Under	the Resource Management Act 1991 (**RMA**)
In the matter of	an application by **Dunedin City Council** to develop a Resource Recovery Park Precinct at Green Island, Dunedin.

Statement of evidence of Dusk Mains

6 November 2024

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Qualifications and experience

1 My full name is Dusk Lily Mains.

2 I am currently employed by GHD as a Technical Director specialising in hydrogeology, groundwater-surface water interactions and water quality.

3 I have over sixteen years' experience in hydrogeology and environmental science. My experience includes assessment of effects on groundwater over a wide range of applications and project settings, in both New Zealand and Australia. My project experience includes dewatering assessments (infrastructure and mining), groundwater supply and aquifer characterisation, surface water interactions (wetlands, stormwater basins, and streams), and water quality assessments (wastewater discharges, landfills and contaminated sites).

4 I have the following qualifications and relevant experience:

(a) Bachelor of Science with Honours in Geology from the University of Otago

(b) Master of Science in Hydrogeology from the University of Western Australia.

(c) I have provided assessment of effects to groundwater for a variety of projects including landfills, quarrying and mining, wastewater discharges, and infrastructure. In undertaking these projects I have been required to interpret a wide range of desktop and field information in order to conceptualise the groundwater system and assess the effects of the activity.

(d) I have led the groundwater investigations into serveral stormwater and flood managment projects for the Christchurch City Council. These projects have involved field investigations to characterise the groundwater system. I have undertaken groundwater modelling to understand the groundwater and tidal interactions with proposed stormwater basins and wetlands including the impact of sea level rise. One of these projects, Horseshoe Lake included characterising the groundwater flows through a historic landfill. In these investigations I utilised a 2D groundwater modelling approach to characterise groundwater and surface water interactions as I have done for the Green Island Landfill and RRPP assessment.

(e) I have also prepared the Groundwater Effects Assessment for the Green Island Landfill consent application, which is relevant to this application.

5 My assessment is based upon the description of the Application as contained in Section 2 of the AEE.

6 I have visited the Green Island Landfill and Resource Recovery Park Precinct (RRPP) site in August 2022.

7 I have read the Code of Conduct for Expert Witnesses in the Environment Court Practice Note 2023. This evidence has been prepared in accordance with it and I agree to comply with it. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

Scope of evidence

8 I have been asked to prepare evidence in relation to the effects of the Resource Recovery Park Precinct (RRPP) on groundwater. This includes:

(a) site history and operation of the leachate interception trench;

(b) the existing environment and characteristics of groundwater at the Green Island Landfill and RRPP area;

(c) the key findings of my assessment of effects on groundwater during the construction and operation of the RRPP;

(d) matters raised by submitters to the Application; and

(e) Proposed conditions of consent.

Executive summary

9 Waste disposal first occurred at the Green Island site in 1954 with the disposal of industrial waste and the site has been used for waste disposal since that time. The pre-existing landform for the Green Island landfill was tidal estuary associated with the upper reaches of the Kaikorai Estuary. Waste was end dumped directly on the estuarine sediments. The RRPP area is estimated to have a waste thickness of between 3 and 7 m, which rises above the Kaikorai Estuary. The placement of waste over the estuarine deposits has created a lens of perched groundwater that is impacted by the waste.

10 The underlying geology comprises low permeability estuarine sediments, predominantly silt with some clay. The more permeable upper Kaikorai

Estuary Formation (KEF) is largely absent from the RRPP area. To the southeast of the site, the landfill and underlying alluvium terminate at the toe of a 30 m high ridge that has been mapped as the upper part of the Abbotsford Formation. The Abbotsford Formation mudstone and siltstone acts as an aquitard to groundwater flows to the south.

11 Groundwater and leachate migration from the landfill is managed via a leachate interception trench which creates a hydraulic barrier and pulls groundwater from both sides of the trench.

12 Groundwater quality beneath the RRPP is likely to be impacted by historic waste. Landfill leachate is characterised by elevated contaminant concentrations including: dissolved metals, ammoniacal-nitrogen, boron, chloride, and high electrical conductivity.

13 The RRPP development will increase hardstand surfaces and building areas, increasing run-off to stormwater and decreased rainfall infiltration into the waste material. In addition, the existing unsealed compositing area will be replaced by the Organics Receivable Building (ORB) and Organics Processing Bunkers/Maturation area. For these new facilities, leachate will be collected and directed to the existing leachate collection system for treatment and stormwater runoff will be managed through the existing stormwater facilities.

