BEFORE A HEARINGS PANEL OF THE GREATER WELLINGTON REGIONAL COUNCIL

UNDER	**the Resource Management Act 1991 ("the Act")**
IN THE MATTER OF	**Resource Consent Applications to Greater Wellington Regional Council pursuant to section 88 of the Act to discharge contaminants to land, air and water**
BY	**South Wairarapa District Council**
FOR	**the proposed staged upgrade and operation of the Featherston Wastewater Treatment Plant**

BRIEF OF EVIDENCE OF CHRISTOPHER ROBERT JAMES SIMPSON ON BEHALF OF SOUTH WAIRARAPA DISTRICT COUNCIL

GROUNDWATER EFFECTS

DATED 29 MARCH 2019

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EVIDENCE OF CHRISTOPHER ROBERT JAMES SIMPSON ON BEHALF OF SOUTH WAIRARAPA DISTRICT COUNCIL

1. My full name is My name is Christopher Robert James Simpson.

RELEVANT EXPERIENCE

2. I presently hold the position of Hydrogeologist and I have been a Director and co-owner of the consultancy company 'GWS Limited' since 2013. I have been practicing as a geologist for the past 25 years.

3. My background is as an engineering geologist and environmental scientist, with my specialist area of expertise being hydrogeology. I hold a Bachelor's Degree and a Master's Degree with Honours in Geology from the University of Auckland. I am a Certified Environmental Practitioner (CEnvP) through the Environmental Institute of Australia and New Zealand (EIANZ) and am a member of IPENZ.

4. My early career was in the mining industry where I held positions in gold exploration and mining. Since 1998 I have been a consultant geologist, initially employed by the engineering company Woodward Clyde / URS and am now an owner and director of GWS Limited, a specialist groundwater consultancy. In addition to my consulting role, I also taught post graduate level hydrogeology part time at the University of Auckland between 2011 and 2014.

5. As a practicing consultant, I have been involved in the fields of soil and groundwater remediation; engineering hydrogeology; construction dewatering; groundwater resource development; and wastewater disposal. During this time, I have become a specialist in assessing the effects that the land application of treated wastewater has on groundwater.

6. The following list provides some projects in which I have had a role in assessing site suitability, groundwater effects and/or as a reviewer.

Community Wastewater Schemes - Kumeu – Huapai - Karaka - Kawakawa Bay - Maketu - Mangawhai - Morrinsville - Oamaru Bay - Omokoroa	- Queenstown - Pauanui-Tairua - Puketutu Island - Riversdale - Rotorua - Te Aroha - Wairakei - Whakaipo - Whitianga
Industrial Wastewater - Dairyfert Pinedale - Fonterra Lichfield - Kawerau Paper Mill	- BP Silverdale - Omaha Golf Course - Waiouru Army Base - Whanganui Prison

CODE OF CONDUCT

7. I have read the Code of Conduct for Expert Witnesses in section 7 of the Environment Court's Practice Note (2014). I agree to comply with that Code of Conduct. Except where I state that I am relying upon the specified evidence of another person, my evidence in this statement is within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions which I express.

MY ROLE IN THE PROJECT

8. The groundwater effects evaluation for the Featherston wastewater land treatment project was undertaken by Lowe Environmental Impact (LEI, June 2016) and was largely based on work previously undertaken by Tidswell (2008).

9. I became involved in the project in August 2016 when I was engaged by the South Wairarapa District Council (SWDC) to assist with answering further information requests made by the Greater Wellington Regional Council (GWRC). These requests were based largely around assessing groundwater mounding effects, as well as effects related to nutrient and pathogen fate in groundwater. This work has included groundwater modelling and an environmental risk assessment. I prepared a number of reports dated 7th February 2017, 1st June 2017, 10th October 2017 and 14th December 2018 in which further assessment of the potential groundwater effects was undertaken.

10. I can confirm that I have previously visited the Featherston WWTP and surrounding land application areas to validate my understanding of the site and its surrounds.

SCOPE OF EVIDENCE

11. My evidence will address the following:

(a) An overview of the methodology applied in my assessment.

(b) Assessment of the likely effects on groundwater.

(c) Mitigation and management of effects where required.

(d) Response to submissions.

(e) Response to officers/technical reports.

(f) Assessment conclusions.

PROJECT DESCRIPTION

12. The project has been described in detail by others, however, the relevant project elements as they relate to groundwater effects are reiterated as follows:

(a) The primary means of wastewater disposal is a direct surface water discharge with land disposal only used as contingency under high flow conditions.

(b) The project includes the periodic application of treated wastewater to the land surface for contingency wastewater disposal via irrigation.

(c) It is proposed that land application of wastewater would take place in a staged manner over two blocks of land referred to as Site A (8 ha irrigation area) and Site B (116 ha irrigation area) [Figure 1]. The land application regime is designed based on deficit irrigation at Site A, where the irrigation rate is matched to plant uptake; and deferred irrigation on Site B, where irrigation is ceased under saturated soil conditions.

(d) I understand that a key initial part of the project is to reduce the volume of water entering the wastewater reticulation system through the reduction of stormwater inputs as well as groundwater infiltration. This will ultimately determine the volume of wastewater required to be disposed to land.

HYDROGEOLOGIC SETTING

13. The hydrogeology of the area has previously been described by others (Tidswell, 2008, GWRC 2010 and LEI, 2016) and is summarised as follows. The Wairarapa Valley is infilled with a sequence of sediments deposited during successive glacial and interglacial periods and consists of thick greywacke gravel beds interbedded with lower permeability mud and silt layers. The subject sites occupy an area of the Tauherenikau fan complex, which is a wedge of mixed outwash sediments deposited from the last glaciation [Figure 2]. These materials consist of poorly sorted, coarse gravels that becomes matrix bound (i.e. have an increasing clay content) with depth. This means the upper 20 to 30 m of the sequence is relatively permeable and due to this fact water supply bores are commonly shallow in this area.

14. On a regional scale, the subject sites are generally, in the middle of a groundwater discharge zone, where the surface of the water table in the aquifer intercepts the land surface [Figure 3]. Where rivers, streams and drains are incised into the land surface and are below the groundwater level, these water bodies gain water (i.e. artesian conditions exist). This discharge zone generally starts in the vicinity of Featherston township and continues south to Lake Wairarapa, being the main direction of groundwater flow. The area is commonly referred to as the Featherston Springs. The presence of the groundwater discharge zone is of

importance as this is where potential contaminants will emerge in surface waters, as opposed to entering the deeper aquifer systems. The general regional flow pattern is in a southerly direction towards Lake Wairarapa [Figure 4]. The lateral hydraulic gradient in the western side of the fan is around 0.008, however, this flattens to the south and in the area of the subject sites to 0.004.

