Memorandum

To	Brydon Hughes (Land & Water People); Time Baker (Jacobs) Hugh Robertson (DOC)	**Date**	17 May 2019
From	Jon Williamson & Jake Scherberg (Williamson Water & Land Advisory)	**Project No**	WWA0026
Subject	**Radon Sampling Results in Kaimaumau Wetland and Implication for Groundwater / Surface Water Interaction**		

1. Introduction

Following the Council Hearing and the Environment Court Appeal on the Council's Decision to grant consents to 17 applicants collectively referred to as the Motutangi-Waiharara Water Users Group (MWWUG), work was initiated to satisfy requirements of the draft Groundwater Monitoring and Contingency Plan (GMCP). In particular, the GMCP requires analysis of a single round of radon samples in and around the Kaimaumau Wetland, amongst a range of other longer-term monitoring.

This memorandum summarises the results of this early radon sampling work, and is intended to provide an update on the understanding of the hydrological and hydrogeological setting of the Kaimaumau wetland. Of particular interest is the connection between water in the wetland and regional groundwater, and thereby any potential effects on wetland conditions that may arise from the proposed groundwater extraction. Several analysis methods have been applied to characterise wetland hydrology, specifically:

- Analysis of hydrological setting.
- Wetland water levels relative to groundwater levels.
- Analysis of dissolved radon concentrations.

2. Hydrological Setting of Kaimaumau Wetland

By way of recap for the technical experts, the Kaimaumau Wetland extends 11 km from Rangaunu Harbour at its southern extent to Motutangi towards its northwest margin, with the Pacific Ocean to the east (**Figure 1**). The wetland is intersected by the Bacica Drain to the north and drained by the Salles and Waikaramu Drains toward the southwest, and the Pirini Drain to the southeast.

