BEFORE THE HEARING COMMITTEE

IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of an application by Grenadier Limited to the Manawatū-Whanganui Regional Council for application **APP-2020203164.01** for the suite of resource consents associated with the construction and development of a proposed eighteen hole links golf course and ancillary activities on land 765 Muhunoa West Road, Ōhau

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REPORT TO THE COMMISSIONERS

MRS CHRISTINE FOSTER (CHAIR), DR FLEUR MASEYK AND MR REGINALD PROFFIT

SECTION 42A REPORT OF TOM GARDEN – CONSULTATANT HYDROGEOLOGIST ON BEHALF OF HORIZONS REGIONAL COUNCIL

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6 April 2022

A. INTRODUCTION

Qualification and Experience

1. My name is Tom Garden.

2. I am currently employed by Pattle Delamore Partners Ltd in the role of Hydrogeologist in the Groundwater team. I have held this role since January 2021. Prior to this I was an Engineering Geologist at Bell Geoconsulting Ltd. I have a Bachelor of Science majoring in Geology from the University of Auckland and a PhD in Geology from the University of Canterbury.

3. In my current role as a hydrogeologist I am involved in technical assessments of environmental effects relating to groundwater abstraction and use, and numerical groundwater modelling. I am regularly involved in technical assessments for consent applications.

4. I have reviewed the application by Grenadier Developments Ltd (Applicant), in particular the assessment of environmental effects provided by Land Matters Ltd on behalf of the Applicant dated July 2021, the Douglas Links Well Aquifer Pump Test Report and AEE provided by Bay Geological Services dated June 2021 and included as part of the application, s92 response dated the 7th September 2021, and the associated letter from Bay Geological Services dated 7th September 2021. I am familiar with the area, having been involved in consent review and source protection zone work in the area. I have also recently been involved in numerical groundwater modelling in the Horowhenua area.

5. I confirm that I have read and agree to comply with the Code of Conduct for Expert Witnesses contained in the Environment Court Practice Note 2014. My evidence has been prepared in compliance with those codes. In particular, unless I state otherwise, the evidence is within my sphere of expertise and I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

B. SCOPE OF REPORT

6. This report covers the groundwater components of the application made by Grenadier Developments Ltd to construct and develop a proposed eighteen hole links golf course and ancillary activities on land 765 Muhunoa West Road, Ōhau. This evidence specifically covers the impact of the proposed groundwater abstraction from a newly drilled bore ('Bore ID 361080') for irrigation of golf greens and fairways, as well as for related landscaping and beautification. The AEE accompanying the application indicates that bore 361080 could also be used for domestic supply if a proposed dedicated domestic supply bore cannot supply water of adequate quality. A second bore on Lot 1 DP 51446 will be used for domestic supply for the clubhouse if required. My understanding is that this bore has not been drilled but has been consented. The volume required for domestic supply from this bore will be less than $50m^3$/day (i.e. permitted) and has not been considered further in this report.

7. In particular I will address:

   a) A review of the pump test conducted and the estimated aquifer parameters;

   b) Reasonable and efficient use of water;

   c) Effects on the overall groundwater resource;

   d) Effects on surface water bodies;

   e) Effects from saline intrusion;

   f) Effects on neighbouring bores; and

   g) Conclusions.

C. DESCRIPTION OF THE ACTIVITY

8. The application is for construction and development of a proposed eighteen hole links golf course and ancillary activities on land 765 Muhunoa West Road, Ōhau.

9. As part of the proposed development, the Applicant proposes to abstract groundwater from a newly drilled (bore ID 361080) near the coast at Muhunoa West Road, Ōhau, in Horowhenua District. The new bore is approximately 250 m north of the Ōhau River and 900 m inland from the coast. The new bore is in the Horowhenua Groundwater Management Zone (HGMZ).

10. Based on information provided by the Applicant, the bore was drilled to a depth of 104.60 m below ground level (bgl) and screened from 96.61 to 102.91 m bgl. The static water level in the bore at the time of drilling was recorded as 11.22 m bgl.

11. The Applicant has applied to take water from the new bore at a maximum rate of 16.07 L/s, a maximum daily volume of 1,388 m^3/day and a maximum annual volume of 208,268 m^3/year.

12. The Applicant has stated that water is required for the irrigation of up to 51.68 ha of land, comprising 18 greens, 36 tees and a practice tee. The Applicant also states that water may be required for landscaping and beautification of the property, while the AEE accompanying the application indicates that the new bore could also be used for domestic supply if a proposed dedicated domestic supply bore cannot supply water of adequate quality.