15. The drainage pattern over much of the Tauherenikau fan is highly influenced by the presence of an extensive network of creeks, drains and interlinked water races [Figure 5]. The artificial drainage and water race system gains groundwater during winter months and are neutral to losing during summer months, depending on the locality. Downstream of the WWTP, surface waters are gaining year-round.

16. A series of investigations (LEI, 2013, 2015, 2018; PGES, 2016) have been undertaken to characterise the sites hydrogeologic conditions. This work has indicated the depth to groundwater in the shallow groundwater system varies from approximately 3 m below elevated areas to <0.5 m in depressions [Figure 6]. There is a general reduction in the depth to groundwater from north to south as the discharge zone is approached. Groundwater levels have been observed to vary by 0.5 m to 1.5 m seasonally.

17. The hydraulic properties of the unconfined aquifer have been assessed from in-situ testing of the soils (LEI, 2013 and 2015); from a stream bed conductance survey (Butcher, 2016); from a site-specific pumping test (Butcher, 2019); from surrounding aquifer tests (GRWC, 2010) and from model calibration as part of the work I have undertaken. Overall, the aquifer is considered to have a high hydraulic conductivity, which is consistent with the gravel and sandy soil textures that are observed in the near-surface below the topsoil layer. A horizontal hydraulic conductivity of 14 m/d and vertical hydraulic conductivity of 3 m/d was adopted in my assessment of effects to represent the shallow groundwater system.

SITE CONCEPTUAL MODEL

18. Understanding of the groundwater system's response to the application of treated wastewater to land is key to understanding the potential for effects that potentially could develop. Typically, where water is discharged to land, groundwater mounding occurs due to the build-up of water in the soil profile. Under such conditions, the aquifer permeability, storage properties, rate of application and irrigation field shape determine the degree of mounding that might occur.

19. I have provided a conceptual illustration [Figure 7] of the shallow groundwater system for the site in cross section, and what is expected to happen in response to the application of treated wastewater to land. The key points are as follows:

- The wastewater infiltration rate is very much lower than the shallow aquifer vertical permeability value (Kv), meaning infiltration to the aquifer will occur readily.

- The aquifer vertical permeability value (Kv) is smaller than the aquifer horizontal permeability (Kh) value and, as such, groundwater will have a tendency to move sideways into the surface water bodies.

- There is a vertically upward hydraulic gradient beneath the site resulting in a limited ability for deep flow paths to develop.

20. In summary, the magnitude of mounding that can develop beneath the land disposal areas is constrained by the ability of groundwater to move laterally and discharge into the water races and surface water bodies. This occurs naturally in any case and any additional raising of the groundwater level due to irrigation will result in a larger seepage profile and area, and an in increased discharge to surface waters limiting the magnitude of groundwater mounding that occurs.

METHODOLOGY

21. The methodology used in my assessment has been to review the work previously undertaken in order to collate the available information relevant to characterising the hydrogeologic environment, such as site geology; groundwater levels; aquifer parameters; and surface water hydrology. This information was then used to develop a conceptual hydrogeologic model that describes how the groundwater system works and interacts with the environment. The conceptual hydrogeologic model also assists in identifying exposure pathways resulting from any constituents entering the groundwater system due to the land application of wastewater.

22. Following development of the conceptual hydrogeologic model, a quantitative groundwater effects assessment was undertaken. This assessment has involved the use of a number of analytical calculations, which were then followed by the development of numerical groundwater models in both SEEP/W and MODFLOW software packages. Steady state (non-time related) flow conditions were calibrated to the interpreted water table [Figure 4]. This provided the initial conditions for the transient model (time related) runs that simulated the daily irrigation of wastewater. The daily surface flux inputs to the groundwater model that represents drainage reaching the aquifer below the rooting zone were provided by LEI and were derived from a water balance model that simulates evapotranspiration and plant uptake.

ASSESSMENT OF EFFECTS

Groundwater Mounding

23. Mounding of the water table surface can result in increased hydraulic gradients within and surrounding the irrigation areas and this can affect flow paths to the receiving environment. Further, if excess mounding occurs, such that the water table reaches the land surface (i.e. fully saturated conditions), then surface ponding and run-off (break out) of the irrigated wastewater can occur. This is an undesirable effect as there would be limited land treatment of the wastewater before entering surface waters. This degree of saturation would also limit the ability to apply wastewater to land, resulting in a loss of treatment capacity for the scheme.

24. The degree of mounding likely to occur from the proposed land application of treated wastewater (without restrictions) was estimated as part of the groundwater assessment. The groundwater model was run under the proposed irrigation scheme and areas where the water table reaches <0.6 m from the land surface has been identified [Figure 8]. The affected areas are coincident with areas adjacent to the Creeks at Site A and in the middle of Site B. This is primarily due to depressions on the land surface relative to the water table. The model results show these areas are relatively small, however, it means that they could not be irrigated at the proposed rate throughout the entire season as runoff to surface waters could occur. The model results indicate that these effects are contained within the irrigation areas as off-site effects are limited by the bounding surface water bodies.

25. To address this potential mounding issue, the proposed conditions of the consent are written such that ponding and surface run off from the irrigation is not permitted to occur. In addition, the irrigation areas have buffer zones in place to provide a separation distance between surface water bodies and this will assist in mitigating the potential for run-off entering the environment. These are standard conditions present in most land discharge consents where treated wastewater is applied to land. In my experience they work well and can be readily implemented and monitored.

26. The proposed means of ensuring compliance would be to reduce the rate and/or duration of irrigation at these locations. Any disposal capacity that has been lost may, be regained by increasing the rate of application in areas where greater vadose zone thickness is present. Alternatively, additional capacity could be gained if additional land becomes available for irrigation (for example the Golf Course site) or if a component of direct surface water discharge remains (as is proposed)

27. Aside from the consent conditions that will manage the potential effects associated with groundwater mounding, the irrigation of wastewater would occur

in a staged manner over time, commencing with Site A. This approach will provide an understanding of the actual mounding effects through monitoring of groundwater levels. This monitoring will enable a direct understanding of changes in groundwater levels and quality in response to irrigation rates and this knowledge can be used to revise the understanding and management of potential risks to other irrigation areas developed in the future. This adaptive management approach will allow the opportunity to adjust loading rates accordingly to site variability, while ensuring that ponding and surface breakout of wastewater does not occur.

