Before Independent Hearings Commissioners
appointed by the Northland Regional Council

under:	the Resource Management Act 1991
in the matter of:	an application by Meridian Energy Limited for resource consents for earthworks, associated stormwater diversion and discharges and vegetation clearance for the construction of a solar farm at Ruakākā, Northland (APP.045356.01.01)
between:	**Meridian Energy Limited** *Applicant*
and:	**Northland Regional Council** *Consent Authority*

Statement of Evidence of Mandy McDavitt (hydrogeology)

Dated: 22 July 2024

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STATEMENT OF EVIDENCE OF MANDY MCDAVITT

INTRODUCTION

1 My full name is Mandy Trina McDavitt.

2 I am a Principal / Technical Director in Hydrogeology at Beca Limited (*Beca*).

3 I hold a Bachelor of Science and a Post Graduate Diploma in Environmental Science.

4 I have over 19 years' post graduate experience in hydrogeological investigations and analysis. I have contributed to a range of projects across New Zealand that have required the analysis of site specific groundwater conditions, installation of monitoring to determine impacts on wetlands and assessment of effects, including effects on wetlands.

5 Beca Limited (*Beca*) were engaged by Meridian Energy Limited (*MEL*) on the Ruakākā solar farm project (*Proposal*) to prepare consent design including Civil, Geotechnical, Flood Modelling and Environmental (Contaminated Land), Traffic Effects, Structural and Electrical. The Proposal is described in **Mr Hood's** evidence.

6 My initial involvement in the Proposal was after the consent appication was submitted, when I was requested to provide high level advice as to whether the climatic and hydrogeologic conditions in the Ruakākā area, during site visits undertaken by both Boffa Miskell Limited (*Boffa Miskell*) and Northland Regional Council (*NRC*), were representative of 'normal' conditions.

7 This advice was to assist with evaluating if the wetland extents mapped by Boffa Miskell on Site 1 could be considered indicative of the typical wetland extent. This was in response to a section 92 request MEL received from NRC.

8 I was subsequently asked to look at additional available information for Site 1 and Site 3 to provide advice on hydrogeological conditions on each site and what key hydrogeological factors are required for a successful wetland development. This is in relation to the proposed wetland recreation (offset) on both sites, which is outlined in **Dr Flynn's** evidence.

9 I undertook a site visit on 19 June 2024 to Sites 1 and 3 with Boffa Miskell.

CODE OF CONDUCT

10 Whilst this is a Council hearing, I acknowledge that I have read and agree to comply with the Environment Court's Code of Conduct for Expert Witnesses, contained in the Environment Court Practice Note

2023. My qualifications as an expert are set out above. Other than where I state that I am relying on the advice of another person, I confirm that the issues addressed in this statement of evidence are within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

SCOPE OF EVIDENCE

11 My evidence will address:

11.1 Methodology and limitations;

11.2 Likely hydrogeological conditions at Site 1 and 3 based on review of the available data collected by others;

11.3 Climatic and hydrogeologic conditions in the Ruakākā area during dates of the wetland assessments completed by both Boffa Miskell and Rural Design 1984 Limited (RDL) on behalf of NRC;

11.4 Key hydrogeological factors for successful wetland restoration; and

11.5 Response to NRC Internal Technical Advice on Groundwater Levels attached as Appendix C to the section 42A report.

SUMMARY OF EVIDENCE

Groundwater levels during wetland assessment dates

12 There was no site-specific groundwater monitoring to make a direct comparison of groundwater levels on Site 1 during the wetland delineation assessment dates. Long-term monitoring data from the Ruakākā racecourse can however be used instead to provide likely groundwater conditions in the general area.

13 Of the five periods of wetland delineation assessment:

13.1 It appears that NRC's internal hydrogeologist is in agreement that for assessments completed in September 2022 and March 2023, groundwater levels in the Ruakākā bores were likely elevated (90^{th}%ile of the groundwater record) above 'normal' levels.

13.2 The groundwater levels in the Ruakākā bores during May and June 2022 and again in September and October 2023 are above the 60^{th}%ile and for the latter close to the 90^{th}%ile for the entire record. NRC defines groundwater levels as above 'normal' for these periods.

13.3 Due to the high rainfall and groundwater levels leading up to September/October 2023 it is likely groundwater levels at

Site 1 would have remained high due to the condition of the Bercich Drain.

14 I therefore do not agree with NRC's internal hydrogeologist's statement that most of Boffa Miskell's assessments occurred during classically 'dry' periods.

Hydrogeology of Site 1

15 Existing and recent groundwater levels are likely to have been significantly modified by the previously installed drainage system, Whangarei District Council's (*WDC*) treated wastewater discharge and blocked drains (historic and current).

16 Further changes in groundwater levels are likely as a result of the ongoing wastewater discharge and suggested drainage modifications to be completed by WDC.

17 Groundwater naturally breaks out in a few low-lying areas, and wetlands in these areas are likely partially or wholly supported by groundwater. Other wetland areas across the site are likely to have a surface water component supporting them.

18 Recent groundwater monitoring by Beca shows groundwater levels on the southeastern boundary of Site 1 range from 3.2 to 3.4 m above sea level (*asl*) and 3.4 to 3.7 masl on Site 1a. This is consistent with the Stantec modelling during average conditions. No tidal influence was noticeable during the eight days of monitoring.

19 I consider the development of a new groundwater supported wetland in the southeastern boundary of Site 1 to be feasible from a hydrogeological perspective, as there is already a wetland in existence at that location that appears partially or wholly supported by groundwater. The proposed wetland lateral extent would however need to be sufficiently deep to encounter seasonal low groundwater levels. I note the proposed collector drain will need to be relocated to avoid draining the proposed wetland.

20 The wastewater discharge to the south-east will likely influence water levels in that area; as will the introduction of further drainage as part of the wastewater discharge (which may reduce groundwater levels). This will need to be taken into consideration in detailed design.

Hydrogeology of Site 3

21 The drainage channels on site and the presence of the tidal Ruakākā River to the south, will likely influence groundwater levels.

22 Limited groundwater monitoring in two piezometers recently installed on site show groundwater levels close to the surface (within 0.1 to 0.5 m) or 1.5 masl to 1.9 masl.

23 The monitoring shows a tidal influence on groundwater.

24 I consider the site would be suitable for construction of a groundwater supported wetland, if the wetland invert level is at or below the seasonal groundwater low and levels have taken into account tidal range and existing drainage invert levels.

METHODOLOGY AND LIMITATIONS

25 My methodology for providing advice as to whether the climatic and hydrogeologic conditions in the Ruakākā area, during the dates of Boffa Miskell's and NRC's wetland delineation assessments were representative of 'normal' conditions or otherwise, comprised a review of:

25.1 The local geological conditions from a summary report prepared by Beca *"Preliminary Geotechnical Assessment Report - Ruakākā Energy Park Solar Farm. Report prepared for Meridian Energy Ltd by Beca Limited, dated 31 May 2023".*

25.2 As there was no site-specific groundwater monitoring undertaken at the time of the wetland assessments, I sourced groundwater level data from long-term monitoring bores located at the Ruakākā Racecourse, known as the Ruakākā Racecourse bore and standby bore. Groundwater levels in these monitoring bores have been monitored since 2003 for the Racecourse bore and since 2009 for the standby bore. The bores are some 40 m and 10 m deep respectively and located some 3-4 km south of the site. The bores target the same geology that underlies Site 1 and are a similar distance from the coast, and hence are considered a suitable proxy for shallow groundwaters at the sites.

25.3 There is little difference between groundwater levels in the deeper Ruakākā Racecourse bore and the standby bore. This indicates that they are both screened in the same unconfined aquifer. As the water level record extends back further for the deeper Ruakākā Racecourse bore, I used this in my assessment.

25.4 Rainfall data sourced from NRC Rainfall Station Whangārei Harbour at Marsden Point Oil Refinery and Waiwarawara at Wilsons Dam. The rainfall stations are the closest to the site and located some 2.2 km and 6.5 km away respectively. Rainfall data from Marsden Point Oil Refinery only extended back to November 2015, and therefore I used NRC's rainfall station Waiwarawara at Wilsons Damas records started in December 2007. My assessment looked at rainfall leading up to each assessment and the water level in the Ruakākā Bores (largely the Ruakākā Racecourse bore), and compared these periods to the full monitoring record, to identify if climatic and groundwater levels were outside of 'average' conditions or above normal (i.e. above the average groundwater level for that particular month).

26 I also checked the NRC hydrology climate reports to confirm if the Marsden- Ruakākā Aquifer's status was above 'normal'. The NRC website[1] advises that 'above normal' is greater than 60 %ile, 'below normal' is the 25th to 40th %ile. Given I was asked to access if climatic conditions where above 'normal', I used this as the grounds of my assessment. The methodology I undertook to understand the hydrogeological conditions at Sites 1 and 3, comprised a review of:

26.1 Geotechnical and hydrogeological information limited to one off groundwater observations during test pit investigations for Site 1 prepared by Hawthorn and Geddes Engineering and Architects Ltd (*HGE&A*) *"Engineering Suitability Report Rev 1" dated 5 December 2019, prepared for Refining New Zealand.*

26.2 Geotechnical and hydrogeological information limited to one off groundwater level measurements during borehole drilling for Site 3 prepared by Tonkin and Taylor *"Pre-Purchase Assessment – Ruakākā Energy Park, Batten Site", dated May 2022.*

26.3 Geotechnical information and a hydrogeological summary for Site 3 prepared by Tonkin and Taylor *"Pre-Purchase Assessment for Ruakākā Energy Park, Batten Site Further Geotechnical Considerations", dated 1 August 2022.*

26.4 A groundwater modelling report prepared by Stantec *"Rama Road Disposal Field – Ruakākā, predicting the maximum treated wastewater discharges to land, Stage 2 – Groundwater Modelling", dated 6 July 2022.* This report is not specific to the project, but provides an assessment of current and future hydrogeological conditions adjacent to Site 1 and the impact of increasing the treated wastewater discharge rate on Site 1.