D. REVIEW OF PUMP TESTS AND AQUIFER PARAMETERS

13. The Applicant has provided details of both a step-drawdown test and a constant rate test. The step-drawdown test involved pumping the Applicant's bore over six 59 minute steps up to a maximum rate of 16.07 L/s, with 16.29 m of drawdown in the pumped bore during the last step. Recovery of the water level after pumping was recorded for 60 minutes after the final step. Drawdown data from the pumped bore during the step-drawdown test was analysed using the Eden-Hazel (1973) method for confined aquifers, which resulted in a transmissivity estimate of 134.3 m^2/day. The recovery data from the pumped bore was also analysed, resulting in an estimated transmissivity of 107.6 m^2/day. I note that the results of the step drawdown test indicate that the pumped bore is capable of supplying the required yield for the groundwater take application.

14. The constant rate test involved pumping the Applicant's bore at an average rate of 16.07 L/s for 4 days (5,760 minutes), with recovery monitored for a subsequent 3 days (4320 minutes). Around 18.86 m of drawdown occurred in the pumped bore by the end of the test. Four additional bores were monitored during the constant rate test, including one shallow bore that was purpose-drilled on the site for water level observation. The observation bores were:

    a) Applicant's monitoring bore: 2.6 m deep, 201 m from pumped bore;

    b) Bryant monitoring bore: 36.7 m deep, 730 m from pumped bore;

    c) Tahamata monitoring bore (bore no. 361051), 45.8 m deep, 1.3 km from pumped bore; and

d) Tahamata irrigation monitoring bore (bore no. 361063), 35.11 m deep, 1.9 km from pumped bore.

15. The Applicant states that no observable response occurred in any of the monitoring bores as a result of pumping the Applicant's new bore. However, it is noted that three of the monitoring bores (the Byrant monitoring bore and the two Tahamata monitoring bores) were pumped during the course of the test, there was significant rainfall during the test, and tidal effects occurred in the water level records for these bores during the test. These factors may have masked any drawdown effect from pumping of the Applicant's bore. Not all of these factors appear to have been corrected for during the analysis of the pumping test data.

16. The Applicant has estimated the transmissivity of the aquifer using both the drawdown data and recovery data from the pumped bore, and has used a variety of solutions. The resulting transmissivity estimates vary from 25.11 m^2/day (using Neuman-Witherspoon, 1969 solution) to 126.90 m^2/day (using the Theis, 1935 solution for confined aquifers and drawdown data). The Applicant assumed a transmissivity of 105 m^2/day for the purposes of well interference assessment, which is considered appropriate. No value of storativity can be obtained from the test; a value of 0.0001 was assumed for well interference assessment, which appears reasonable.

17. No value of leakage could be obtained from the test due to the lack of observable response in monitoring bores. However, the recovery data from the pumped bores appears to show signs of leakage effects (i.e., the recovery curve does not intersect the origin). As discussed by the Applicant, some leakage is likely to have occurred during the test, but the Applicant does not appear to have considered the implications of this effect.

18. I have reviewed the pumping test data to determine a maximum potential leakage effect based on the following parameters: Transmissivity of 125 m^2/day, storage of 1×10^{-4} and specific yield of 0.1.

19. The maximum value of leakage is determined based on the absence of drawdown interference effects in the overlying strata after 4 days pumping at a rate of 16.07 L/s. This indicates that the maximum value of leakage is in the order of 0.05 day^{-1}, although the actual value may be less than this.

E. RECEIVING ENVIRONMENT

20. The hydrogeological setting of the Horowhenua area generally consists of a plain extending from the foothills of the Tararua Range to the ocean. The plain consists of young alluvial, beach and dune deposits, with the sandy beach and dune deposits being dominant at shallow depths close to the coast.

21. Groundwater in the area is recharged via both rainfall and seepage loss from rivers in the east of the area as they emerge from the Tararua Range, such as the Ōhau River. Groundwater flows westwards towards the coast and in the east of the area, close to the foot of the Tararua Ranges, the vertical hydraulic gradient is downwards, while at the coast in the vicinity of the proposal there is an upwards hydraulic gradient.

22. Radon data indicates that significant groundwater discharge occurs into the lower reaches of the Ōhau River, particularly just upstream from where the river intercepts and flows across the Quaternary sands (Morgenstern et al., 2019). It is inferred that these sands are significantly less permeable than the alluvial gravel deposits.

23. The new bore location is close to the coast and approximately 250 m north of the Ōhau River. There is a lagoon and associated saltmarsh near where the Ōhau River enters the ocean.

F. EFFECTS OF THE ACTIVITY

24. There are a range of potential effects of the proposed groundwater abstraction, which have been assessed by the Applicant. These are reviewed below.