Nutrients

Environmental Effects

28. It is proposed that deficit and deferred irrigation will be adopted as a management philosophy for the land application. This approach would result in the maximum plant uptake of nitrogen and result in minimal leaching or loss of nitrogen to the aquifer. There will, however, be some nitrogen introduced into the unconfined aquifer system. The pathways for nutrients to enter surface water is via the surface water bodies and drainage network that may intercept shallow groundwater.

29. Groundwater discharge from the land application would likely enter Donalds Creek in down-gradient gaining reaches, however the discharge volumes would be very small relative to river flows. The effects of nutrients entering the surface waters are discussed in detail by Mr Hamill and Ms Hammond.

30. Ongoing monitoring of shallow groundwater quality will be undertaken as part of the consent conditions that requires the development of a groundwater monitoring and management plan. This monitoring will assist in validating the effects assessment undertaken as well as providing an early indication of changes (if any) to groundwater quality beyond those predicted and will allow adjustments to the irrigation management to reduce off site impacts if that is required.

Human Health Effects

31. The average aquifer concentration of nitrogen after mixing is dependent on the initial wastewater concentration assumed and the background concentrations already present in the shallow groundwater system. The groundwater effects assessment has shown that the discharge from the irrigation areas would not result in concentrations of nitrate in the aquifer in excess of Ministry of Health (MoH, 2008) drinking water standards (11.3 mg/L). It should be noted that the nitrogen loading from the proposed land application of treated effluent will be no worse than that presently emanating from the sites under the land use of dairy farming.

32. I also note that the Applicant is now proposing to offer and alternative supply of potable water for all shallow bores which are being used to provide drinking water within the area of effect. This means that issues associated with human health arising from nitrate levels in water are not of concern.

Pathogens

33. The fate and survival of pathogens during the wastewater treatment and land disposal process will be governed by three principal factors:

- Reduction of pathogens due to the level of treatment prior to disposal.
- Reduction of pathogens in the unsaturated zone during percolation.
- Reduction of pathogens in the aquifer.

34. It is anticipated that a 2-3 logarithmic (i.e. 100 to 1000) reduction in pathogens could occur through the wastewater treatment process. With initial populations likely to be in the order of 100,000 bacteria and 1,000 viruses per litre, the wastewater treatment process is the most significant stage of pathogen removal prior to land application.

35. Once applied to the land, a further reduction in pathogens will occur in the unsaturated zone due to filtration. The effectiveness of filtration within the unsaturated zone is dependent on certain conditions related, largely, to the rate of application, unsaturated zone thickness within the soil profile and soil texture. Under the proposed deficit and deferred irrigation methods, these conditions would be satisfied and the reduction of pathogens in water passing through the soil profile will be optimised and a further 1 to 2 logarithmic reduction in pathogens can be expected.

36. Once entered into the shallow groundwater system, a further reduction in pathogens occurs due to die-off over time as they are transported away from the irrigation areas. The rate of die-off is dependent on the type of pathogen (bacteria or virus), and the rate of movement in the groundwater system (velocity). Travel time for groundwater movement through the 25 m buffer zones has been calculated to be in the order of 10 days.

37. An assessment of bacterial die-off in the aquifer has been undertaken by adopting E.Coli, with an initial concentration of 100 bacteria per litre, and this indicates there would be complete die-off (<1 viable E.Coli) within 7 days. In other words, no viable E.Coli would be expected to be present in the groundwater discharge beyond the 25 m irrigation site buffer zone. A more conservative assessment adopting an initial concentration of 1,000 bacteria per litre indicates there would be complete die-off within 10 days. Again, no viable E.Coli would be expected to be present in the groundwater discharge beyond the 25 m irrigation site buffer zone.

38. In summary, it is unlikely that significant counts of viable pathogens derived from the wastewater would move beyond the property boundary and enter surface waters and the wider groundwater system.

39. There are, however, three circumstances under which a departure from the assumptions used in these calculations might deviate in relation to viruses;

- An outbreak of a more persistent virus could occur (e.g. Norovirus).
- The viral population is higher than assumed during an outbreak.
- Travel times are faster than expected (e.g. due to the influence of bores and/or preferential flow paths).

Under such conditions there is a residual risk that viruses could enter surface waters or move past the site boundary in the shallow groundwater system.

40. If viruses were to enter surface waters, the exposure pathway to human health would be via recreational contact or ingestion (i.e. contact with and drinking surface waters). The risks associated with this exposure are addressed by Mr McBride.

41. If viruses were to enter the shallow groundwater system, there is the potential that these could be ingested if the water is taken for potable use from a nearby bore. Norovirus, in particular, is considered to be a conservative tracer virus as it can potentially survive in groundwater for up to 3 years (Seitz et al, 2011) and is highly infectious. To remain conservative, and to account for uncertainties associated with preferential flow paths, a 5 year travel time envelop is typically adopted to protect groundwater users. For this reason, the groundwater model has been used to define an effects envelop to identify potentially at risk water supply bores based on a 5 year travel time [Figure 9]. I note that this envelope does not account for interception of the treated wastewater by the surface water bodies i.e. it assumes groundwater can flow beneath the creeks and drains. In reality, I expect most of the groundwater from the site to discharge to surface waters as previously stated. Accordingly, I believe that my assessment below and therefore Mr McBride's is conservative.

42. There is a total of 26 groundwater users within or near the edge of this envelope based on the GWRC database. I note that the applicant also undertook a mail survey to property owners in the surrounding area to identify any previously unregistered bores. The bores identified to be within or close to the 5-year travel envelope are included in Table 1 showing details of their recorded depth and use. Figure 10 shows the location of these bores. The bores have been classified as potentially being at risk where they are shallow (<30 m depth) and within the effect envelope. Bores that are shallow and on the periphery of the effects envelop, or are bores >30 m depth, are classified as not being at risk. This

screening highlights 17 bores as being potentially at risk. Only 9 of these bores are identified as being for domestic use, however it cannot be assumed water taken for other purposes does not include a component of potable water use.

