



Memorandum

To	Eros Foshieri
Copy	Lizzie Fox
From	Courtenay Bremner and Andy Mourits
Office	Wellington
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Subject	Mangawhai Hydrology and Soil Analysis

Kaipara District Council requested an investigation into the feasibility of discharging excess treated water from a nearby wastewater plant via irrigation to the Mangawhai Golf Course and surrounding bush. This required a high-level hydrology and soil analysis to determine the impacts of this proposed activity. The following memo provides a summary of the key findings from the analysis. It is recommended this summary should be read in conjunction with the respective Hydrology and Soil reports, which provides detailed commentary on the analysis conducted.

High level soil analysis summary

A site visit over two days was carried out to determine the soils across the Mangawhai Golf Course. This information was then fed into a water balance model to assess the potential volume of water that could be discharged, via irrigation, to the golf course.

- Two soil types were identified during the site visits; Red Hill Sand and Red Hill Sandy Loam. They are grouped into four groups based on their texture, as is common practice (Table 1).
- There is a difference in the soil texture between the upper and lower terrace. The upper terrace (Red Hill Sand) texture is largely consisting of varying sand, whereas the lower terrace (Red Hill Sandy Loam) has differing ratios of silt, clay and sand. The soil textures are mixed across the soil horizons.
- An iron pan is in the middle of the golf course. This has formed because of high iron content of the parent sand material. The chemically modified soils form a relatively impermeable pan. However, this is limited to the central area of the golf course (Figure 1).
- Areas where grass covers have been maintained have resulted in thicker topsoils. These have higher infiltration rates, suggesting a greater irrigation rate could be applied here.
- Soil areas where the topsoil has been exposed for long periods of time are showing signs of hydrophobicity. This is where the sand particles repel water due to non-polar waxy compounds coating the sand particles. This may cause increased runoff, and therefore these areas should be managed closely if irrigating.
- The golf course is a highly modified environment, therefore the observed variances in soil types may be a result of previous earthworks to establish the golf course.
- The texture and depth of the soils, along with the contour across the grass area of the golf course, suggest that irrigation would be suitable.

Table 1: Soil groupings across the Mangawhai Golf Course

Red Hill Sandy Loam



Red Hill Sand



Red Hill Sandy Loam (higher clay content)



Red Hill Sandy Loam (higher Silt content)



High-level hydrology analysis summary

- A high-level water balance was completed to provide an indication of the volume of water, and when it could be applied, to the golf course seasonally. Key inputs in the water balance were obtained and derived. These included deriving the storage capacity (PRAW) of the soil using information gathered during the site visit; carrying out rainfall analysis from available hydrometric data for rainfall depths; and obtaining and analysing potential evapotranspiration (PE) data.
- Using the PRAW data, the land area was categorized into zones of commonality for the water balance model (Figure 1).

- Low PRAW soils have only a limited capacity to store moisture. This would increase the frequency of wastewater irrigation; although it does not influence the total depth of wastewater that could be applied over the different time periods.
- Figure 1 shows an approximate location of the pan at varying depths from 800mm and shallower; however, it's exact location and extent are unclear. In areas where the pan is present, the rate and/or volume of irrigation may be reduced due to its impermeable nature.
- To provide a detailed 'water balance model' PRAW values of 46 mm, 62 mm, and 80 mm were determined for use in the water balance.
 - Based on the detailed scenarios, the golf course could be irrigated from December through to March.
 - Using the deficit calculated in the water balance, a daily rate of irrigation and monthly irrigation volume can be determined; based on the area of the different zones and the total area of the golf course (i.e. 45ha) (Table 2).

Table 2: *The daily deficit and monthly and total irrigation volume for individual zones and the total area of the golf course during potential irrigation months. Refer to Figure 1 for the 'zones' identified which may be suitable for wastewater irrigation.*

PRAW (mm)	Area (ha)	Daily Deficit (mm/day)				Monthly irrigation volume (m ³)				Total Volume (Dec - Mar; m ³)
		Dec	Jan	Feb	Mar	Dec	Jan	Feb	Mar	
46	12	2	3	2	1	6,986	11,011	6,630	4,618	29,244
62	12	1	3	2	1	5,267	11,390	6,859	4,777	28,292
80	6	1	3	2	1	1,597	5,940	3,577	2,491	13,605
46	45	2	3	2	1	26,550	41,850	25,200	17,550	111,150
62	45	1	3	2	1	19,350	41,850	25,200	17,550	103,950
80	45	1	3	2	1	11,250	41,850	25,200	17,550	95,850

- The following assumptions and limitations should be considered regarding the water balance model;
 - Monthly rainfall and PE can vary significantly from the median and consequently there may be considerable residual risk if this water balance is strictly applied. The water balance does not explicitly account for the specific amount and timing of rainfall throughout the month.
 - There is inherent uncertainty in deriving irrigation rates and volumes, based solely on the approximate area of the different zones. Therefore, a conservative approach to development and construction of any irrigation system is recommended.
 - Attention should be given to the areas of the golf course with higher water storage capacity and therefore lower irrigation requirements (e.g. the area to the south of the course with a PRAW of 80mm).
 - Care should be taken to only irrigate with sufficient time pre and post rainfall events to allow an appropriate reduction in storage capacity to prevent runoff.