Reasonable and Efficient Use of Water

25. The maximum annual volume of 208,268 m^3/year is based on estimation of irrigation demand conducted using the Soil Plant Atmosphere System Model (SPASMO) conducted by Lattey Group in 2020, for a 107 ha area, then reduced proportionally to account for the 51.68 ha proposed irrigation area.

26. As an independent check, the annual irrigation demand has been estimated using Irricalc (http://mycatchment.info/). Manaaki Whenua S-Maps do not cover the Applicant's property, therefore the default "Most likely PAW [profile-available water] in this area" was used, with an area of 51.68 ha and an 80% efficient irrigator as the irrigation method.

27. The Irricalc results estimated a daily volume of 2,739 m^3 and an annual volume of 260,467 m^3. Therefore, the proposed maximum annual volume of 208,268 m^3 is considered reasonable. The maximum daily volume is proportional to the SPASMO estimate of 4,140 m^3/day for 107 ha of irrigation, and is considered reasonable.

Effects on the Overall Groundwater Resource

28. The Applicant's bore is located within the Horowhenua Groundwater Management Zone (HGMZ), which has a groundwater allocation limit of 27,000,000 m^3/year and is 12.8% allocated, according to information provided by the Applicant. The requested annual volume fits within the available allocation for the HGMZ.

29. There are five Horizons monitoring bores within 5 km of the Applicant's bore with water level records for the previous ten years. These bores are:

    a) 361003, which is 10 m deep and approximately 1.3 km from the Applicant's bore.

    b) 361041, which is 36.7 m deep and approximately 1.3 km from the Applicant's bore.

    c) 362003, which is 11.1 m deep and approximately 4.0 km from the Applicant's bore.

    d) 362035, which is 12.81 m deep and approximately 4.3 km from the Applicant's bore.

    e) 362331, which is 18.6 m deep and approximately 4.9 km from the Applicant's bore.

30. All of these bores listed above show generally stable water levels in the previous ten years. As such, effects on the overall groundwater resource are expected to be less than minor.

Effects on Surface Water Bodies

31. The Applicant's bore is located approximately 250 m north of the Ōhau River, which has an associated saltmarsh and lagoon near its outlet to the ocean. The submission by Te Iwi o Ngāti Tukorehe Trust notes the cultural and ecological significance of the saltmarsh and lagoon.

32. The Applicant has conducted a quantitative stream depletion assessment, and considers the stream depletion effect low. There are some concerns with not all of the parameters used being fully explained or justified by the Applicant, for example the streambed conductance parameter is not known with any certainty and cannot be estimated from pump test data, and there is considerable uncertainty in what is the appropriate leakage value for the assessment. However, despite this uncertainty, the borelog indicates that there are several layers of clay and silty sand

in the strata above the screened interval, and this information combined with the significant depth of the bore (104.6 m) suggests that a direct hydraulic connection with surface waterways is unlikely.

33. As a result, any effects on surface waterways are expected to be slow and widely distributed and fall into the 'low' stream depletion category in Table 16-1 of the One Plan. Stream depletion effects are therefore considered to be less than minor.

34. My initial technical review raised the possibility that proposed abstraction could reduce groundwater discharge to the Ōhau River and its associated saltmarsh and lagoon. The Applicant has provided further information regarding studies in the area, and we generally agree with the conceptual model provided by the Applicant.

35. However, it does appear from the pumping test data provided that the aquifer is leaky and we therefore consider it likely that discharge to surface water bodies would be reduced in the long term.

36. The Applicant provided information regarding the sensitivity of the saltmarsh and lagoon to changes in freshwater input (due to groundwater discharge) and/or salinity[1]. In general we agree with the Applicant's assessment of the scale of effects in terms of effects of groundwater pumping on surface water bodies, though there is still uncertainty around some of the parameters used for the stream depletion assessment, as noted in paragraph 32 above.

37. A full assessment of the scale of the effect on surface water bodies depends on an assessment of the ecological sensitivity of the lagoon to changes in groundwater discharge, which is outside of my area of expertise. This aspect of the application has been addressed in the s42A report of Connor Whiteley (BECA).

Effects from Saline Intrusion

38. The Applicant's bore is approximately 900 m inland of the coast, and as such there is potential for pumping of the bore to cause the position of the saltwater-freshwater interface to move, with resulting saline intrusion.

39. The static water level of the bore at the time of drilling (presumed to be measured in February 2021 based on information provided by the Applicant) was recorded as being at an elevation of 14.76 m amsl. Using the Ghyben-Herzberg ratio, this corresponds to an estimated freshwater –

[1] S92 Response email to F. Morton, 4 October 2021

saltwater interface depth of 590 m bgl. It is noted that the static water level may not have been at its seasonally lowest point at the time of drilling in February 2021, however it is likely to be near the seasonally lowest level, and the nearby monitoring bore data (see section 2.2 above) indicates that seasonal fluctuations are generally less than 1.0 m in this area (although greater fluctuations could occur at depth).