43. It is of note that irrespective of the proposed land application of treated wastewater these shallow bores, being in an unconfined aquifer, are deemed insecure in any case, and those that are in gravel aquifers with shallow soils are particularly susceptible to potential pathogen contamination (MoH, 2000).

44. Given there is potable groundwater use within the area of effect, monitoring and/or mitigation is proposed for those bores identified as being potentially at risk. This is likely to take the form of a providing and alternative source of potable use groundwater, for domestic use to eliminate the risk. Alternatively, treatment of groundwater to achieve a potable standard at the point of use could be considered (i.e. disinfection). Given the distance and travel time to many of the bores, the likely risk of the water supply being impacted is low and monitoring of the groundwater water quality could also be considered at the effluent discharge point, site boundary or at the points of use. As groundwater moves very slowly, any potential changes in water quality could be identified prior to it impacting the water supplies. If unacceptable levels of contamination are identified, then potable water supply could be offered at that point.

PROPOSED CONDITIONS

45. The following bullet points outline the proposed conditions that manage the potential risks identified though the groundwater effects assessment:

a) Prevention of surface ponding and breakout.

b) Appropriate buffer distances to surface waters.

c) Maintaining separation to groundwater surface through groundwater level monitoring.

d) Monitoring of groundwater quality at the site boundary to assess nutrient and pathogen loading.

e) Ensuring that no potable use of shallow groundwater in area affected by the land discharge based on the 5-year travel envelope.

f) Development of a groundwater monitoring and management plan.

RESPONSE TO OFFICERS REPORTS

46. The information requested by the council reviewers was provided on 26th February but was not included in the officer's report issued on 27th February. I expect most of the further information requirements are now satisfied. However, I provide the following comments on specific items raised.

47. I note that the depths to groundwater quoted on p18 of the report are more accurately defined by recent investigations as discussed in paragraph 16 of my evidence.

48. In reference to p20 of the report, I can confirm SWDC have undertaken a mail drop survey to identify bores that were previously unregistered.

49. P22 the report refers to water supply bores within the envelop of effect that could potentially be impacted by pathogens. This is discussed in paragraphs 41 to 44 of my evidence and proposed conditions for management of this risk in paragraph 45.

50. On p22 of the report, there is an indication that the reviewers consider there is the potential for more than minor effects occurring on neighbouring properties as a result of groundwater mounding. My understanding is that the effects referred to relate to raising of the groundwater level such that it might affect land use i.e. drainage. I respond by referring to my earlier evidence which outlines the steps which will ensure mounding does not occur. I also note that the site is naturally in a groundwater discharge zone and that is why the land has been extensively drained. Maintaining buffer zones, as proposed, will allow dissipation of groundwater mounding before reaching the site boundary. In addition, almost all of the site boundaries are adjacent to a creek or drain, therefore limiting the ability for mounding effects to propagate off site. Monitoring of groundwater levels at the site boundary is proposed to ensure saturation conditions are not exacerbated by the irrigation of treated wastewater. The locations of these monitoring wells will be targeted towards areas where creeks or drains do not bound the site, notably at the southern boundary and parts of the eastern boundary of Site B. In summary, in my opinion the proposed adaptive management provisions will ensure that mounding does not occur off site to the extent it affects land use.

RESPONSE TO SUBMISSIONS

51. Many submissions have been made on the basis that a shallow water table exists. I agree with these statements and this has been quantified as part of the site investigations. The inference is that this could result in surface ponding or breakout of treated wastewater that could then enter surface waters. I am satisfied that the proposed consent conditions relating to the prevention of ponding and surface breakout, as well as the proposed conditions relating to buffer distances and the monitoring plan, adequately manages this potential risk.

52. Submissions related to impacts on the aquifer and on bores are addressed through bore security. Where deep bores exist, the risk of contamination is in my opinion very low. Where shallow bores are located within the area affected by the land discharge, the use of this groundwater will need to be limited to stock

watering or the bores completely abandoned for potable use and an alternative supply provided.

53. I understand that Sustainable Wairarapa have made a submission (#146) that suggests a reduction in infiltration into the wastewater reticulation network would raise groundwater levels. In my opinion I consider that the reduction in infiltration will be comparatively small relative to the magnitude of groundwater throughflow, and any such effects are likely to be localised and a function of the immediate surrounds. Mr Park comments further on this matter in his evidence.

CONCLUSIONS

54. Overall, I consider the effects related to the application of treated wastewater to the land surrounding the Featherston WWTP to be less than minor. I consider this to be the case because either the effects are insignificant or can be managed by imposing conditions to address potential risks.

55. I consider the potential risk associated with avoiding groundwater mounding, affecting the scheme capacity can be resolved through adaptive management using a staged approach to irrigation.

56. In my opinion, the risks of groundwater mounding affecting adjacent land use to be less than minor due to site buffer zones and bounding surface water conveyance bodies. Monitoring of groundwater levels to ensure the water table remains below the land surface will be undertaken and this will manage the residual risks.

57. Irrespective of the proposed land application, the health risks associated with potable use of the groundwater system already exist due to the nature of the surrounding land use being dairy farming and the shallow bores not being secure. There is a potential risk to potable groundwater users due to virus transport in the shallow groundwater system over a limited area, and as such, Myself and Mr McBride have recommended measures which will avoid the risk to these users by providing a source of alternative potable water. That could either be provided from the outset or could be provided to any bores found to be at risk after monitoring of virus travel.

Signed:

NAME: Christopher Simpson

DATE: 29th March 2019

REFERENCES

Ministry of Health, 2000. Code HE1129.Secure Groundwater Bores and Wells for Safe Household Water.

Seitz et. al. 2001. Norovirus Infectivity in Humans and Persistence in Water. Applied and Environmental Microbiology, Vol 77, No 19.