26.5 Geotechnical and hydrogeological information from the New Zealand Geotechnical Database and Beca's internal report database.

26.6 Hydrogeological information associated with Site 1 prepared by Voss Infrastructure Consulting - letter titled *"Investigation of potential disposal capacity onto Rio Tinto Block", dated 14 January 2009.* The Rio Tinto Block is Site 1.

26.7 Landonline information for Site 1.

26.8 Groundwater level data and peat thickness information from site walkover data collected by Boffa Miskell on 28 March 2024, 19 June 2024, 21 June 2024 and 4 July 2024.

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[1] https://www.nrc.govt.nz/environment/environmental-data/hydrology-climate-report/2023/

26.9 Site photographs of the Bercich Drain taken on 3 November 2021 supplied by Boffa Miskell.

26.10 Memo on Rama Road groundwater model from Jim Bradley, MWH Rama Road Team, dated 4 January 2010.

26.11 Monitoring bore logs and monitoring bore as built data for R202 and RT03 from Mr Simon Charles of Whangārei District Council on 5 July 2024.

26.12 Observed conditions during my site walkover on 19 June 2024.

26.13 Recent groundwater level monitoring from piezometers and level loggers recently installed at Sites 1 and 3.

27 The information provided me an understanding of the likely groundwater conditions at the sites. My advice herein is largely based on the work listed above and completed by others, and on my judgement and experience.

LIKELY GROUNDWATER CONDITIONS ON SITE 1

Site geological profile

28 The site predominately consists of undulating sand dunes of the Kariotahi Group running in a southwest to northeast direction, approximately parallel to the current coastline.

29 The sand dune crests peak between 5 masl[2] to 7 masl with terrain elevation changes along the length of the sand dunes of up to 2 m. The troughs located between the sand dunes are at approximately 3 masl to 4 masl based on lidar data with a stated vertical accuracy of ±0.2 m (Beca 2023).

30 56 test pits were excavated across Site 1 in November 2019 by HGE&A. The investigations encountered:

30.1 Typically, non-fibrous organic peat (topsoil) in every test pit from ground surface to 0.05 m to 0.4 m depth.

30.2 Underlying the peat deposits in 17 of the test pits was 0.1-0.4 m of peaty sand.

30.3 Underlying these deposits and topsoil in the remaining test pits was fine to coarse, dry to wet sand that was loose to poorly consolidated.

[2] masl – metres above sea level

31 The dune deposits are expected to extend to some 40 m below ground level (*bgl*) before its contact with the underlying greywacke rock (Stantec 2022).

Site specific groundwater data

32 Groundwater observations were recorded by HGE&A during test pit investigations in November 2019. The following observations can be made:

32.1 Groundwater was encountered between 0.4 m to below 1.5 m bgl (at the completed depth of each test pit).

32.2 Groundwater was encountered close to the surface at one location to the SE boundary of Site 1C (**Figure 1**).

32.3 The depth to groundwater appears to be determined by where the soil is logged as saturated.

32.4 It is uncertain if test pits remained open to allow for additional groundwater measurements once groundwater levels had stabilised i.e. levels are indicative only and may not reflect longer term conditions.

32.5 It should be noted that these investigations were completed less than two-months prior to a drought being declared for the region.

33 Shallow groundwater in the area and on Site 1 is unconfined and the hydraulic gradient is gentle (Stantec 2022).

34 Due to the site’s topography, rainfall recharge would likely pond in depressions on top of the surficial peat deposits before slowly infiltrating through the peat to the groundwater table.

Surface water drainage

35 There is an open drain (referred to as the “Bercich Drain”) that extends through the centre of the site, from the NE property boundary adjoining Roma Road to the SW boundary of the site (**Figure 1**).

36 Water in the Bercich Drain flows northeast towards Rama Road, before eventually discharging to the sea (**Figure 2**).

37 The Bercich Drain is some 2 m deep and 1.5 m wide at its base (Land Information New Zealand).

38 The site is also partially dewatered by a network of drains that discharge directly to the Bercich Drain (**Figure 1**).

39 I expect that the Bercich Drain and feeder drains will control groundwater levels on Site 1.

40 Prior to January 2024, the Bercich Drain was densely filled with vegetation in places, likely reducing its capacity to remove water efficiently from the site (**Photo 1 & 2, Figure 3**). The photos provided in **Figure 3** show the Bercich Drain was likely heavily vegetated in places since at least November 2021.

41 MEL has advised that the drainage easement along Alis Bloy Place is not currently open or fully operational, as a section of this drain was filled in to make Allis Bloy Place wider. The farmer that leases the land on Site 1C states that water levels on Site 1C have steadily risen as a result. It is uncertain when the drain was infilled but is believed to have occurred approximately 5 years ago.

Discharge of treated wastewater to adjacent site and implications for groundwater levels on Site 1

42 WDC hold consent to discharge treated wastewater to land on the adjacent site southwest of Site 1 (yellow area in **Figure 2**). I understand that in regard to the rate of discharge:

42.1 WDC are consented to discharge at rates of 1,700 m^3/day during summer and 1,030 m^3/day in the winter.

42.2 WDC started discharging treated wastewater at their disposal site in mid-2013 (Stantec 2022).

42.3 Volumes discharged have progressively increased over time from 200 m^3/day (starting rate in 2013) to 800 m^3/day (October 2021). Further increases to the maximum consented discharge rate are likely.

43 Groundwater monitoring of the discharge site was undertaken by WDC. The key findings relevant to Site 1 are:

43.1 There were up to 7 monitoring bores (MB33-37 & RD2, RD3). Locations are provided in **Figure 4**.

43.2 Groundwater level monitoring was undertaken over the period 2013 to late 2022.

43.3 Groundwater levels range from 2.5 mbgl -7.5 mbgl or 1.2 to 4.1 masl.

43.4 Groundwater level fluctuations are seen over the increased treated wastewater application rate from 300 to 800 m^3/day (Stantec 2022).

43.5 Groundwater levels rose between 0.5-1.0 m during rainfall events in 2020 and 2022 (Stantec 2022). Although the magnitude in change maybe insignificant at higher elevations, it can be significant in low lying areas in terms of groundwater daylighting.

44 There is modelling undertaken by others to support consenting for the wastewater discharge site:

44.1 '*Rama Road Groundwater Models'*, Voss, January 2009.

44.2 '*Investigation of potential disposal capacity onto Rio Tinto Block (Site 1)* – Voss 2009-2012.

44.3 '*Rama Road Disposal Field – Ruakākā, predicting the maximum treated wastewater discharges to land, Stage 2 – Groundwater Modelling',* Stantec July 2022.

45 I was not involved in this modelling work, and I have not undertaken a comprehensive peer review, however I have considered the key findings of that work as they relate to groundwater conditions at Site 1.

46 With regards to the modelling, the key findings relevant to Site 1 are:

Voss modelling (2009-2012)

47 Voss 2009 infers a modest groundwater divide exists about mid-way between the dune sands (where WDC discharges wastewater to land adjacent to Site 1 (yellow area on **Figure 2**)) and the Bercich Drain, but groundwater flow is predominately towards the coast.

48 Voss 2009 identified two existing areas on site where groundwater daylights at the surface (blue circled areas on **Figure 2**). These areas of 'holding' water predate the wastewater discharge to land on Rama Road.

49 Modelling by Voss 2012 suggests groundwater mounding will occur as a result of treated wastewater being discharged at the consented rates, and may result in additional groundwater daylighting on Site 1, particularly in natural depressions.

50 Voss recommended the installation of a collector drain that connects to the Bercich Drain to mitigate groundwater mounding and daylighting.

51 No drain has been installed to date and it is therefore possible that groundwater levels on Site 1 are slightly elevated as a result of the wastewater discharge.

52 Should the drain be installed, it may lower groundwater levels, which in turn may have an impact on any wetlands that are partially or wholly dependent on groundwater.

Stantec modelling

53 As part of Stantec's groundwater modelling and reporting, they presented the likely groundwater table under average recharge

conditions and “unseasonable recharge” conditions. Their model includes the majority of Site 1 (Figure 5) and concludes:

53.1 Under average conditions groundwater levels on Site 1 range from 2.5 m to 3.5 masl.

53.2 Under unseasonably high recharge, a rise of 0.5 m can be observed. It should be noted that this assumes the Bercich drain is fully operational (i.e. freely draining). If the drain is not fully operational, then I assume that the rise in groundwater level could be higher than 0.5 m.

Site visit and investigations

54 I undertook a site visit on 19 June 2024 and made the following observations:

54.1 Surface water ponding was observed across the site. In most areas water was sitting on the surficial peat deposits, with dry sand underlying the peat until the groundwater table was reached at depth (**Figure 6**).