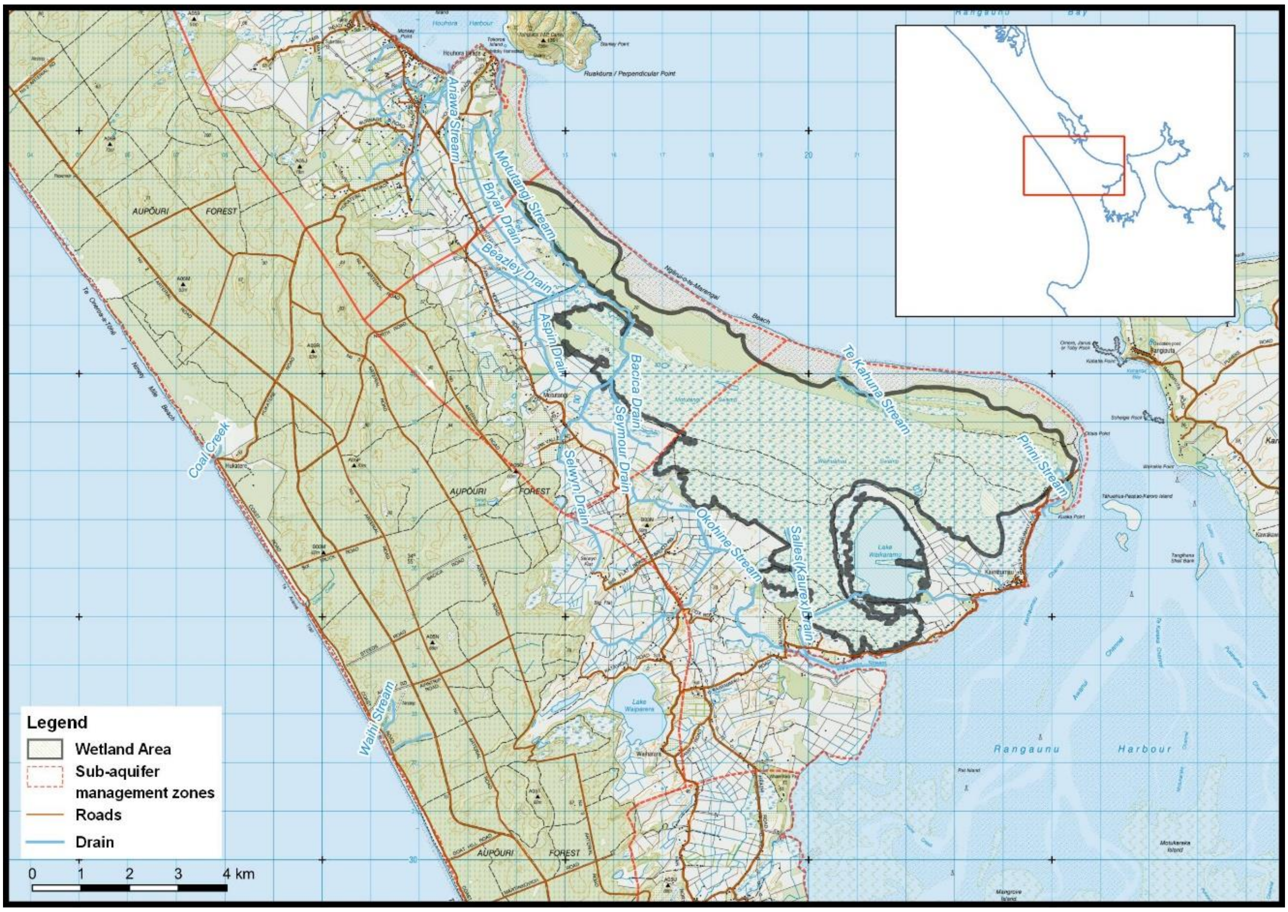

Figure 1. Location of Kaimaumau Wetland

The wetland has minimal gradient at the surface, with ground elevation ranging from 6 to 12 mAMSL. The lowest portion of the wetland according the LINZ data is located between the centre of the wetland and the Bacica drain to the north (**Figure 2**). However, it is evident from information provided by Tim Baker that a surface water discharge from the wetlands to the Motutangi Drain near its confluence with the Bacica Drain, and therefore the northern part of the wetland is confirmed as the lowest point in the wetland, as marked on **Figure 2**.

Groundwater level surveys performed in September 2018 show that water levels in the southern portion of the wetland are perched above the shallow groundwater table.

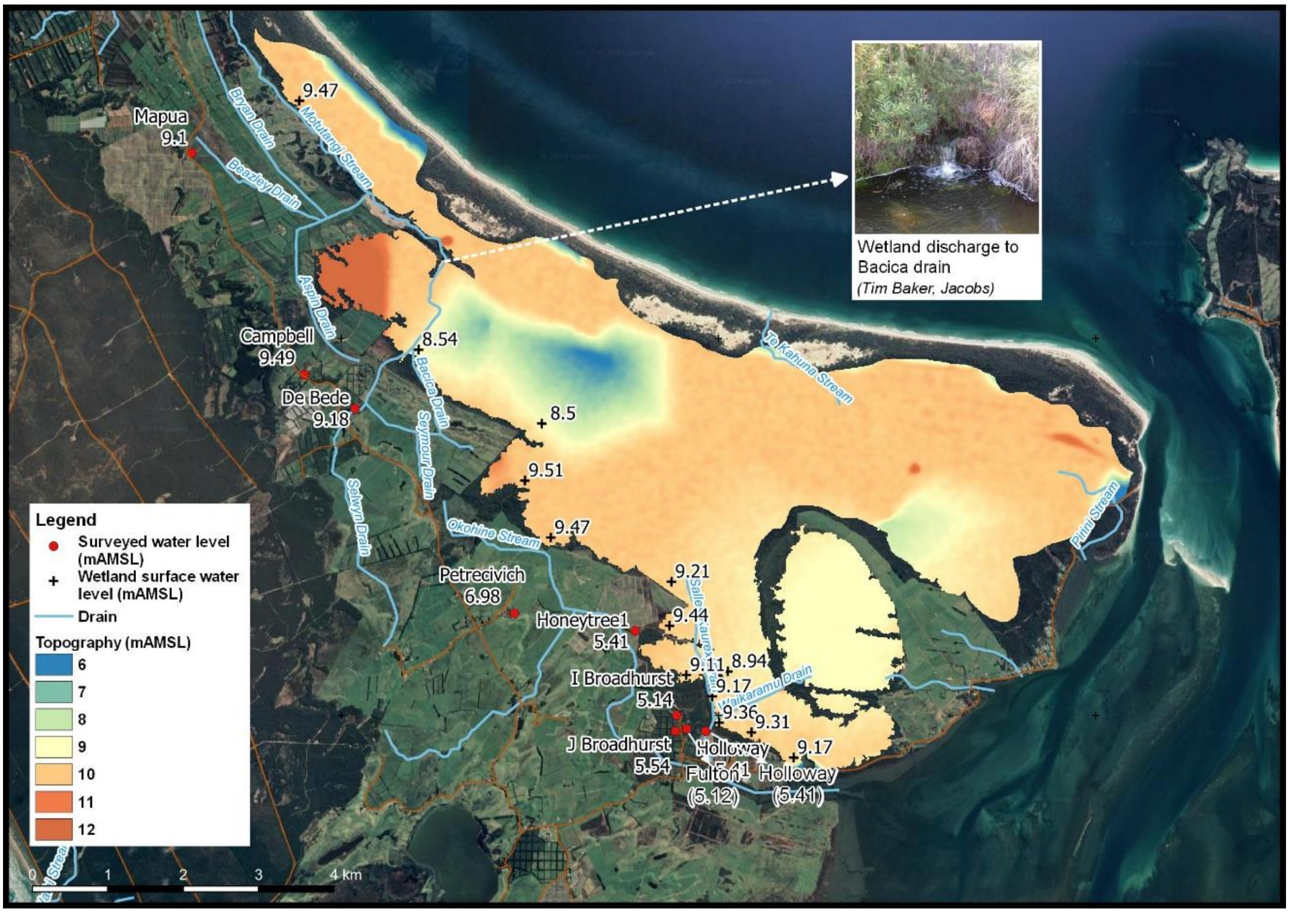

Figure 2. September 2018 groundwater level survey results compared to inferred wetland water levels.