14 During construction activities, excavations undertaken for building foundations for the RRPP development may require temporary dewatering. However, I expect that the inflow rates will be low and can be discharged to the leachate interception trench system or back to the main landfill without resulting in a discharge to the surrounding environment outside the leachate trench.

15 The RRPP development and temporary construction activities are not expected to impact the groundwater environment or groundwater users outside of the site boundary.

16 I consider that the overall impact of the RRPP development on groundwater is positive due to the reduction in leachate generation from the increased hardstand areas and subsequent decrease in rainfall infiltration to the waste.

Site Description and Landfilling History

17 A full site description is provided in section 3.2 of the Applications for Resource Consent and Assessment of Environmental Effects Prepared for Dunedin City Council, dated 15 March 2024.

18 I provide below an overview of the landfill history and deposition of waste to inform my assessment of leachate migration and the wider groundwater environment.

19 Waste disposal first occurred at the Green Island site in 1954 with the disposal of industrial waste and the site has been used for waste disposal since that time.

20 Landfilling commenced at the south-east corner of the landfill site and has continued north and west over the decades. The RRPP area is estimated to have a waste thickness of between 3 and 7 m. The RRPP is located over the older part of the landfill.

21 The pre-existing landform for the Green Island landfill was tidal estuary associated with the upper reaches of the Kaikorai Estuary. Abbotts Creek flows into Kaikorai Stream to the north of the site with the Kaikorai Stream flowing to the east then south into the Kaikorai Estuary. Waste was originally end dumped directly onto the estuarine muds and up against the southeastern estuary edge where the pre-existing landform rises gently to the southeast.

22 A soil bund has been constructed around the edges of the landfill to constrain waste placement. The soil bund separates the main landfill area from the RRPP.

Geological setting

23 In the RRPP area the historic landfill waste is sitting on sedimentary deposits associated with the Kaikorai Estuary. The geological profile is summarised in Table 1 below and is based on published reports and the results of the GHD site investigation. The RRPP area is not capped with low permeability landfill capping material that would meet current MfE guidance documentation.

Table 1 Geological summary: RRPP

Unit	Geology	Description	Layer thickness
Fill		Variable landfill waste and soil	~7 m
Kaikorai Estuary Formation (KEF)	UKEM	Silty fine to medium sand, sandy silt	Mostly absent from RRPP area
	LKEM	Organic silt, silty clay	2 – 3 m
	Coarse sediments	Sands/gravel	~0.5 m, mostly absent from RRPP area
Abbotsford Formation	Mudstone and Siltstone	Grey-brown mudstone/siltstone, very weak	-

24 The geological map for the surrounding area is shown in Figure 1. To the southeast of the site, the landfill and underlying alluvium terminate at the toe of a 30 m high ridge that has been mapped as the upper part of the Abbotsford Formation sequence (Adams Geotechnical, 2019) as shown in Figure 2. The Abbotsford Formation is described as “Grey to dark grey sandstone, siltstone and claystone with some glauconitic mudstone and green sand layers” (McKellar, 1990). Overlying the mudstone is a layer of loess and colluvium (clay-silt soils).

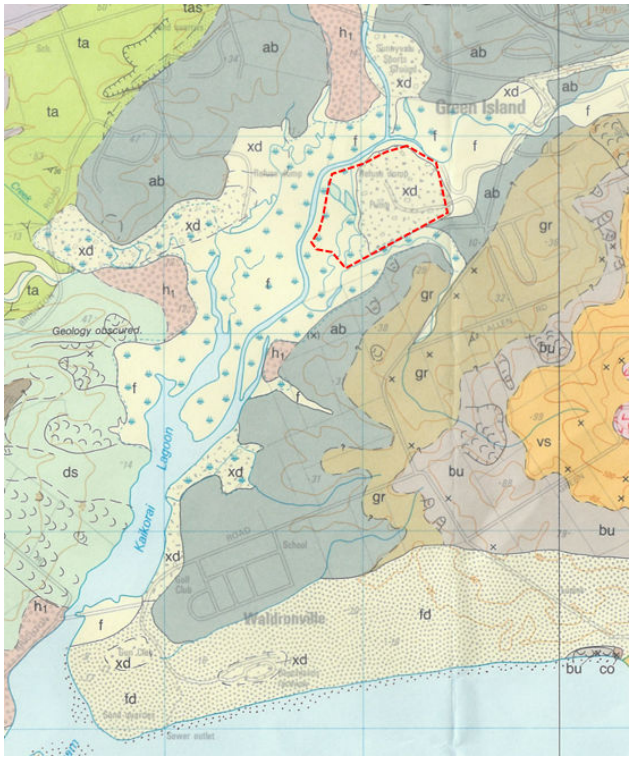


Figure 1 1 Geological map of Green Island area (McKellar, 1990). Approximate site boundary shown by red dashed line. ab: Abbotsford mudstone, f: alluvium, xd:fill