54.2 Groundwater was likely contributing to the wetland located at the SE area of the site due to being low lying.

54.3 Water in the Bercich Drain appeared stagnant, that is, it may not be freely draining.

54.4 Around 1 m of water was sitting in the 2 m deep Bercich Drain at the time of the site visit, this likely represents the groundwater table at that location on that date. **Figure 6** shows water siting on the peat above the drain water level.

55 Boffa Miskell recently undertook targeted investigations to determine groundwater levels, surface water and wetland extents, in the wetland area extents of contention (**Figure 7**). The following findings are of relevance:

55.1 The investigation dates were 28 March 2024, 19 June 2024, 21 June 2024, and 4 July 2024. The time of the investigation was considered by **Ms Cook** to be ‘normal’ climatic conditions, although heavy rainfall occurred in the week prior to 19 June 2024.

55.2 Investigations comprised of shovel dug holes in selected areas, to depths of some 0.8 mbgl.

55.3 Groundwater levels recorded ranged from 0.25 to 0.75 mbgl. At some locations, the holes were dry to the full depth of the hole.

55.4 The investigations identified three locations (shown in blue) where groundwater was at the surface or measured within the peat (**Figure 7**). This may indicate that wetlands are partially or wholly supported by groundwater at these locations, which correlate well in one location with the Voss site survey (**Figure 2**).

56 Beca installed three piezometers with level loggers on Site 1 between 8-10 July 2024 (**Figure 8a**). Only eight days of monitoring was completed before writing this evidence, but the data collected to date shows (**Figure 9**):

56.1 Groundwater levels range from 3.2 to 3.4 masl (S1P1 and S1P2), and 3.4 to 3.7 masl (S1P3). This is equivalent to a depth range of 0.3 m mbgl to 3.1 mbgl across the site.

56.2 There was minimal groundwater variation (0.02-0.03 m) in response to rainfall events of up to 70 mm in S1P1 and S1P2 (located SE corner of Site 1), however a greater response (0.1-0.3 m) is seen in S1P3 (located on Site 1A). This is expected as rainfall would sit on the peat before slowly percolating down to the water table.

56.3 There is no obvious tidal response in groundwater levels monitored in the piezometers.

Summary of Site 1 hydrogeology

57 The following conclusions can be made on the hydrogeology of Site 1:

57.1 The water level in the Bercich Drain is likely to be an indicator of adjacent groundwater levels. There is however no stage gauging to monitor water levels in the drain.

57.2 Piezometers recently installed on site show groundwater levels around 3.2 to 3.4 masl around the SE boundary of Site 1C and 3.4 to 3.7 masl on Site 1A. This is broadly similar to the groundwater levels modelled by Stantec as "average" conditions (2.5 -3.5 masl).

57.3 Groundwater, under average seasonal conditions may daylight in localised areas where the ground surface is at low elevations. In these areas wetlands may be partially or wholly supported by groundwater.

57.4 In higher areas on site, groundwater likely sits below the surface within the sand deposits. In these areas, any wetlands are more likely to be supported by surface water.

57.5 Following significant rainfall events groundwater levels are expected to rise and may daylight in additional areas on site, however the purpose of the Bercich Drain (when fully operational) is to return levels back to "normal' relatively quickly.

57.6 Due to the Bercich Drain being heavily vegetated from at least 2021 to January 2024, its capacity to drain water from the site would have reduced. Together with the drain being blocked along Allis Bloy Place, this has likely led to locally elevated groundwater levels for longer durations after rainfall events.

57.7 The wastewater discharge to the south-east is also expected to influence groundwater levels on Site 1, especially in low-lying areas where groundwater is known to daylight.

57.8 A fully functioning and freely draining Bercich Drain is important in managing mounding from the wastewater discharge and the risk of increased groundwater levels on Site 1.

57.9 If new collector drain(s) are installed by WDC, it could result in further lowering of the groundwater level on Site 1 and could potentially lead to the reduction of low-lying existing wetlands on site that are reliant on groundwater.

57.10 Since the introduction of the Bercich Drain, groundwater levels would have been significantly modified.

57.11 It is expected that prior to the Bercich Drain being installed, groundwater levels were likely higher on site, leading to larger extents of groundwater possibly supporting wetland features.

LIKELY GEOLOGICAL AND HYDROGEOLOGICAL CONDITIONS ON SITE 3

58 Site 3 is located across four parcels of land which are bounded by McCathie Road to the south and Marsden Point Road to the east. The site predominately comprises of paddocks in pasture and sparse trees.

59 The paddocks are partitioned by drainage channels, which convey surface water from the east of the site to a main drainage channel along the western boundary. The main drainage channel conveys water directly into the Ruakākā River, immediately south of the site (Tonkin and Taylor, 2022).

60 The drainage channels on site and the presence of the tidal Ruakākā River to the south, will likely influence groundwater levels.

61 The site is predominately low lying and flat (about 3-4 masl), excluding a prominent break in slope close to the eastern boundary, where the elevation increases by approximately 3-4 m (to about 6-7 masl) (Tonkin and Taylor 2022).

62 Tonkin and Taylor carried out geotechnical investigations between 23-25 February 2022. Based on their investigations:

62.1 The surface deposit across much of the site is fibrous and amorphous peat / silty peat of the Tauranga Group. This unit extends to some 4.2 m depth.

62.2 Sand deposits of the Kariotahi Group (like Site 1) underlie the Tauranga Group but are present as surface deposits where they form an elevated dune along the eastern margin of the site.

62.3 Waipapa Group basement rock was not encountered during the investigations but expected to be at some 30 m depth.

62.4 Groundwater was observed typically at or close to the ground surface (within 1.5 m), except along the elevated eastern margin of the site, where groundwater was encountered around 4.2 m depth.

62.5 It should be noted that groundwater levels were measured in boreholes on the day that they were drilled and therefore are a single measurement in time that may be influenced by drilling fluid or muds used, and so may not be indicative of longer term conditions.

63 The New Zealand Geotechnical Database has borelog data on geotechnical test pit investigations carried out to the east of the site at Bream Bay College by Geocivil Ltd. Relevant information to Site 3 includes:

63.1 Investigations were undertaken between 24 April 2020 and 8 December 2020.

63.2 Groundwater levels measured in test pits were one-off readings and showed groundwater levels around 0.9 -1.2 mbgl in April and 1.8-2 mbgl in late 2020 (September to December).

63.3 Again, these are one-off measurements of groundwater that may not fully reflect long term conditions.

64 Beca recently installed piezometers with level loggers on Site 3 (**Figure 8b**). Limited monitoring of up to eight days prior to this evidence being prepared has been undertaken and the data to date shows:

64.1 Groundwater levels ranged from 1.46 masl to 1.87 masl or 0.13 mbgl to 0.54 mbgl. This is similar to groundwater levels measured by Tonkin and Taylor in their borehole investigations.

64.2 Tidal fluctuation is evident in the data with fluctuations ranging from 0.1 to 0.2 m. Tidal influence is more evident in the piezometer located in the southern end of the site (Figure 9) / closest to the tidally influenced Ruakākā River.

64.3 There is minimal rise in groundwater levels from rainfall events (0.1 m rise in level following 70 mm of rainfall over 24 hours). This is expected, as rainfall would sit on the peat before slowly percolating down to the water table.

CLIMATIC AND HYDROGEOLOGIC CONDITIONS IN THE RUAKĀKĀ AREA DURING THE WETLAND ASSESSMENT DATES BY BOTH BOFFA MISKELL AND NORTHLAND REGIONAL COUNCIL

65 As outlined above, I was asked to undertake a high-level assessment of publicly available information to determine if climatic and hydrogeological conditions in the Ruakākā area were considered "normal' during the dates when wetland delineation assessments on Site 1 were completed by both Boffa Miskell and NRC.

66 The dates of the assessments are presented in the **Table 1** in the appendices to my evidence.

67 Where appropriate and to avoid duplication, I have grouped some visits into periods of "like conditions" (column 4 of **Table 1**).

68 In the subsequent paragraphs of this statement, I will discuss the five broad periods identified in **Table 1**.

Period 1 climatic conditions

69 Within the period 27 Oct - 2 Nov 2021, the groundwater level in the Ruakākā Racecourse bore was 127% of average for that month (**Figure 10a**). This level is above the 60th%ile and very close to the 90th%ile of all data, which NRC define as above 'normal' groundwater conditions.

70 The WDC monitoring boreholes MB33-37 (closer to the coast) did not show noticeably elevated groundwater levels over this period, however RT03 and RT02 (located inland and closer to Site 1) showed a steady increase in levels leading up to these dates. It is likely the wastewater discharge had some influence on these levels.

Period 2 climatic conditions

71 Groundwater levels during assessments completed on 31 May 2022 and 20 June 2022 are 116% to 120% of the average groundwater levels for those months (**Table 1**) (**Figure 10b**).. These levels are above the 60th%ile of all data, which NRC define as above 'normal' groundwater conditions.

72 The drone footage flown by MEL on 6 September 2022 was from a period when groundwater levels were at the upper extent of the

historic groundwater level recorded in the Ruakākā Bores for that time of year (**Figure 10b**). Some 21 mm of rain had fallen the day before and 453 mm of rain two months prior (rainfall data provided by Boffa Miskell). There likely would have also been more surface ponding on site, due to the preceding rainfall.

73 August 2022 was the start of an extended period of abnormally high rainfall for the area.

Period 3 climatic conditions

74 In March 2023 (site visit completed by Boffa Miskell and assessment based on google earth imagery by NRC), a groundwater level of 3.95 masl was measured in the Ruakākā Racecourse bore, some 1.45 m above the historic median March level of 2.3 masl.