40. Drawdown due to pumping of a bore has the potential to cause upconing of the freshwater – saltwater interface and saline intrusion. We have made a conservative upconing assessment using the Schmorak and Mercado (1969) and Dagan and Bear (1968) equations, with an assumed pre-pumping distance from 400 m and a hydraulic conductivity 1 m/day. With a pumping rate of 16.07 L/s this results in a rise in interface elevation of 22.1 m, which given the estimated depth of the interface is considered a less than minor effect.

41. Overall, the effects from saline intrusion are considered likely to be less than minor, however due to the proximity to the coast it is still recommended that conductivity monitoring be required in the conditions of consent. These consent conditions include trigger levels for electrical conductivity at which abstraction rates are required to reduce. There are some standard thresholds that can be used, but the Applicant may wish to obtain a water quality sample from the bore to show background levels at their site, which can then be used to determine trigger levels appropriate to their bore.

Effects on Neighbouring Bores

42. Based on information provided by HRC, there are 120 bores within 5 km of the site, the deepest of which is 77.8 m deep. Therefore, all neighbouring bores within 5 km are shallower than the Applicant's bore. The closest bores to the Applicant's bores are:

a) 361051, which is 45.8 m deep and approximately 1.2 km from the Applicant's bore.

b) 361003, which is 10 m deep and approximately 1.3 km from the Applicant's bore.

c) 361041, which is 36.7 m deep and approximately 1.3 km from the Applicant's bore.

d) 361060, which is 25 m deep and approximately 1.3 km from the Applicant's bore.

43. I conducted an assessment of the potential drawdown effects on neighbouring bores using a transmissivity of 105 m^2/day, an assumed storativity of 0.0001 a leakage value of 0.05 day^{-1}, and a pumping rate of 16.07 L/s for 150 days. These aquifer parameters are based on my

interpretation of the constant-rate pumping test undertaken by the Applicant. Based on this assessment, the potential drawdown effect in shallower bores is likely to be in the order of 0.1 m after 150 days (on bore 361051, 1.2 km away, 45.8 m deep). This effect is likely to be less than minor and effects on more distant bores are expected to be less.

44. Overall effects on neighbouring bores are expected to be less than minor.

G. SUBMISSIONS

45. I have read the submissions that have been made on the applications. Many of the submissions cover topics that fall outside of my area of expertise and will be covered in the technical reports of other experts. For those submissions that do overlap with my area of expertise, I have considered and incorporated any salient points in my evidence above.

H. PROPOSED CONSENT CONDITIONS

46. The standard conditions relating to monitoring for saline intrusion should included in the groundwater consent, should the Hearing Committee be of a mind to grant consent. I have reviewed the conditions proposed by Ms Morton. I am satisfied that these conditions address the matters I have discussed in my report.

I. CONCLUSIONS

47. The volumes applied for are considered reasonable and efficient, based on the SPASMO estimates presented.

48. Effects on the overall resource are expected to be less than minor.

49. Stream depletion effects on surface waterways are expected to be less than minor.

50. Effects from saline intrusion are expected to be less than minor, however conductivity monitoring is recommended.

51. Effects on neighbouring bores are expected to be less than minor.

52. Overall, the effects on groundwater are expected to be less than minor.

DATED this 6th day of April 2022

Dr. Tom Garden

CONSULTING HYDROGEOLOGIST

J. REFERENCES

- Bay Geological Services. 2021a. Douglas Links Well Aquifer Pump Test Report and AEE, 765 Muhunoa West Road, Ohau. Report for Grenadier Developments Limited, dated June 2021.
- Bay Geological Services. 2021b. Douglas Links Application for Groundwater Resources 765 Muhunoa West Road, Ohau. Letter to Grenadier Limited dated 7 September 2021.
- Land Matters. 2021. Application and Assessment of Environmental Effects. Douglas Links Golf Course. Report dated July 2021, for Grenadier Limited.
- Morgenstern U, van der Raaij R, Baisden T, Stewart M, Martindale H, Matthews A, Collins S. 2019. Ohau and Waikawa catchments of the Horowhenua Groundwater Management Zone — Groundwater dynamics, source, and hydrochemical processes as inferred from the groundwater tracer data. Lower Hutt (NZ): GNS Science. 54 p. + supplementary spreadsheet (GNS Science report; 2018/06). doi:10.21420/G2434W.