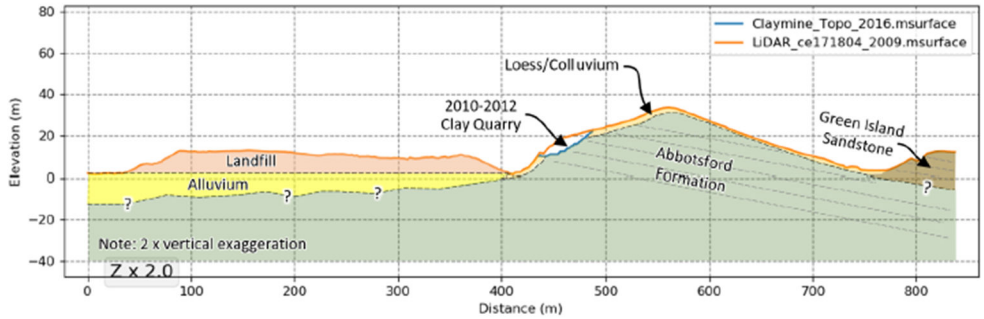


Figure 2 2 Interpreted geological cross section from Adams Geotechnical (2019)

Leachate Management

25 The RRPP will not generate a significant leachate volume in and of itself. The organics bunkers and maturation areas are expected to generate leachate, whilst the Bulk Waste Transfer Station (BWTS) is also likely to generate a small volume of leachate. The leachate generated by these areas of the RRPP will not be allowed to infiltrate into the underlying landfill, with the leachate and impacted stormwater managed onsite and directed to the leachate collection trench pump stations, as noted in the evidence of Ms Wood.

26 The existing layout of the area where the proposed RRPP will be located is set out in Figure 2.1 of the Green Island Resource Recovery Park Precinct - Groundwater Technical Assessment dated 29 February 2024. Stormwater that interacts with waste, including composting, is largely directed to soakage holes within the landfill. The leachate generated from these discharges and the rainfall infiltration is managed by the leachate interception trench. Whilst I will provide a brief description of the functionality of the trench, I consider that the RRPP proposal will not materially impact the way leachate from the historical and existing landfilling operations is managed at the site.

27 Leachate is managed via a leachate interception trench which was commissioned in 1995. Details of the leachate trench operation are provided in section 2.2.2 of the Green Island Resource Recovery Park Precinct - Groundwater Technical Assessment dated 29 February 2024. The leachate trench was installed around the perimeter of the site with the exception of the southern boundary and between MH8 and PS9. In these areas, the landfill abuts areas of low permeability Abbotsford Formation siltstone and mudstone. The leachate interception trench surrounds the landfill area and is located between the RRPP, the sedimentation ponds and Kaikorai Stream (**Drawing 1**, provided in **Appendix 1**).

28 The trench creates a hydraulic barrier for groundwater and leachate migration offsite. The continuous dewatering of the trench is required to maintain this barrier, with the pump stations set to maintain water levels at low levels to create the hydraulic gradient which directs groundwater and leachate flow to the trench. The landfill consent conditions require regular monitoring of groundwater levels adjacent to the trench to confirm the hydraulic gradient. A typical cross section of the leachate trench is included in Figure 3 below.

29 The trench includes a HPDE liner on the outside of the trench. The HDPE liner aids in reducing the volume of water entering the trench from the

Kaikorai Stream and groundwater flow from outside of the landfill site but does not completely prevent inflows.