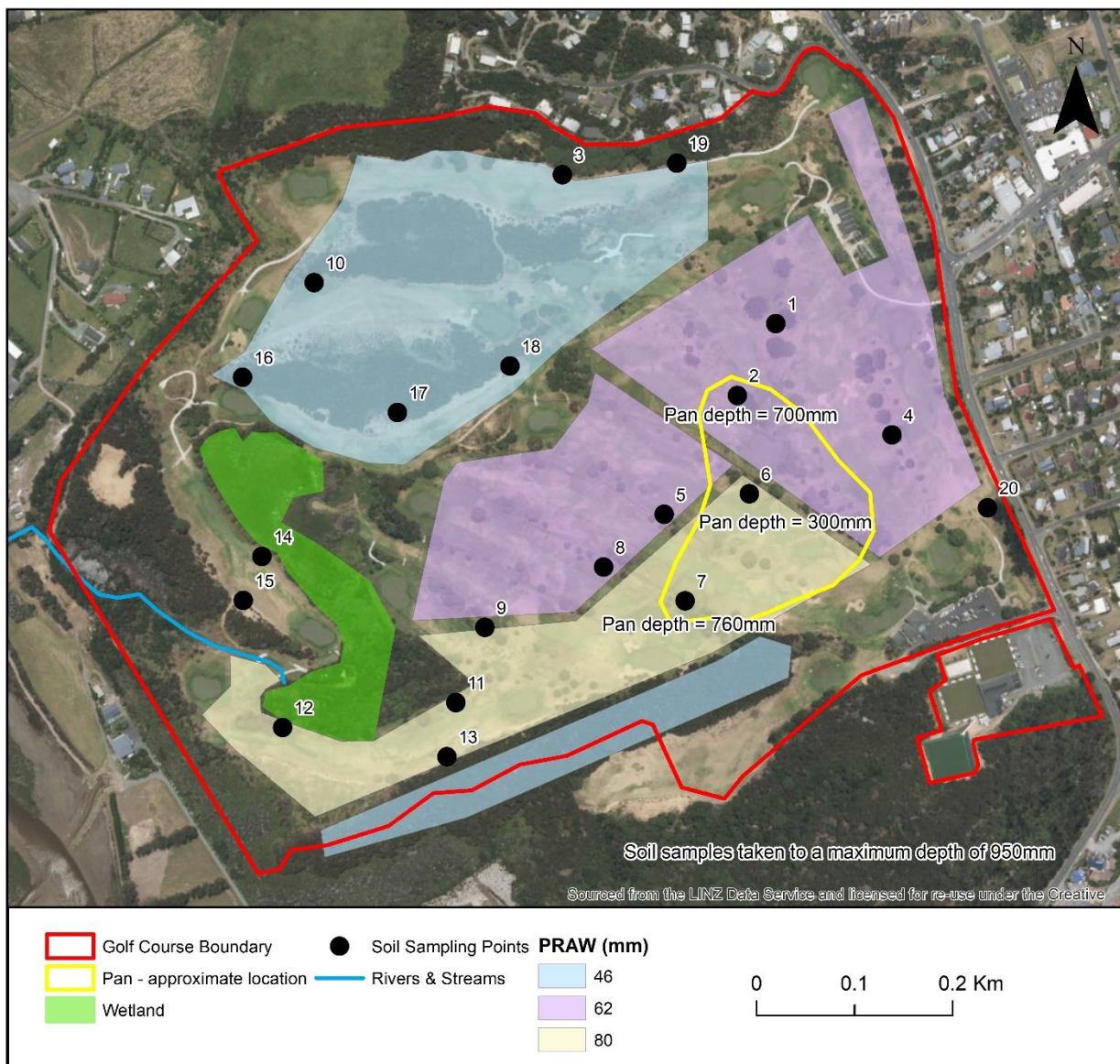


Figure 1: Areas of the golf course differentiated by water storage capacity based on soil characteristics.

Key conclusion

- The combined soils, hydrology and irrigation analysis has confirmed that excess treated wastewater could be irrigated on the Mangawhai Golf Course and surrounding bush, in a way that the risk of runoff is limited;
 - The success of this activity lies in how and when the irrigation system is operated.
 - The analysis suggests deficit irrigation would only be suitable from December through to March, with an approximate total discharge of approximately 100,000m³ per irrigation season, though this is dependent upon the area to be irrigated. No deficit irrigation is possible from April to November.
 - Ultimately, the decision to irrigate, given the above analysis, lies solely with the client based on their needs and desired outcomes.