users.

NIWA notes from GDC visit 6 and 7 May 2010

Thursday 6 May

NIWA staff – Mandy Meriano, Ned Norton, Helen Rouse. GDC – Keriana Wilcox, Paul Murphy, Greg Hall

NIWA staff arrived in Gisborne at 9:30 and were picked up by KW. At GDC offices, over initial cup of tea NIWA staff talked to KW and PM about: groundwater (gw) data, analysis and staff capacity.

Data

- Most data in Hilltop already
- Consented takes (n = 150) are metered – mostly paper records of returns
- 90 monitoring wells (51 council, 39 private)
- Approx 1400 borelogs, in database and with paper copies
- Monitoring is outsourced to old council team now working as private company

Analysis of groundwater data

- Nothing really done since Gordon work

Capacity of staff to 'do' gw data analysis

- 3 water resources staff (PM, DC, Jenna, plus Trevor as conservator))
- Planners – KW, Yvette
- Plus GH – data man!
- No-one with specialist gw background
- Paul keen to be involved in gw analysis but time limited

Discussion moved up to KW's office and we were joined by GH

- GH brought selection of old maps and reports rescued from old depot
- MM led groundwater 101 on whiteboard – covered some key concepts including:
    - Basic findings of gw review report, from Barber & Gordon work – how Poverty Bay Flats (PBF) aquifer system works
    - Terminology:
    - DIRECT recharge – from rainfall
    - INDIRECT recharge – interaquifer fluxes, leakage from surface water (rivers)
    - recharge (water IN) and allocation (water OUT) – a water balance
- There was a brief discussion about other gw resources (other than PBF) eg Tolaga Bay, and potential for gw use to increase in these areas in the future and if that needed to be considered in developing tools to manage Gisborne's gw resources
- Talked briefly about current gw data collection and the desirability to collect other data – eg could redeploy 3 GDC level recorders to key locations.

Thursday pm – field visit of key PBF and Waipoua river locations

- Camerons rd, Ferry rd, Caesar rd – bore visits, as potential sites to deploy the 3 level recorders
- Kaiteratahi
- Kanakanaia bridge – Waipoua monitoring site
- Return over SH2 bridge.