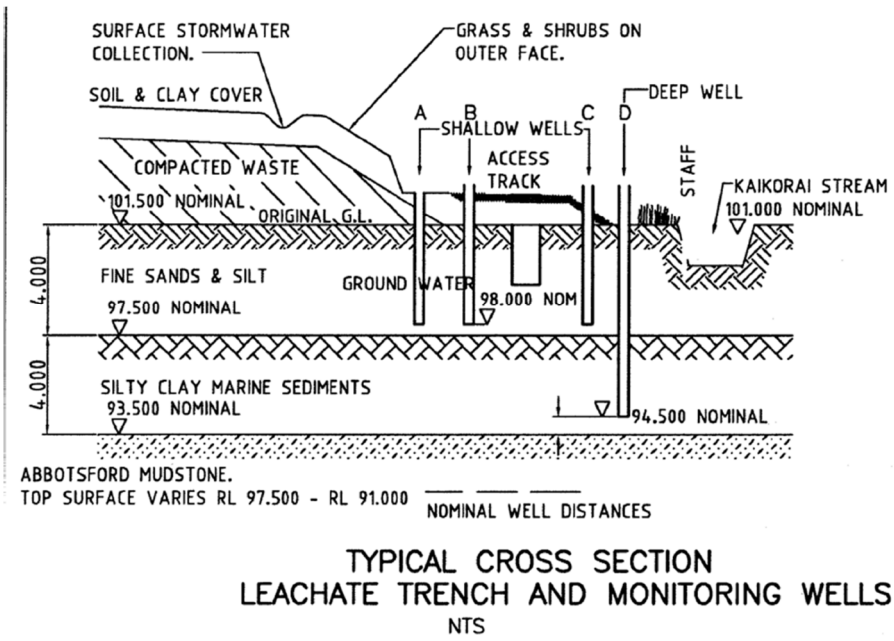


Figure 3 3 Schematic of leachate interception trench (MWH, 2004)

30 I have reviewed the groundwater measurements collected for the compliance monitoring (GHD, 2024a). These show the lowest water levels in the manholes and/or closest monitoring well to the interception trench. An example of the water level monitoring is provided as (**Drawing 2**, provided in **Appendix 1**).

31 As part of my assessment, I reviewed the leachate trench pump station flow rates. The flow rates vary, with higher flows during wet weather due to the diversion of stormwater flows to the leachate collection system as discussed in the evidence of Ms Wood.

Hydrogeology

32 Prior to the landfill, groundwater within the estuarine deposits (KEF) is likely to have been hydraulically connected to the Kaikorai Stream and other surface water features. The underlying Abbotsford Formation is inferred to be an aquitard due to the very low permeability of the mudstone/siltstone and is effectively an impermeable barrier for downward seepage. Adams Geotechnical (2019) reported permeabilities of between 3.8-7.8 x 10^{-10} m/s for the Abbotsford Formation Siltstone.

33 Groundwater investigations undertaken by GHD (2024b) and Beca (1992) determined low hydraulic conductivities for the estuarine sediments (LKEM, 10^{-6} to 10^{-10} m/s). Most of these investigations have been undertaken around the landfill perimeter. It is expected that the hydraulic conductivity of the estuarine sediments under the landfill may be further reduced due to the compression of the sediments from the weight of the landfill.

Groundwater levels

34 Monitoring of groundwater levels and groundwater quality in the perimeter monitoring wells (around leachate trench) is undertaken on a routine basis in accordance with the conditions of current landfill consent. The monitoring well network around the RRPP area is shown in **Drawing 1** (provided in **Appendix 1**). Additional monitoring wells (RRPPBH01-04) were installed in 2021 in landfill waste within the RRPP area.

35 There is a limited amount of groundwater level monitoring data that has been collected within the RRPP area. However, from the data I have reviewed, groundwater levels are mostly between 2 and 3 m depth within the landfill waste. Groundwater levels in RRPPBH04 were slightly deeper, between 3-3.5 m depth. Figure 4 shows groundwater levels recorded in RRPPBH03 and rainfall from June to July 2023.