75 March 2023 followed a particularly wet February, where a groundwater level of 4.45 masl was recorded in the Ruakākā Racecourse Bore, some 2.23 m above the median February level of 2.22 masl.

76 Sustained higher groundwater levels were recorded from 16 August 2022 to 28 July 2023, and were the highest on record since records began for the Racecourse Bores (**Figure 10c**).

77 Rainfall over this period was also exceptionally high, particularly in the Ruakākā area (**Figure 11**).

78 Higher than 'normal' rainfall and groundwater levels would also have been experienced on Site 1 and Site 3, leading to more areas on site where groundwater was at or close to the surface and more areas of surface ponding.

Period 4 climatic conditions

79 Groundwater levels on the dates 28 September 2023 and 8 October 2023 (**Table 1 and Figure 10c)** were above the 60^{th}%ile for and close to the 90^{th}%ile of all data, which NRC define as above 'normal' groundwater conditions.

80 I note groundwater levels at Site 1 may have been elevated relative to typical winter levels, due to the blocked condition of the Bercich Drain at that time, potentially reducing its ability to remove the unseasonably high recharge experienced at the site in the proceeding months.

Period 5 climatic conditions

81 Groundwater levels were measured in holes dug on Site 1 during site visits completed on 28 March, 19 June 21 June and 4th July 2024. The areas investigated are provided in Figure 7, which included wetland areas of contention at that time.

82 Groundwater was observed at or close to the surface in four locations (shown as a blue dot in **Figure 7**). In the remainder of the

investigation locations groundwater was encountered between 0.25 mbgl and 0.75 mBGL. Some holes did not encounter groundwater.

83 The groundwater level measured in March 2024 for the Racecourse bore was 2.31 masl and 2.61 masl in June 2024. Note groundwater levels are only measured monthly.

Summary and implications for conditions at time of wetland mapping on Site 1

84 With the absence of site-specific groundwater or stage monitoring for the Bercich Drain it is not possible to quantify actual groundwater levels at Site 1 during the times when assessments were undertaken to determine wetland extents. However, it is reasonable to infer that conditions would be broadly similar to that in the Ruakākā Racecourse bore.

85 The monitoring data for the Racecourse bore shows that groundwater levels in the area were likely to be above 'normal' conditions and close to or above 90^{th}%ile for all data, for the assessment dates of 27 October - 2 November 2021, September 2022, 7 & 8 March 2023, 22 March 2023 and 24 March 2023. I note that from August 2022 to July 2023 groundwater levels were the highest recorded since records began for the Ruakākā bores.

86 The remaining assessments (31 May, 20 June, 28 September 2023, 5 October 2023, 28 March 2024, 19 June 2024, and 4 July 2024) were completed when groundwater conditions were still above the 60^{th} %ile, and therefore still above 'normal' for those respective months..

87 It is likely that the condition of the Bercich Drain until January 2024 may have exacerbated groundwater levels on Site 1.

88 It is also not possible to discount the impact that wastewater discharge has on groundwater levels at Site 1, especially in the low-lying areas of known 'daylighting'.

89 Site data collected in recent investigations in March, June and July 2024 are more likely to be representative of 'normal' conditions. Groundwater levels encountered during this time showed only three locations where groundwater was at or close to the surface (possibly contributing to wetland hydrology). Of which two of the areas are similar to the 'holding water' areas identified by Voss 2009.

KEY HYDROGEOLOGICAL FACTORS FOR SUCCESSFUL WETLAND RESTORATION

Recommendations for Site 1

90 I understand that at Site 1, the identified "holding water area" southeast of Site 1C (**Figure 1**) is proposed to remain and will be extended to provide a wetland offset (I refer to **Dr Flynn's** evidence).

91 Based on the Voss 2009 report and site observations, it is likely that at this location, groundwater in places is at or close to the ground surface.

92 If the proposed wetland is to be sustained by groundwater year-round, groundwater monitoring for at least a year should be undertaken to capture seasonal fluctuations across the proposed wetland extent. Monitoring boreholes for this purpose have been installed.

93 The data collected will be able to inform suitable invert depths for the wetland if it is to be largely sustained by groundwater. Consideration should however be given to if groundwater levels representative of 'normal' conditions were experienced during the 1-year monitoring period.

94 In my view, it is feasible from a hydrogeological perspective to create a wetland supported by groundwater at this location providing the wetland extent is deep enough to encounter the seasonal low groundwater level.

95 It should be noted that both Voss and Stantec modelling shows the wastewater discharge likely contributes to elevated groundwater levels at the proposed wetland location.

96 The collector drain proposed by the Voss and Stantec modelling appears to locate where the proposed off-set wetland locates. This drain will influence the proposed wetland by reducing water levels. Discussions will need to take place with WDC about the collector drains.

97 Planting design will need to consider plants that can withstand the expected seasonal fluctuation in groundwater level, variability in levels due to discharge and / or drainage on adjacent properties, and standing water at the surface also.

Recommendations for Site 3

98 Part of Site 3 is also proposed to be used for an offset wetland area. This is described in **Dr Flynn's** evidence.

99 Similar to Site 1, groundwater monitoring for at least a year would be required to determine groundwater levels across a seasonal range. Two boreholes have been installed across the proposed off-set wetland footprint.

100 The data collected will be able to inform suitable invert depths for the wetland if it is to be largely sustained by groundwater. Consideration should however be given to if 'normal' groundwater levels were experienced during the monitoring period.

101 The presence of existing drains on site will influence groundwater levels and they will also need to be taken into consideration when determining wetland invert levels.

102 In my view, it is feasible from a hydrogeological perspective to create groundwater sustaining wetlands on Site 3 providing they are deep enough to encounter groundwater at its seasonal low and that invert levels take into account the current drainage on site.

103 Planting design will need to consider plants that can withstand the expected seasonal fluctuation in groundwater level, possibly salt resistant species due to tidal influences from the adjacent Ruakākā River, and standing water at the surface also.

RESPONSE TO NRC INTERNAL TECHNICAL ADVICE

104 The NRC internal technical advice (Appendix C, section 42A report) stated that there was very little analysis on the connection between the wetlands and groundwater at Site 1.

105 This is correct as, at that time there was no groundwater monitoring information for Site 1 to compare to. Having undertaken a comprehensive review of all available information in relation to this matter, I expect that under 'normal' climatic conditions there are only a few of areas where wetlands are partially or fully groundwater dependent, while the remaining wetlands will likely be supported by surface water.

106 In respect of the March 2023 period, NRC's internal technical reviewer noted that "*due to the relatively low level of the wetlands (3-4 mRL) and the very high groundwater levels (3.95 masl), at the time of the google satellite assessment by NRC, it is fair to suggest that at this time groundwater could have been maintaining the water levels in the wetlands beyond typical levels"*.

107 I agree with the conclusion of this statement. As discussed in my evidence, the groundwater conditions measured in the Ruakākā bores during March 2023 would likely to have been experienced in the wider Ruakākā area and therefore groundwater levels on Site 1 would more than likely been higher than typical.

108 In response to Beca's statement about groundwater levels measured in September 2022 during NRC's assessment of MEL drone imagery, NRC's internal technical reviewer states that groundwater at this time is 117% of average for the month, which is just above the 90^{th} %ile for the groundwater record.

109 I agree with this statement. As discussed in my evidence and shown in **Figure 10b** the groundwater levels in the Ruakaka bores during this period are just above the 90^{th} %ile of the complete groundwater record and therefore above "normal" groundwater conditions. These

elevated levels would have more than likely been experienced at Site 1 also.

110 Based on the conclusions drawn by NRC's internal technical reviewer, it appears they are in agreement that assessments completed in March 2023 would have been influenced by high groundwater levels.

111 NRC's internal technical reviewer states that site walkovers by RDL in September and October 2023 were close to average conditions for that month. I note however that conditions were above 60th%ile and close to the 90th%ile for the complete record, therefore above 'normal' groundwater conditions according to NRC's website. In addition, due to unprecedented groundwater water levels and rain leading up to the Sep/Oct 2023 visits, I cannot rule out that groundwater levels on Site 1 could have remained high due to the condition of the Bercich Drain.

112 I therefore do not agree with Council's statement that most of Boffa Miskell's assessments occurred during classically 'dry' periods.

22 July 2024

Mandy McDavitt

Figure 1 shows the Bercich Drain (in dark blue), feeder drains in light blue and location of TP12 where groundwater was identified close to the surface in test pit investigations in November 2019 (Source: Boffa Miskell, Nov 2023).