3. March 2019 Radon Sampling

As required under the GMCP, investigations were initiated into wetland water levels and radon sampling in March 2019 in the later stages of a significant drought. Radon isotope analysis was undertaken to determine the significance of groundwater input into the Kaimaumau Wetland. The presence of dissolved radon is indicative of groundwater influx, while a lack of radon indicates that the water source is exclusively rainfall.

The March 2019 sampling was the second time radon had been measured in the wetland, with the first samples collected in February 2017. The sampling locations and results are shown in **Figure 3**.

Figure 3. Surface water and groundwater radon sampling locations. Radon concentrations are shown in BqL^{-1}.

Figure 3 shows that from both sampling rounds, all water samples collected outside of the wetland had radon concentrations above the concentration considered to be indicative of some degree of groundwater contribution (0.5 BqL^{-1}), whereas samples collected from drains discharging from the wetland were below this threshold. The sample collected directly from within the wetland and approximately 200 m from the drain (Site 2) in March 2019, was found to have no detectable radon, indicating it is purely rainfall derived.

Low to moderate radon concentrations, approximately 1 BqL^{-1}, were found in the Seymour, Selwyn, and Bacica Drains upstream of the wetland. The groundwater inputs in these cases are likely to be a result of shallow aquifer groundwater due to the deep cut drain channels in the case of the Seymour Drain, and seepage from the western sand dunes in the case of the Selwyn Drain.

In the Bacica drain, which begins at the confluence of the Seymour and Selwyn drains, the radon concentration collected from the upstream location (Site 1) in March 2019 measured 0.9 BqL^{-1}. At the downstream location (Site 3) the concentration in a sample collected on the same day had reduced to 0.4 BqL^{-1}. The Site 3 sample location is a short distance downstream from the location where the wetland has been observed to discharge into the drain (**Figure 3**). It is likely that there are other discharges from the wetland into the drain that have not been documented.

There are two possible explanations for the reduction in radon concentration as the drain passes through the wetland:

1) Natural degassing with travel time; or

2) Diluted by inputs from the rainfall derived water from the wetland effectively reducing the radon concentration in the drain.

The Pirini stream, which drains the eastern edge of the wetland, was sampled at its outflow from the wetland area and was found to have a 0.1 BqL^{-1} radon concentration indicating no interaction with groundwater at this location.

Water samples from Salles drain, flowing southward out of the wetland, measured 0.1 BqL^{-1} at the upstream location in the wetland. At the downstream location, outside of the wetland area, the radon concentration in the Salles Drain increased to 2.6 BqL^{-1} indicating a groundwater input that is likely due to the deeply incised drain channel intersecting shallow groundwater. A groundwater sample from the deep aquifer in the Stanisich bore was found to have a radon concentration of 6.3 BqL^{-1}.

In total, the results of radon sampling show that radon is present in the groundwater, however it is not detected in the wetland itself, as illustrated by the Site 2 water sample. Several drains interact with groundwater in reaches outside of the wetland, however as they flow through the wetland area they are diluted by wetland drainage water that are of low radon concentration. By contrast, the Salles Drain has a low radon concentration at its headwaters within the wetland, increasing in concentration outside of the wetland where it interacts with shallow groundwater.

4. Summary and Conclusions

The second round of radon sampling was undertaken at the end of a three month drought in mid-March 2019. Results indicate that:

- water from the wetland massif is radon free indicating rainfall derived;
- water in the drain entering the wetland has low to moderate radon concentrations (<0.9 BqL) indicating some groundwater inputs presumably from seepage from the sand dunes and shallow aquifer that intersects the drain further to the west;
- radon concentration exiting the wetland has lower radon concentration (at 0.4 BqL) compared to the incoming water, reflecting dilution from water discharging from the wetland.

In summary, the baseflow in the drain on the inlet to the wetland has some groundwater input (which you would expect i.e. seepage from the sand hills and shallow groundwater on the plains), but as the drain moves through the wetland, the drain water is diluted by discharges from the wetland, which have no groundwater inputs.

We look forward to discussing your thoughts on this.

Yours sincerely,

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