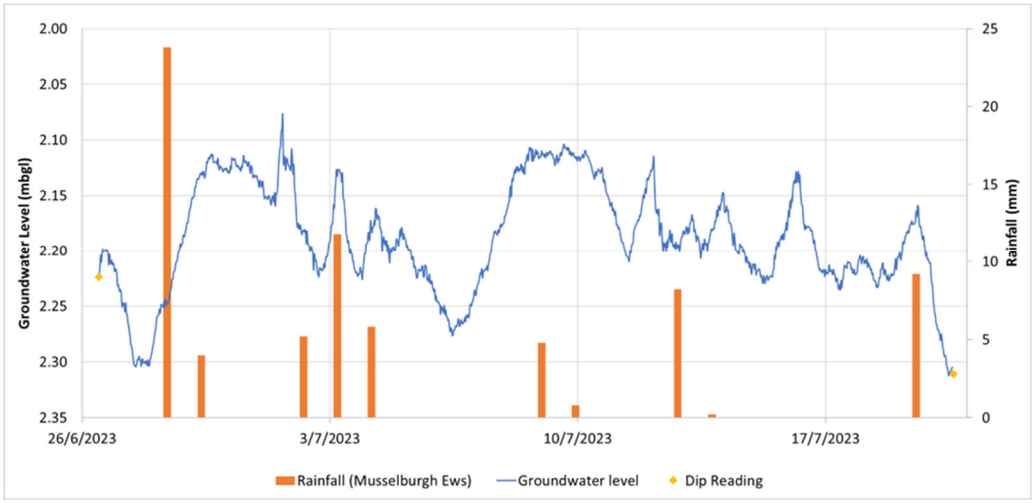


Figure 4 Groundwater level monitoring in RRPPBH03

Groundwater quality

36 Groundwater quality is influenced by the presence of landfill waste. In general, monitoring wells on the inside of the leachate (A and B series) are impacted by landfill waste. However, some of the wells on the outside of the trench also show the influence of landfill waste due to historic activities.

37 No water quality data is available for the monitoring wells installed within the RRPP area. However, given that they are screened in waste materials it is expected that the water quality will reflect landfill leachate chemistry with elevated contaminant concentrations including: dissolved metals, ammoniacal-nitrogen, boron, chloride, and high electrical conductivity

Other groundwater users

38 Bore records and bore and water take consents listed on ORC webmaps[1] were reviewed for a 2 km radius surrounding the site. Two water takes were identified, one upgradient of the site at Blackhead quarry and the other for Maxwells Landfill.

39 Two bore consents were identified, one of the bore consents (RM14.355.01) is described as "proposed". The other (RM22.311.01) is described as "decommissioned". Details on the RM22.311.01 consent indicates that bore (ORC well number CE17/0153) was drilled in March 2023. The bore was drilled to a depth of 32 m (Table 2.9) and appears to have been dry. This is not unexpected given the low permeability geology (mudstone and sandstone) that is present between the landfill and the coast.

40 Forty-nine bore records were identified in the area of interest. Forty six of the bore records are for monitoring and/or investigation (mostly for Green Island Landfill), one is listed as for dewatering (Green Island WWTP) and the two bore consents described above. The site is not located within a mapped aquifer or groundwater protection zone[2].

Assessment of effects

Approach taken

41 I have undertaken an assessment of the proposed RRPP development on groundwater and leachate migration. I have developed a conceptual model of the RRPP area to demonstrate the likely changes to the groundwater system as a result of the proposal. This conceptual model is shown in Figure 5.

42 I have also undertaken groundwater modelling to assess construction dewatering that may be required during the construction of the larger RRPP facilities. Modelling of the proposed dewatering was undertaken using 2D

[1] https://maps.orc.govt.nz/OtagoMaps/

[2] https://www.orc.govt.nz/plans-policies-reports/regional-plans-and-policies/water

Geostudio 2021 SEEP/W finite element modelling software. Modelling was undertaken to estimate the seepage into the proposed excavation and simulate drawdown of leachate levels within the RRPP area.