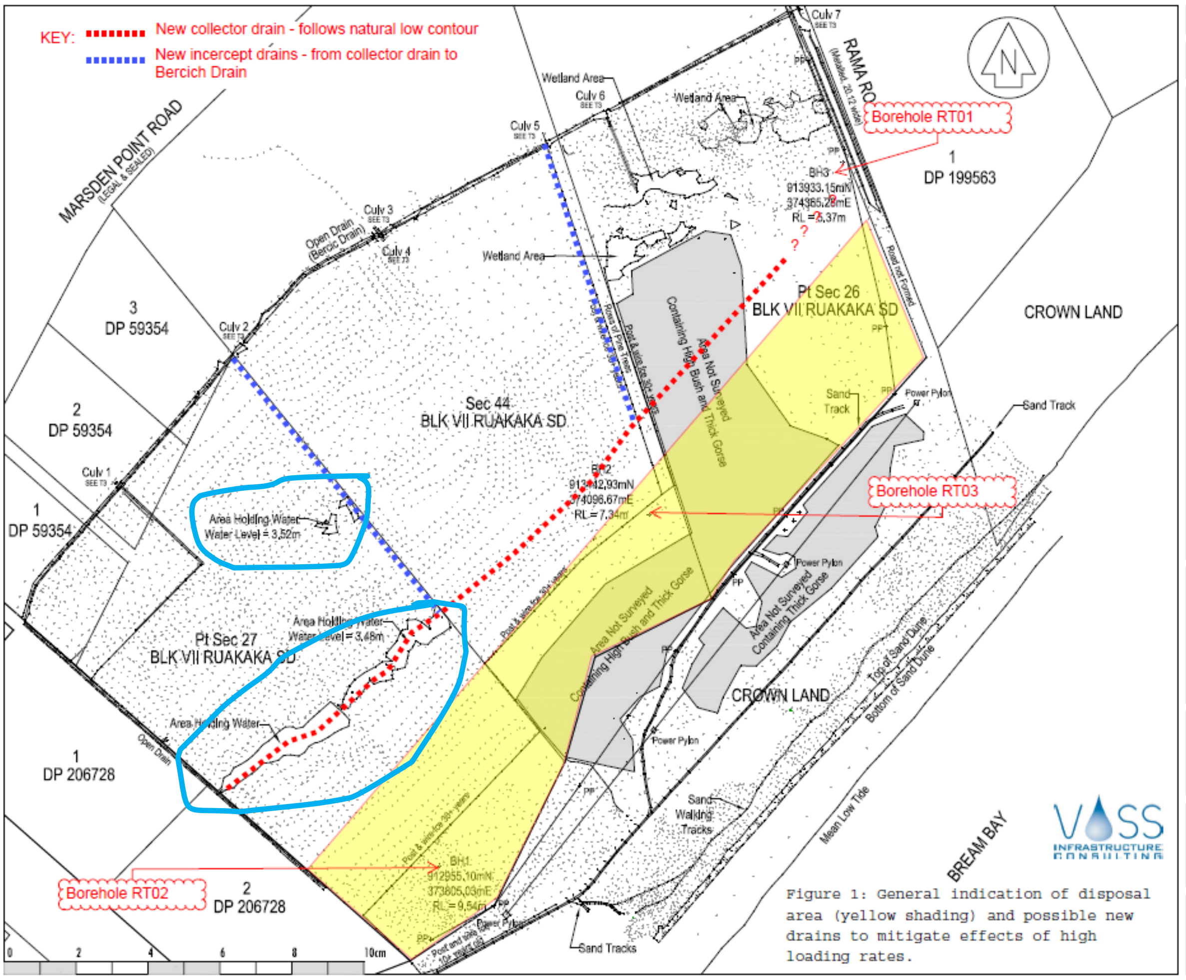

Figure 2 shows the Bercich Drain, WDC's discharge disposal area in yellow, existing mapped wetlands on Site 1C, and blue outlines indicate areas where surface ponding naturally occurs on site (understood to be groundwater fed). All marked features as identified in 2008 prior to wastewater discharged commencing (Source: Voss 2008).

	
Photo 1 taken of the Bercich Drain on 3/11/21 looking SW towards Allis Bloy Place. Photo taken from culvert on Site 1c (Source: Boffa Miskell).	Photo 2 taken of the Bercich Drain on 3/11/21 looking NW towards Rama Road. Photo taken from culvert on Site 1c (Source: Boffa Miskell).

Figure 3: Pictures taken of the Bercich Drain in November 2021, source Boffa Miskell.

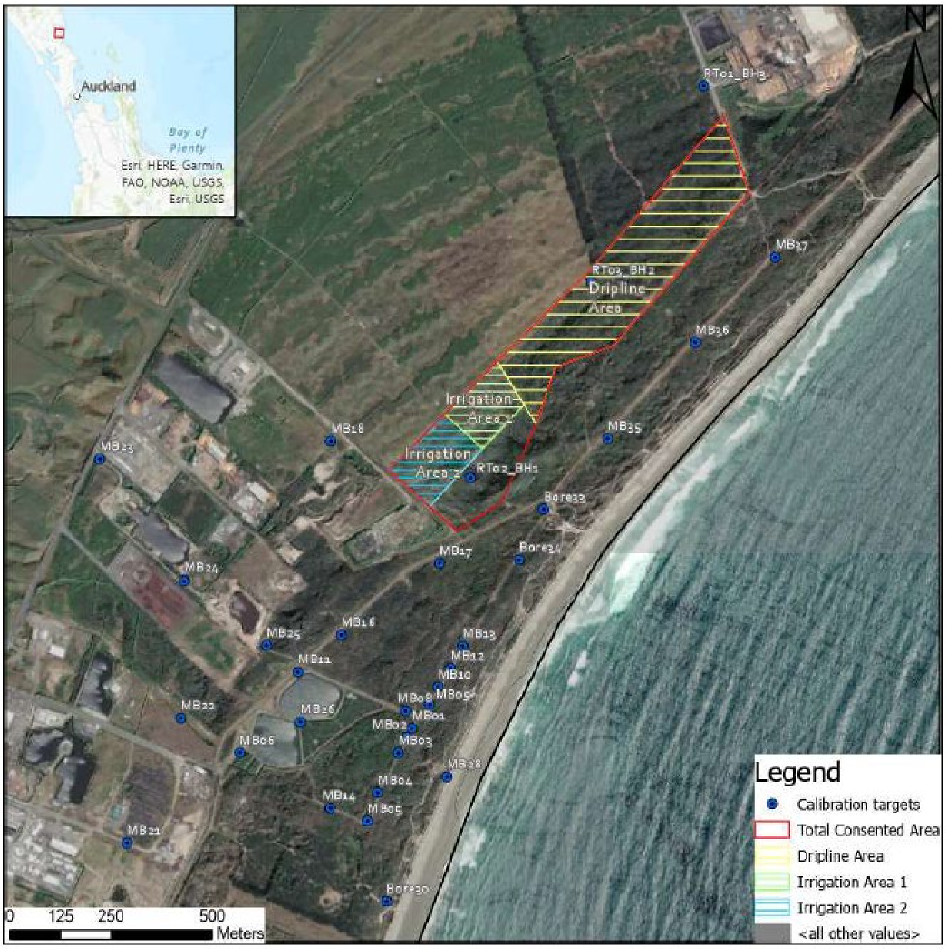

Figure 4: WDC Groundwater monitoring bores (Stantec 2022)

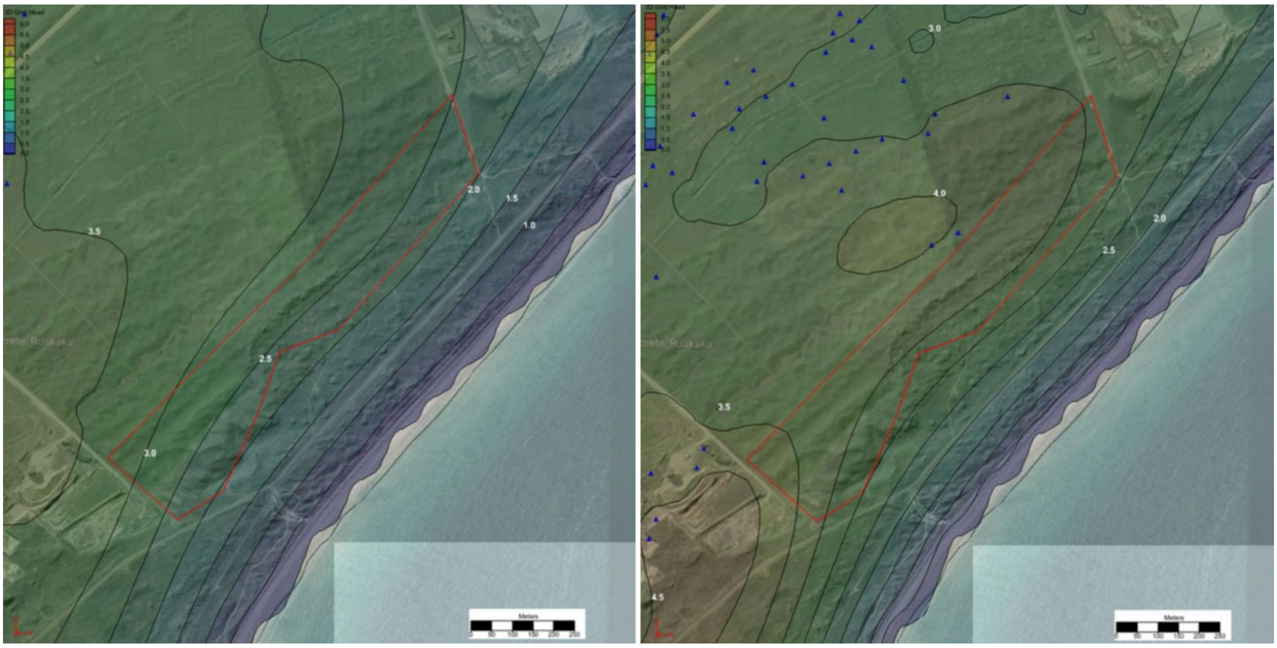

Figure 5: Modelled groundwater table with no wastewater application, during average recharge conditions (left) and unseasonably high recharge (right) (Stantec 2022).