Figures

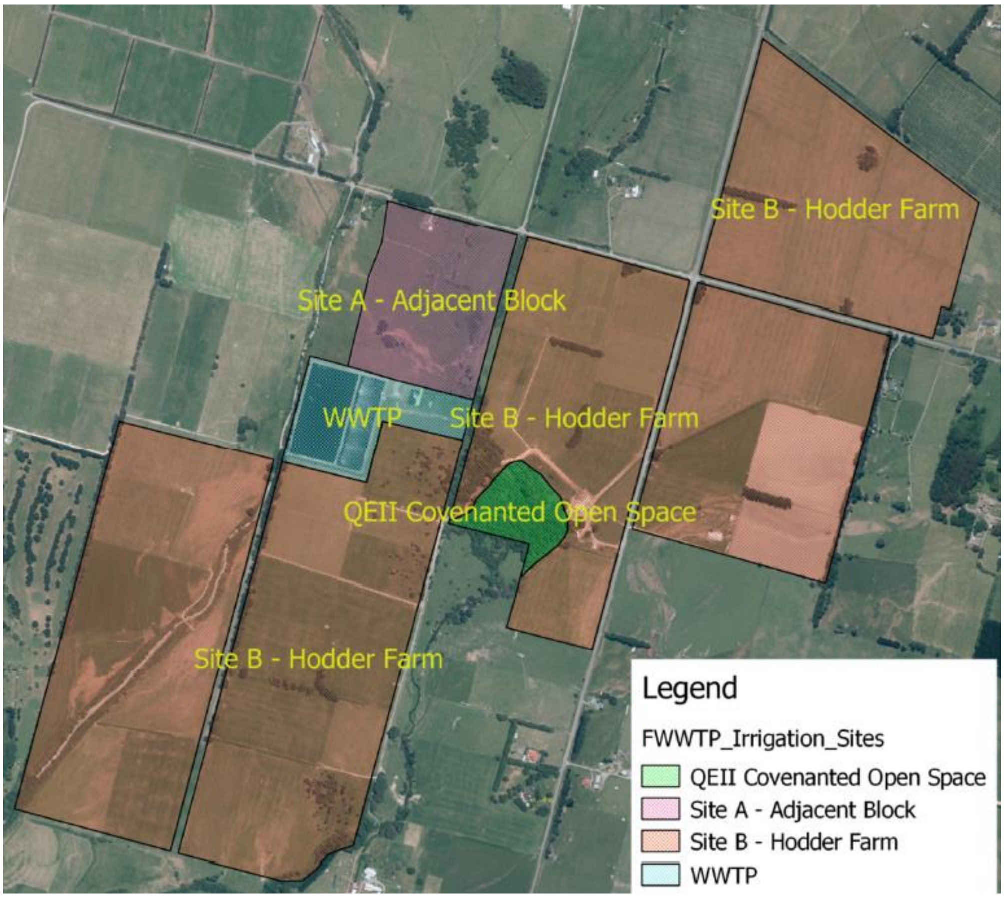

Figure 1 Land Disposal Area

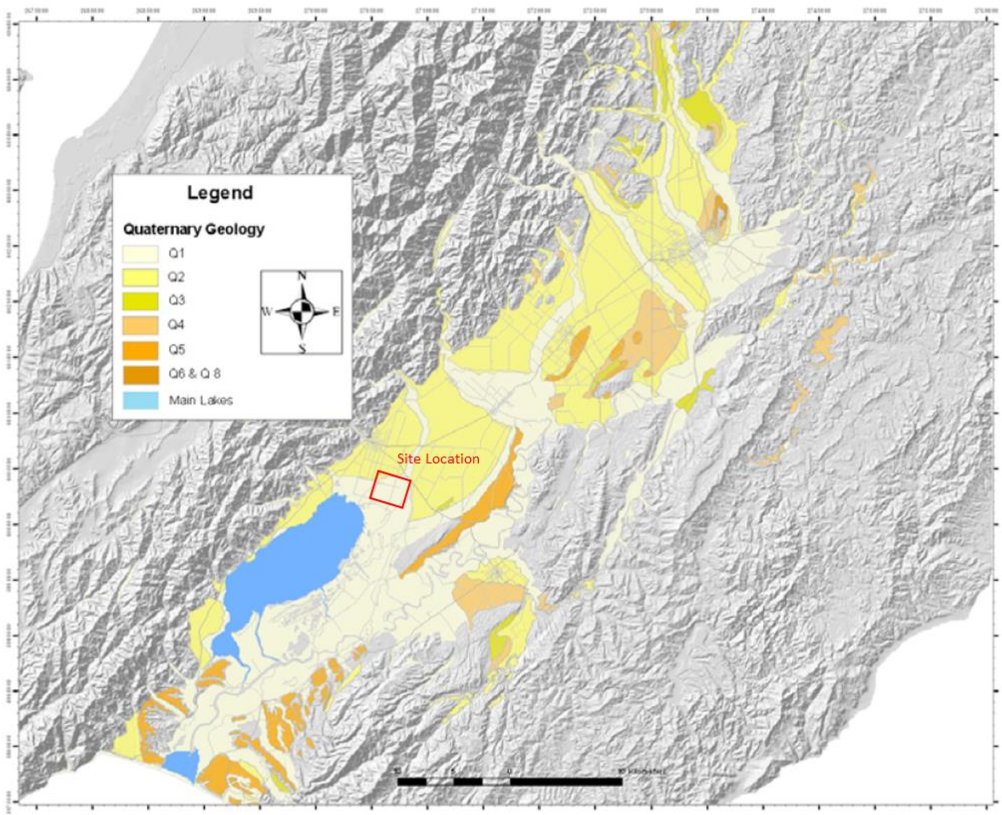

Figure 2 Surface Geology of the Wairarapa Valley (after Beeg et al. 2005)