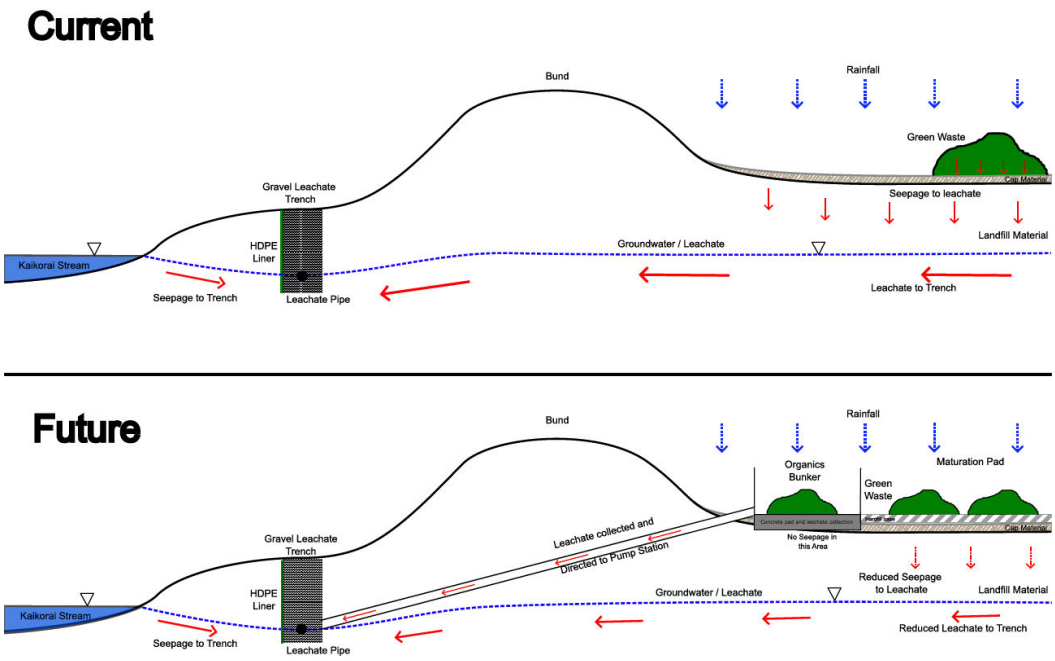


Figure 5 Conceptual groundwater model

Operational effects

43 As shown in the conceptual model, the increase in hardstand surfaces and building areas along with additional stormwater control measures as described in the evidence of Ms Wood, will result in more runoff and less infiltration into the landfill waste material underlying the RRPP area. This will result in a decrease in infiltration to groundwater, decreased leachate generation, and a decrease in the requirement for pumping and treating via the leachate collection system and Green Island Waste Water Treatment Plant (GIWWTP). I consider this to be a positive effect.

44 The current green waste/organics processing area (~ 1 ha) has no hard standing or formalised stormwater control measures. Any rainfall or seepage from the current operation will mostly seep into the underlying groundwater/leachate system. The past composting operation at the site will be replaced by the Organics Receivable Building (ORB) and Organics Processing Bunkers/Maturation area. For these new facilities, leachate will be collected and directed to the existing leachate collection system for treatment and stormwater runoff will be managed through the existing stormwater facilities as described in the evidence of Ms Mary Wood.

45 I understand that there are no changes proposed to the existing design and functioning of the leachate collection system to address the changes in runoff and leachate volumes as a consequence of the RRPP development. This leachate trench will continue to act as a hydraulic barrier and intercept leachate from the historical and existing landfill activities. The evidence of Ms Wood describes how the stormwater and leachate will be managed on site to ensure that leachate from the RRPP is pumped directly from the pump stations and will not backflow into the adjacent sections of leachate collection trench during periods of high rainfall and leachate generation.

Construction phase

46 Monitoring of leachate levels in the waste materials underlying the RRPP area indicates that dewatering may be required during the excavation and installation of a gravel raft foundation proposed for the RRPP buildings. Modelling was undertaken to estimate the required dewatering rate for the largest of the proposed excavations. The modelling assessment indicated inflow rates up to 0.2 L/s for the MRF building and apron excavation. Due to the presence of waste materials, it is assumed that all inflows will be landfill leachate.

47 I consider that my dewatering assessment is conservative, as I have modelled the largest (and deepest) excavation for the proposed structures. In addition, the modelling used winter groundwater levels. It is possible that dewatering may not be required if the works are undertaken during summer/dry conditions or a shallower excavation depth is used.

48 Leachate intercepted for construction dewatering will be directed to the leachate collection system or recirculated and discharge to the landfill for disposal. The estimated flow rates are well within the usual operating range of the leachate system.

49 The operation of the leachate collection trench (hydraulic barrier) means that the potential dewatering activities are unlikely to result in any additional groundwater drawdown outside of the landfill and RRPP footprint.

Effects on other groundwater users

50 The surrounding area is not used for groundwater supply due to the low permeability geology, with only two consented groundwater takes (within a 2 km radius of the site) located upgradient of the site (quarry and landfill). Of the two domestic bore consents in the surrounding area, one was dry and the other does not appear to have been drilled.

51 As noted above, the effect of the proposed dewatering activities of groundwater are expected to be limited to the area within the leachate perimeter trench with no effect on any other groundwater users.

52 The operation of the RRPP will not result in a discharge to groundwater and hence there are no impacts from the RRPP on groundwater quality.

Cumulative effects

53 The overall impact of the RRPP development on groundwater is likely to be a reduction in leachate generation at the site and leachate collection from groundwater / treatment requirements. This is considered a positive effect on the wider management of leachate at the site.

Matters raised by submitters

54 I have reviewed the matters raised by submitters. There were no submissions relating to groundwater effects.

Conclusion

55 I consider that the overall impact of the RRPP development on groundwater is positive due to the reduction in leachate generation from the increased hardstand areas and subsequent decrease in rainfall infiltration to the waste.

56 Excavations undertaken for building construction for the RRPP development may require temporary dewatering. However, it is expected that the inflow rates will be slow and can be discharged to the leachate interception trench system or back to the main landfill.