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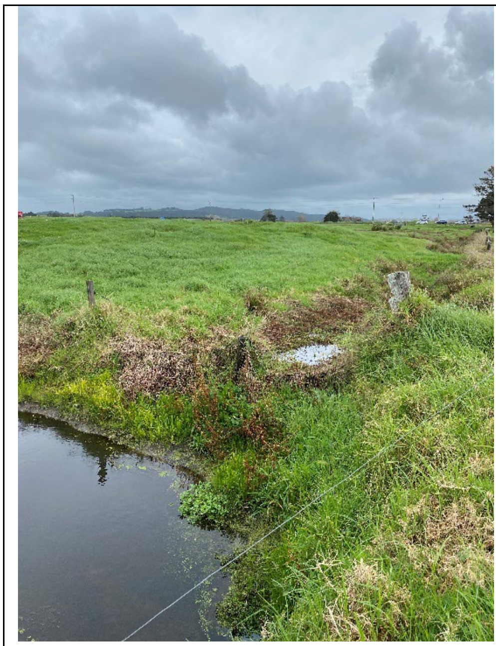
<td rowspan="3">

Photo 3 taken on 19 June 2024 at Site 1c at Bercich Drain culvert by main 4WD track. Looking west. (Date 19 June 2024)</td>
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<td>Photo 4 above shows wetland area of contention on Site 1b. (Date: 19 June 2024).

Photo 5 below shows hole dug adjacent to above with dry sand underlying the peat with groundwater encountered around 0.45 mBGL. Surface ponding can be seen on the ground surface. (Date: 19 June 2024)</td>
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Figure 6: Photos taken during site visit on 19 June 2024

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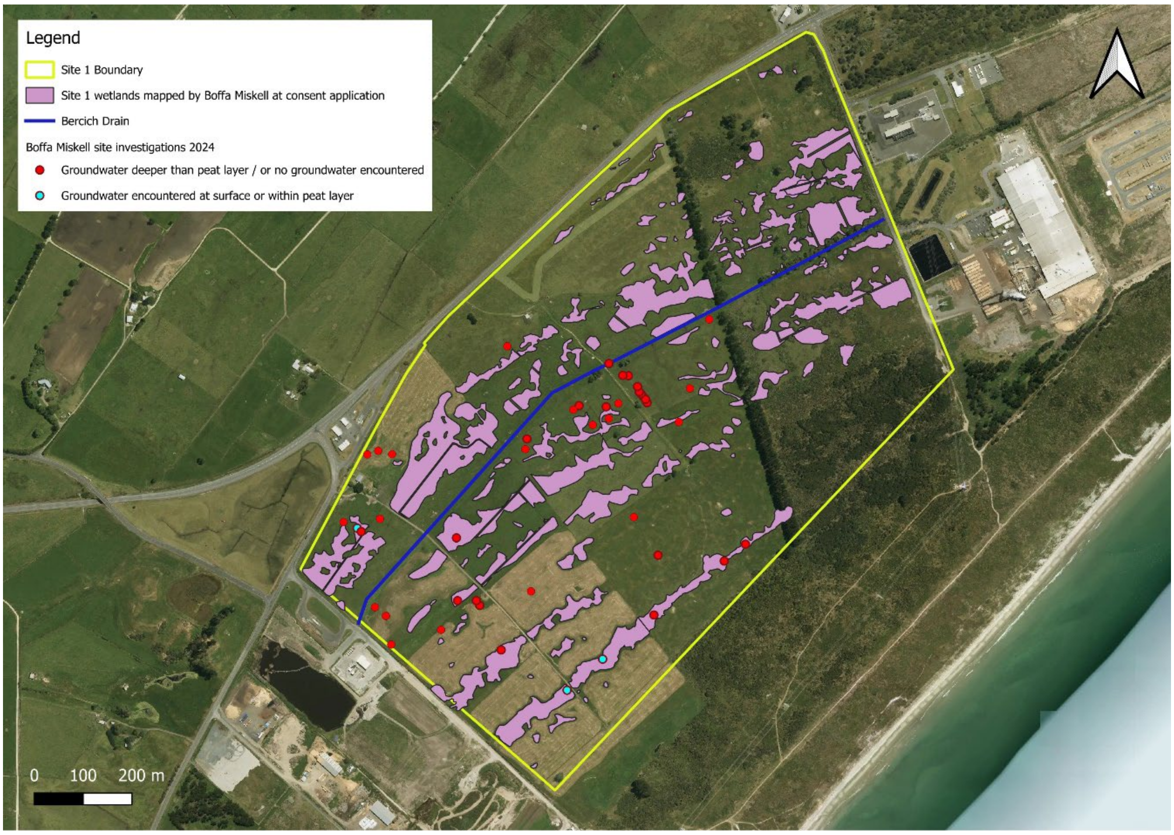


Figure 7: Site investigations completed by Boffa Miskell on 28 March, 19 & 21 June, 4 July 2024.

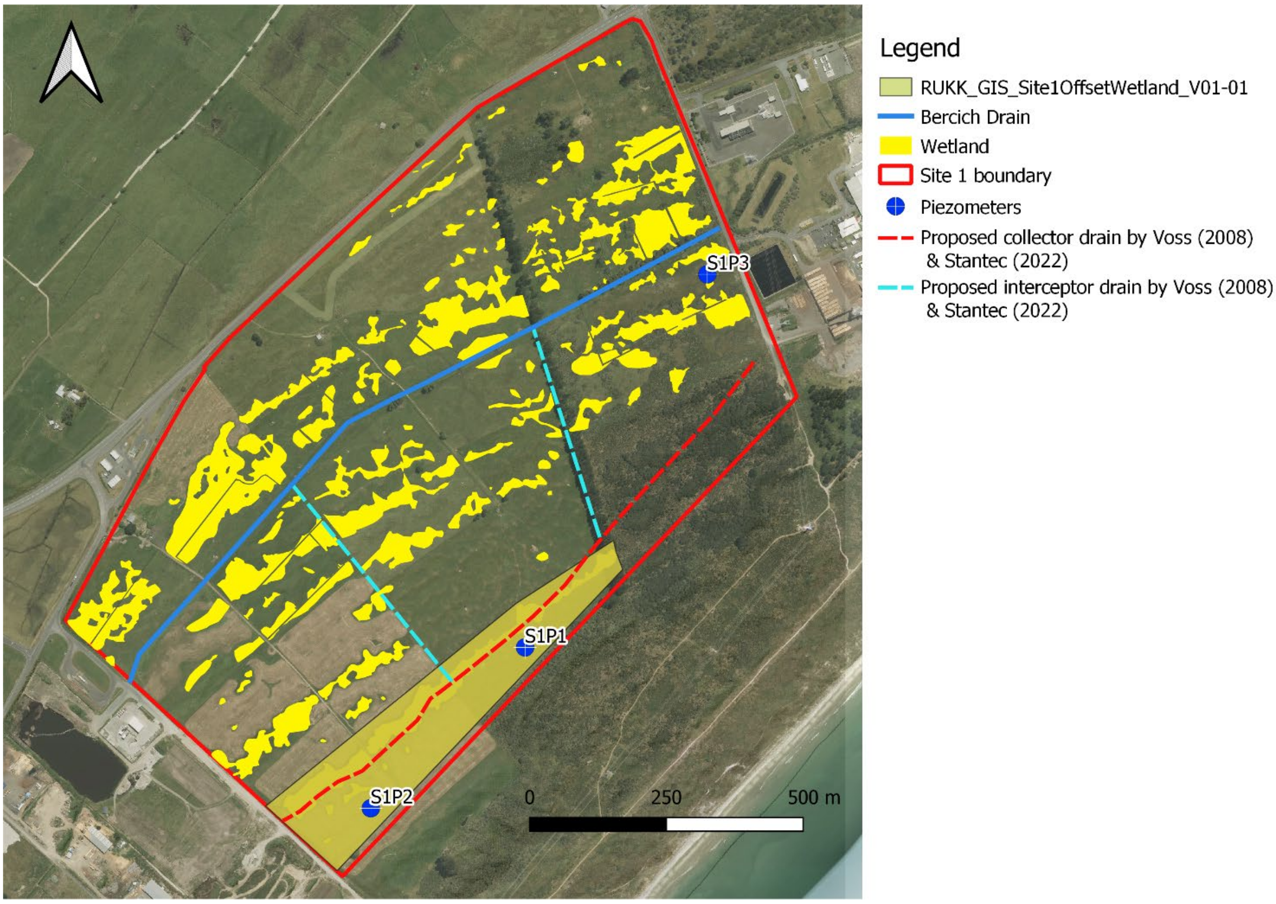


Figure 8a – Piezometer locations on Site 1 relative to proposed wetland, existing wetlands and key drainage features.