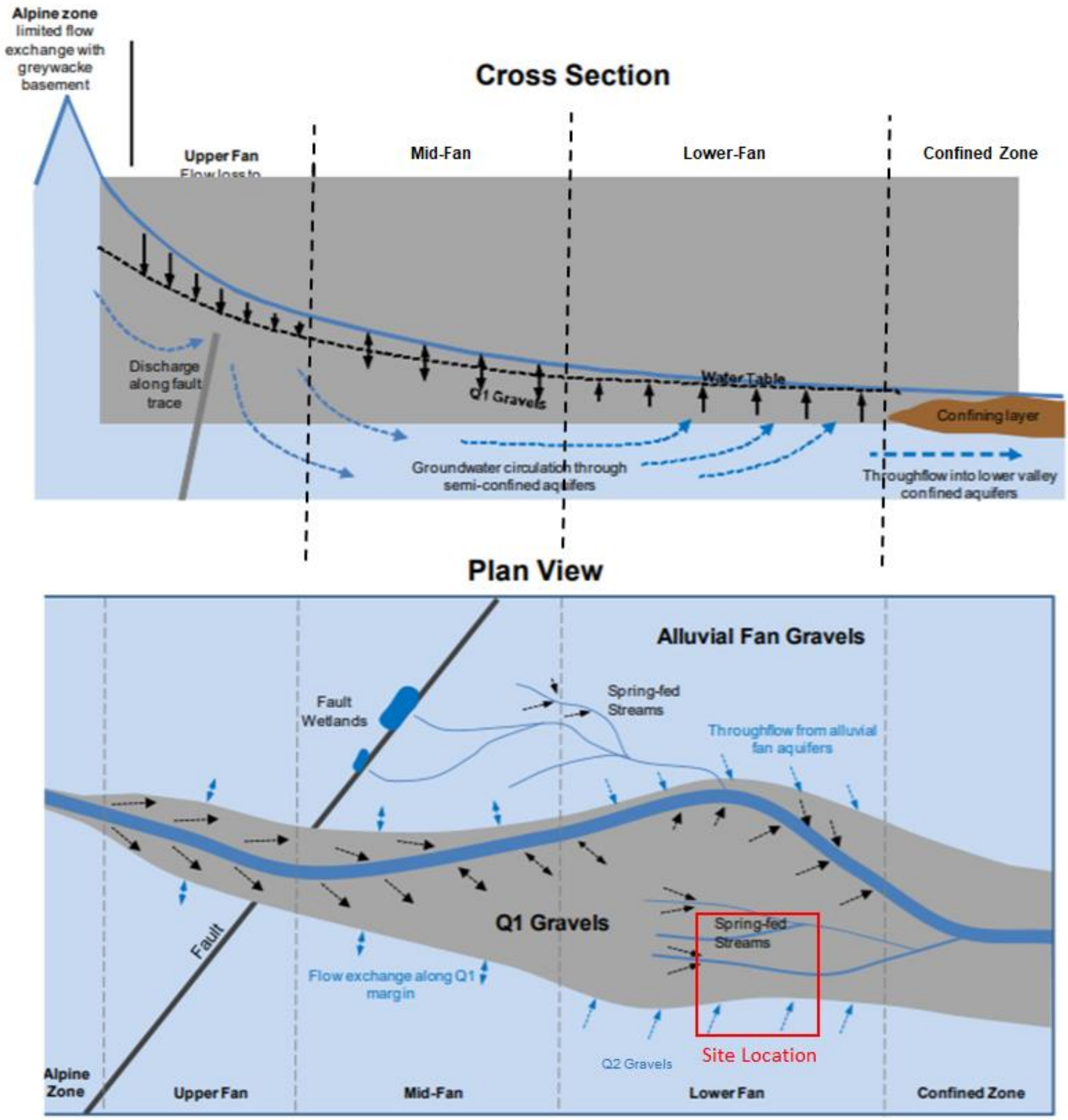

Figure 3 Conceptual Hydrogeology

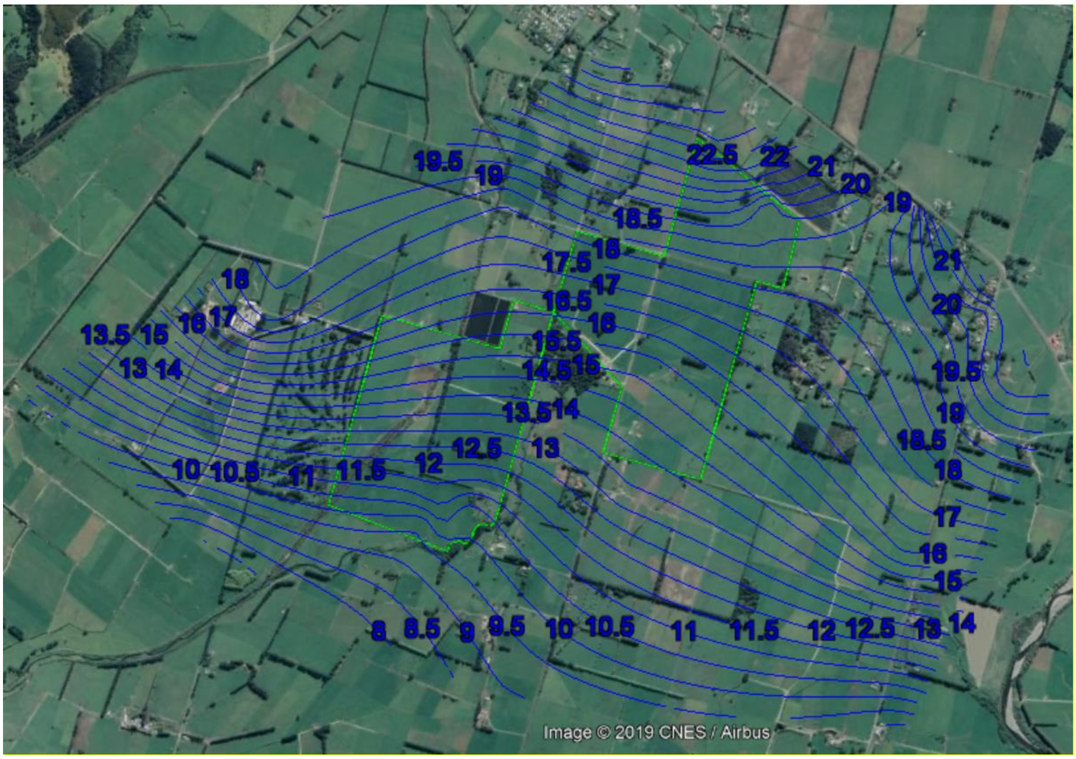

Figure 4 Interpreted Water Table Elevation Plan (m RL) Nov - Dec 2018

Figure 5 Surface Water Drainage Network within the Site Area

Figure 6 Depth to Groundwater (m Below Ground Level)