Dusk Mains

6/11/2024

References

Adams Geotechnical (2019): Green Island Landfill Clay cover System. Borrow South Investigations. Report C301-J1810-D005-v1. Issued 11 June 2019.

Beca Steven, 1992. Environmental Impact Assessment of the Extended Green Island Sanitary Landfill.

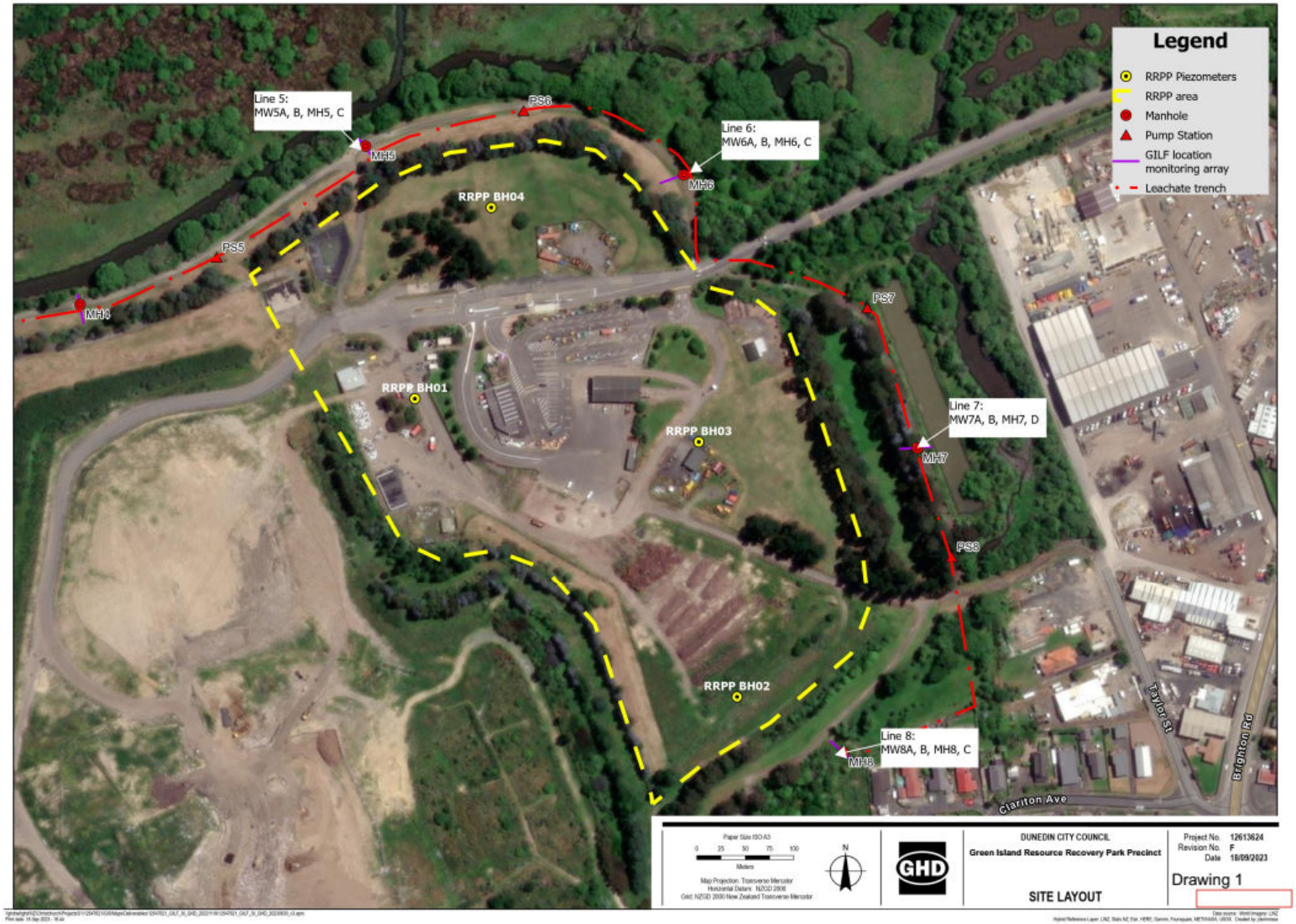
GHD (2024a) Green Island Landfill Annual Compliance Monitoring Report July 2023 – June 2024. Report prepared for the Dunedin City Council, September 2024.