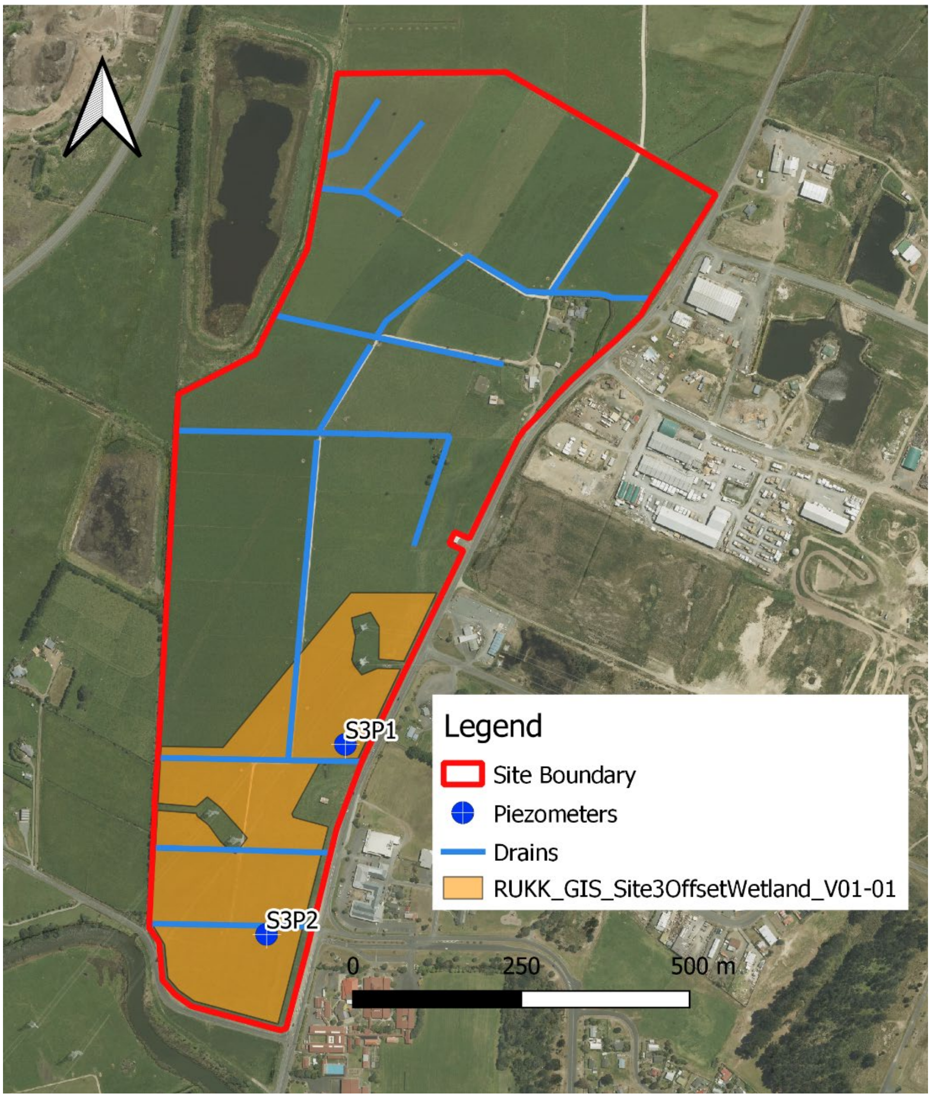


Figure 8b – Piezometer locations at Site 3.

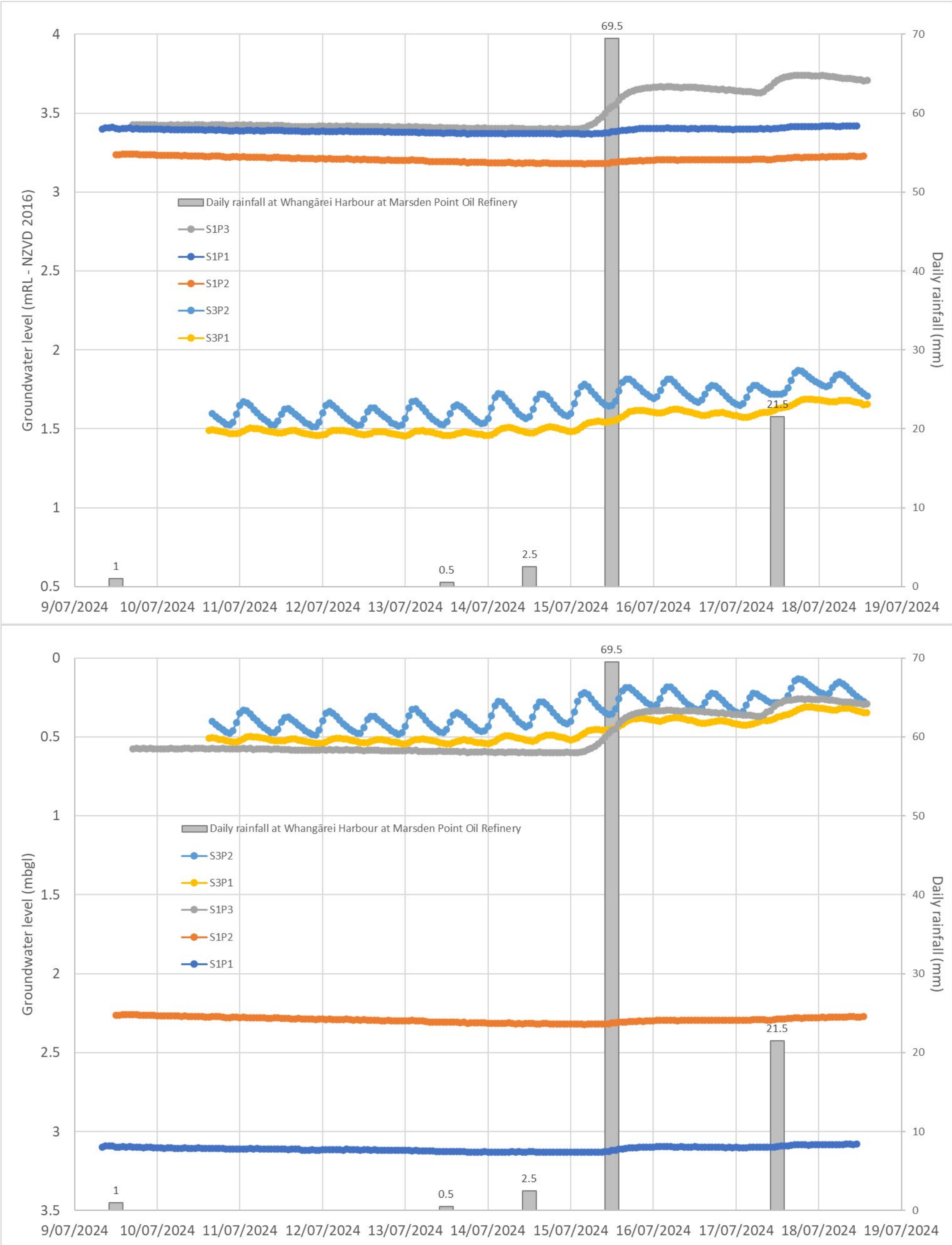


Figure 9 – Groundwater level monitoring data from Piezometers recently installed at Site 1 (S1P1 to S1P3) and Site 3 (S3P1 to S3P2).

Table 1: Assessment dates

Date of assessment	Assessment completed by	Site covered during assessment	Period	Groundwater level in Racecourse bore, and description in terms of average or above average.
27 Oct -2 Nov 2021	Boffa Miskell	Site 1 (A+B+C)	Period 1	3.26 masl, 127% of Oct / Nov average condition, or 0.7 m above average groundwater level for Oct / Nov. 99% of 90th percentile.
31 May 2022	Boffa Miskell	Site 1A	Period 2	2.72 masl, 116% of May average conditions, 0.37 m above average groundwater level for May. 82% of 90th percentile.
20 June 2022	Boffa Miskell	Site 1 (B + C)		2.91 masl, 120% of June average conditions or 0.48 m above average groundwater level for June. 88% of 90th percentile.
Sep 2022	No site visit. Drone footage only.	Site 1A		3.37 mMSL, 117% of average Sep conditions, and upper end of groundwater level record. 102% of 90th percentile.
7 & 8 March 2023	Boffa Miskell	Site 1A	Period 3	4.45 masl, 172% of average Mar groundwater conditions. Highest

				groundwater level recorded since records began. 135% of 90th percentile.
22 March 2023	Boffa Miskell	Site 1B		3.95 masl, 150% of average March groundwater conditions. Highest groundwater level recorded since records began. 120% of 90th percentile.
24 March 2023	No site visit. Google Earth imagery used by NRC.			
28 September 2023	Northland Regional Council	Site 1	Period 4	3.09 mMSL, 108% of average groundwater conditions or 0.22 m above average groundwater level for September. 94% of 90th percentile.
5 October 2023	Northland Regional Council	Site 1		
28 March 2024	Boffa Miskell	Site 1	Period 5	2.31 masl, 88% of average March conditions or 0.32 m below average groundwater level for March.
19 June 2024	Boffa Miskell	Site 1		

21 June 2024	Boffa Miskell	Site 1		2.61 masl, 107% of average June groundwater conditions or 0.18 m above average groundwater level for June.
4 July 2024	Boffa Miskell	Site 1		Closest groundwater level measurement 24 June 2024, which is 2.31 mMSL or 107% of average June groundwater conditions. July data not yet published on NRC website.