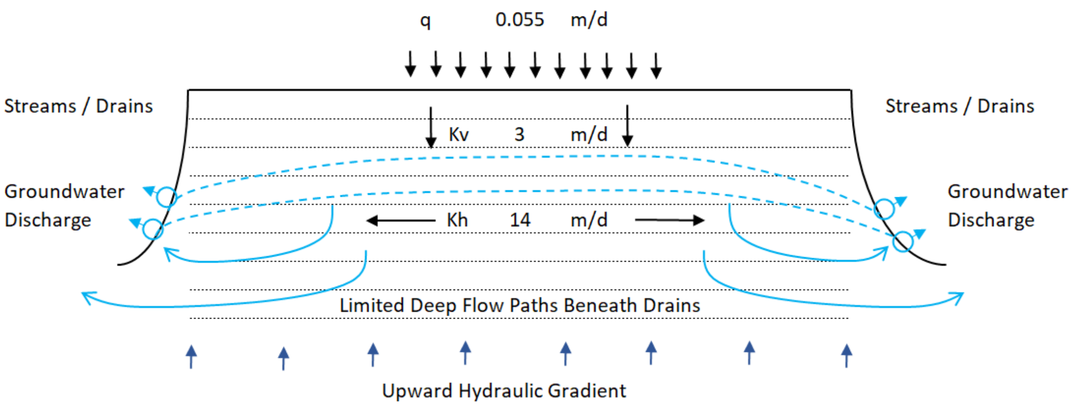

Figure 7 Site Conceptual Model

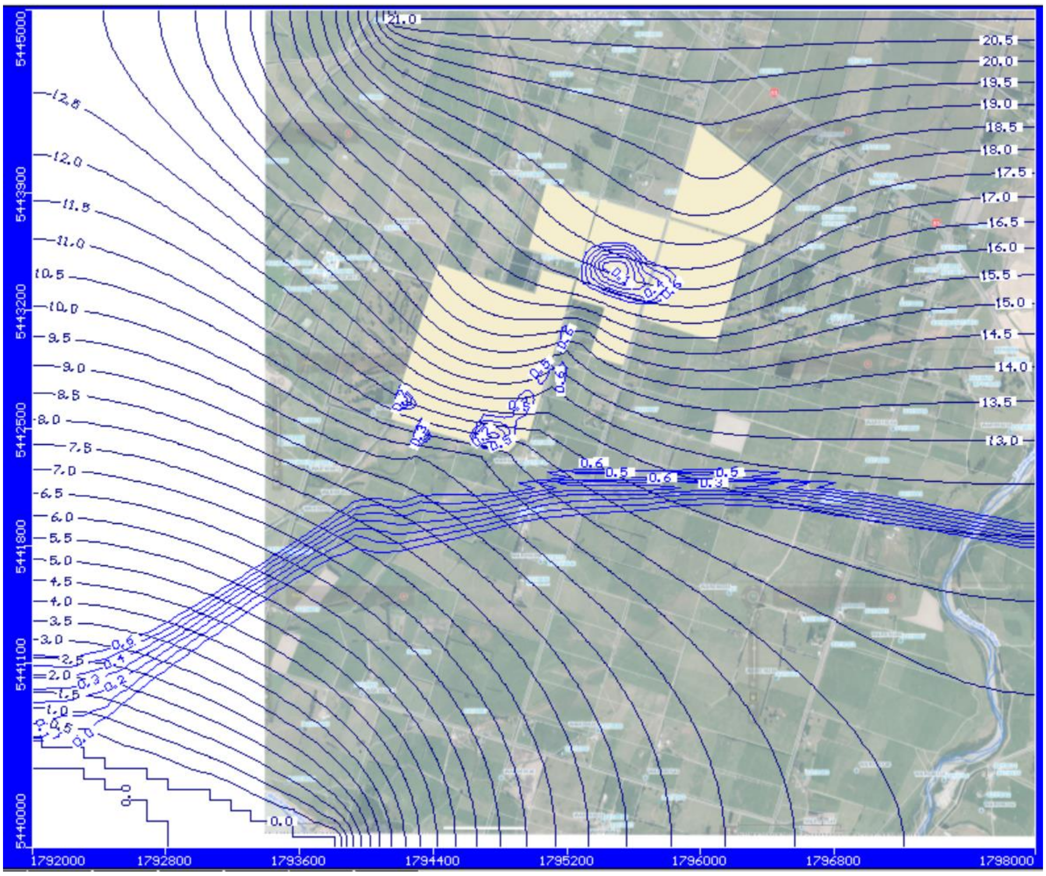

Figure 8 Model Output Showing Vadose Zone Depth <0.6 m

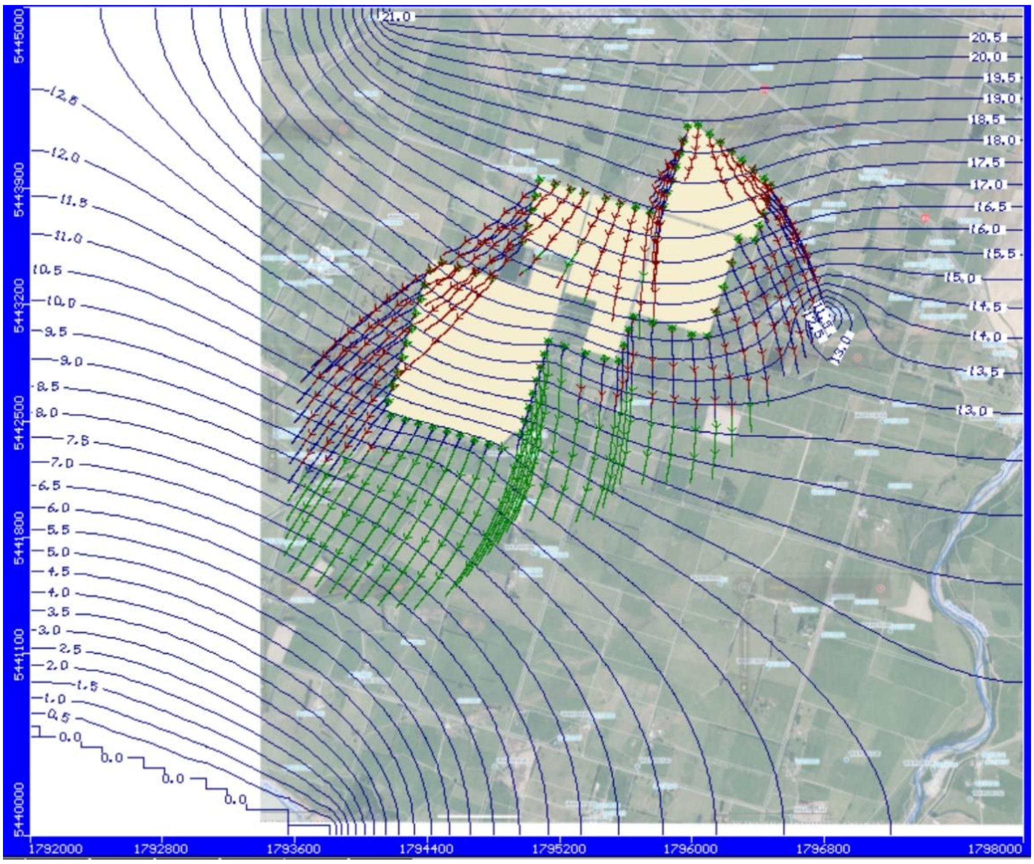

Figure 9 Flow Path Lines Showing 5 Year Travel Envelope

Table 1

Bore ID	Depth (m)	Use	Risk	Pathline Distance (m)	Travel Time (Years)
S27/0840	5.2	Domestic	Potentially	120	<1
S27/0812	8.1	Domestic	Potentially	285	1.5
S27/0023	8.0	Domestic	Potentially	350	2.25
S27/0063	16.6	Domestic	Potentially	770	4.5
S27/0026	10.0	Domestic	Potentially	290	2.5
S27/0027	5.0	Domestic	Potentially	175	2.5
S27/0044	5.5	Irrigation	Potentially	0	0
S27/0701	4.2	Not Used	Potentially	0	0
S27/0019	4.3	Irrigation	Potentially	35	0.5
S27/0080	9.0	Domestic	Potentially	440	4