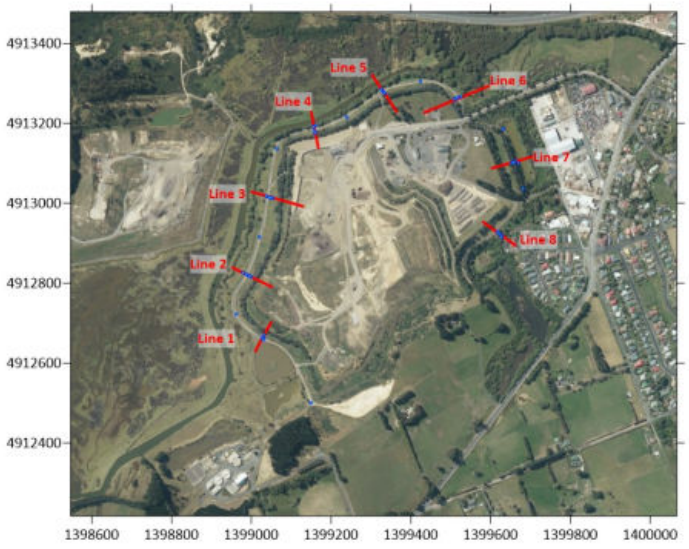
GHD (2024b) Waste Futures – Green Island Landfill Closure. Groundwater Technical Assessment – October 2024 Update.

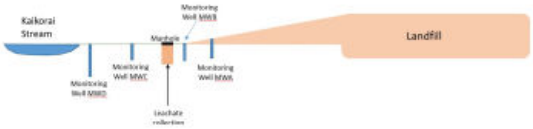
McKellar, I.C. 1990: Miscellaneous map of New Zealand – southwest Dunedin urban 1:25 000. Map (1 sheet) and notes (64 p) Wellington, Department of Scientific and Industrial Research.

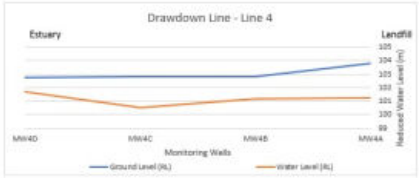
MWH 2004; DCC Landfill Annual Survey Plans – July 2004. Green Island Landfill – Leachate Collection & Environmental Monitoring System. Drawing 006116-19-01, Sheet G11, Rev C. Dated 01 July 2004.

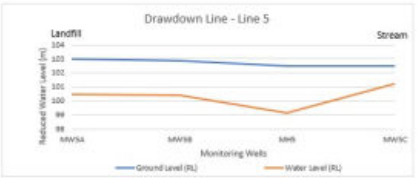
Appendix 1 – Drawings

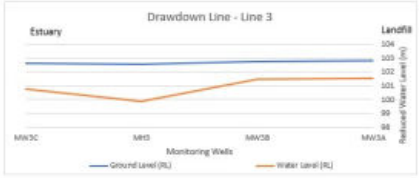


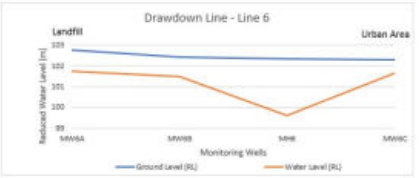


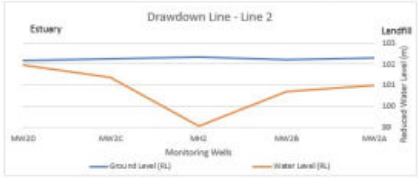


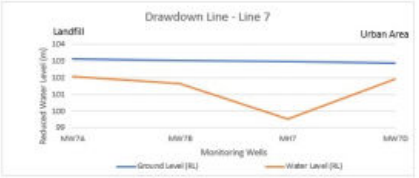


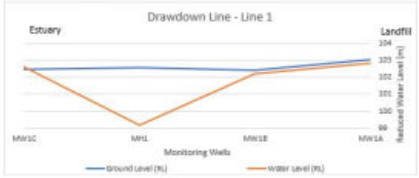


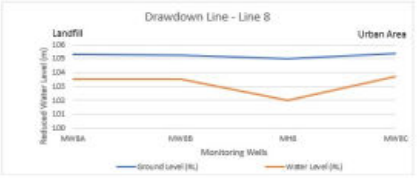












Sources: Aerial (LINZ: Aerial Dunedin 0.4m Rural, 2013, NZGD2000) ; Computed using Green_Island_water_levels.xlsb.xlsx

GHD

Dunedin City Council

DCC Landfills 2024

Monthly Transects - Green Island July 2023

Job Number 12615516
Revision A
Date 30/07/2024

Drawing 2

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