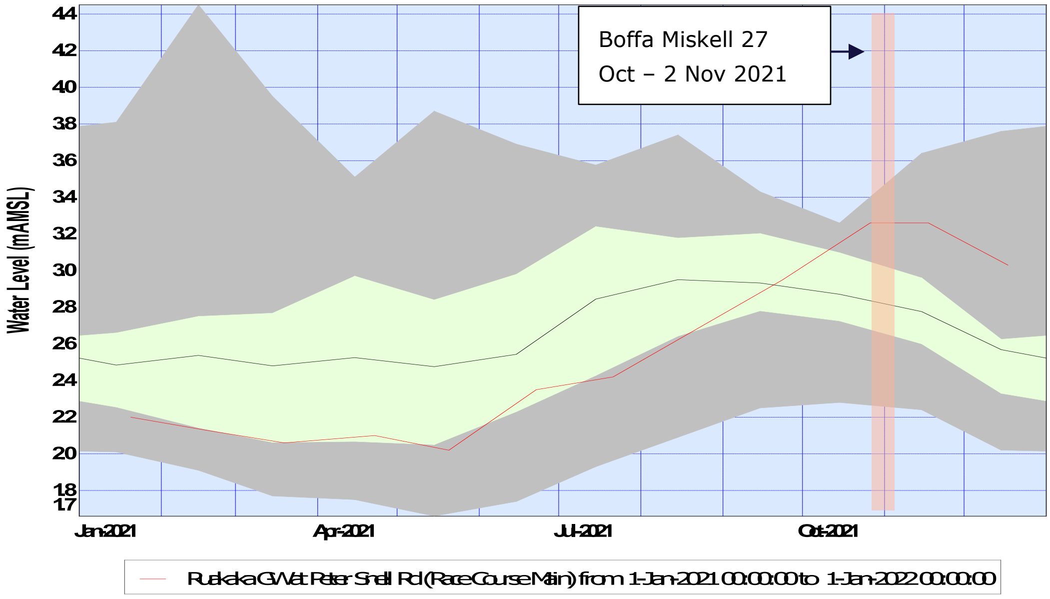


Figure 10a: Groundwater levels in the Racecourse Bore for 2021. Red line showing recorded groundwater levels for the period. Grey shaded area shows the historic range of groundwater levels for the same calendar month but over the longer-term data set. The green shaded area is the range 50% of the historic measurements fall within (Source NRC review dated 13 June 2024).

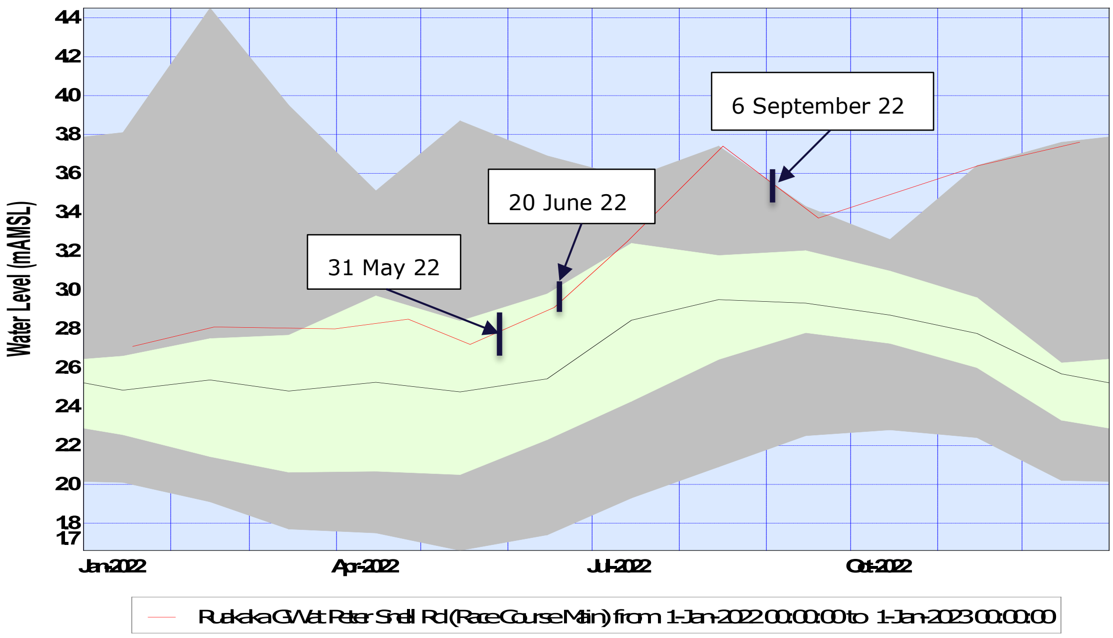


Figure 10b Groundwater levels in the Racecourse Bore for 2022. Refer figure 10a caption for details.

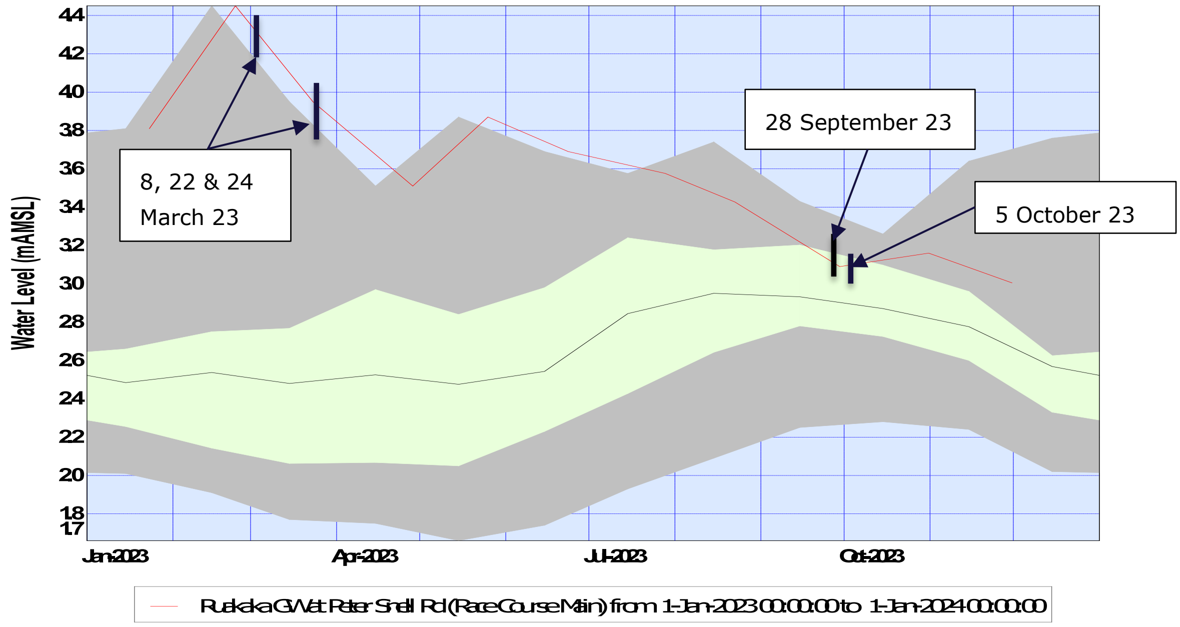
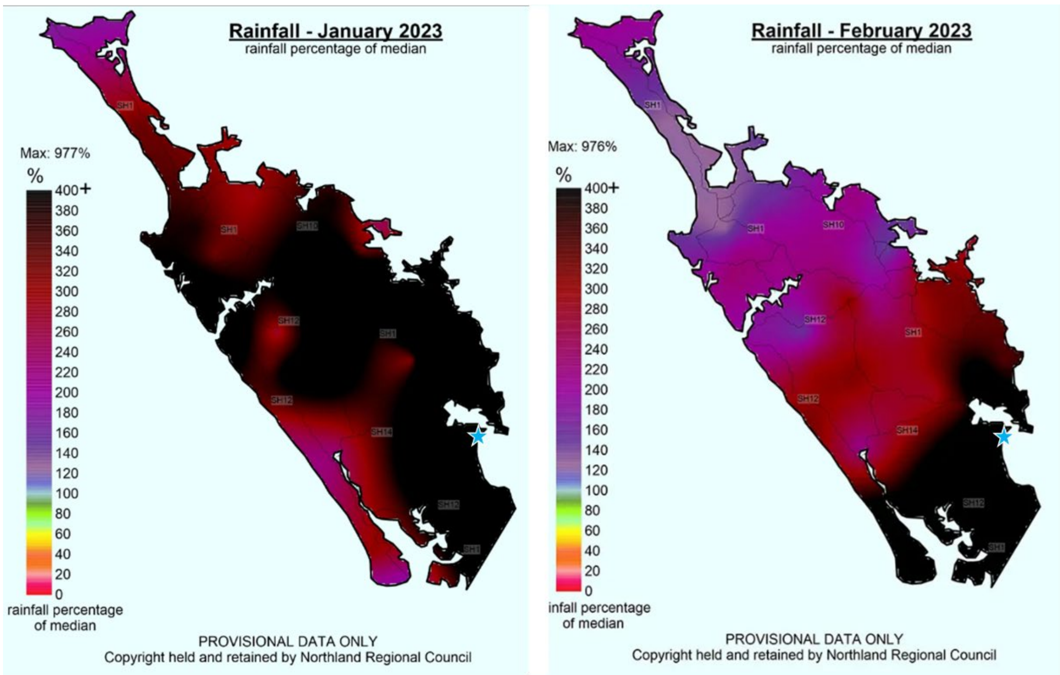


Figure 10c: Groundwater levels in the Racecourse Bore for 2023. Refer figure 10a caption for details.



Figures 11: Monthly rainfall percentage of median sourced from NRC hydrology climate reports. Ruakākā marked by blue star in both figures.