S27/0838	24.0	Irrigation	Potentially	750	5
S27/0664	24.0	Irrigation	Potentially	600	4.5
S27/0010	24.0	Irrigation	Potentially	160	<1
S27/0813	12.0	Stock	Potentially	0	0
S27/0827	8.0	Domestic	Potentially	No connection	
S27/0090	7.2	Irrigation	Potentially	No connection	
S27/0671	Unknown	Domestic	Potentially	No connection	
S27/0042	12.8	Stock	No Risk	No connection	
S27/0753	9.0	Domestic	No Risk	No connection	
S27/0683	4.0	Stock	No Risk	1,200	>5
S27/0011	24.0	Stock	No Risk	1,000	>5
S27/0659	20.8	Domestic	No Risk	1,000	>5
S27/0017	27.0	Unknown	No Risk	1,300	>5
S27/0059	53.0	Irrigation	No Risk	Deep Aquifer	
S27/0772	33.0	Irrigation	No Risk	Deep Aquifer	
BP33/0037	61.4	Irrigation	No Risk	Deep Aquifer	

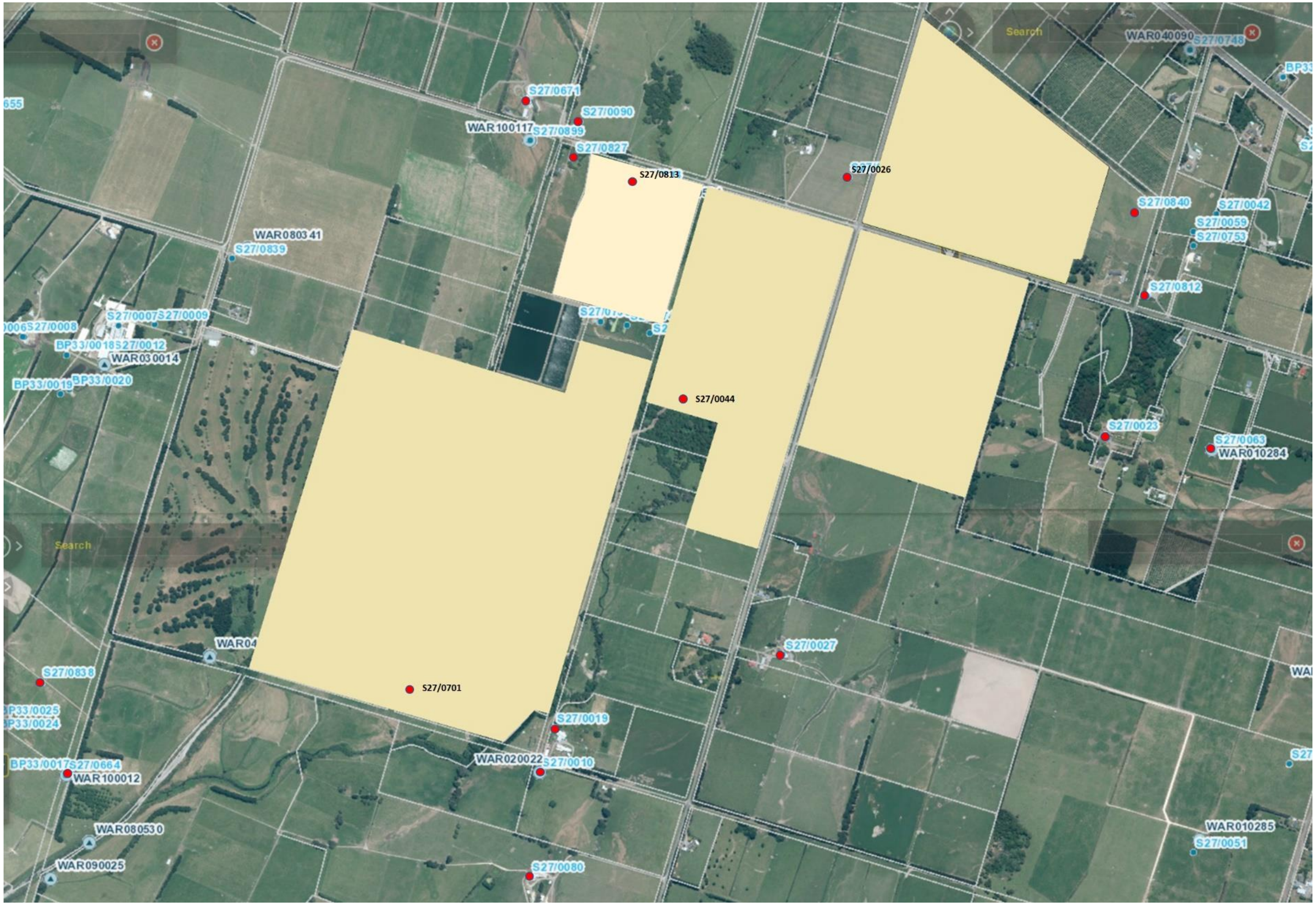

Figure 10 **Potentially Affected Groundwater Users**