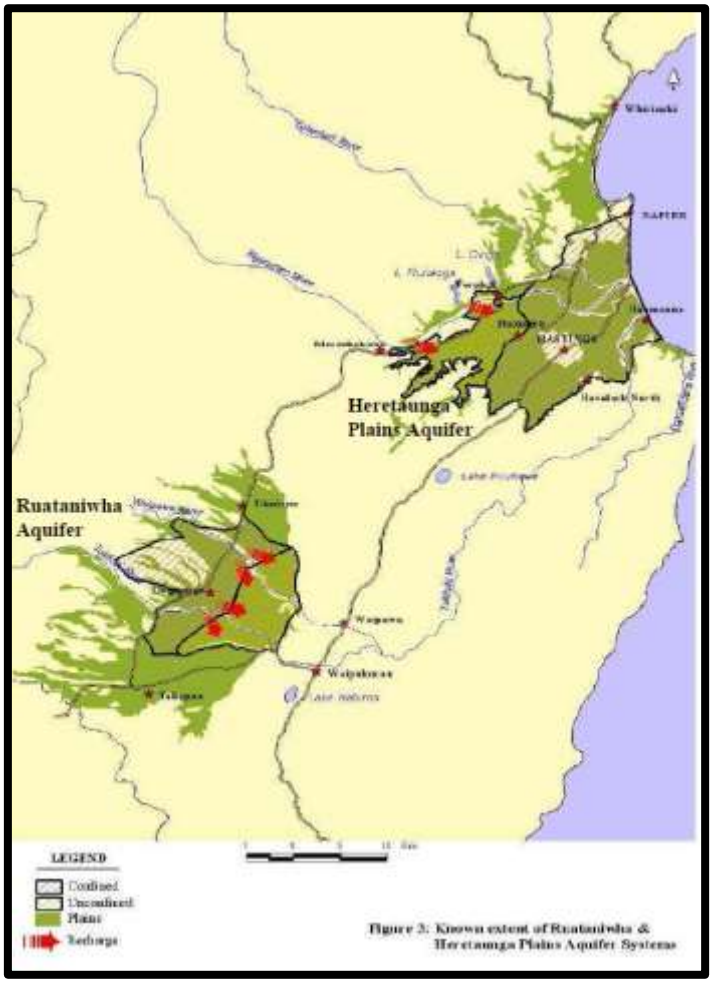
Heretaunga Aquifer



Key Values
Cultural
Ecology
Natural characteristics

Table 1: List of documents reviewed

Year	Name	Author
1997	Heretaunga Plains Groundwater Study	HBRC, Crown Research Institute, NIWA, Landcare Research New Zealand
2003	Hastings District Plan (Section 12.1 – Heretaunga Plains Unconfined Aquifer Resource Management Unit)	Hastings District Council
2006	Updating Evidence of Ngahiwi Tomoana on behalf of Ngāti Kahungunu Iwi Incorporated for Wai 262 Claim	Ngahiwi Tomoana (Ngāti Kahungunu Iwi Incorporated)
2009	A Review of Current Groundwater Management in Hawke's Bay and Recommendations for Protection of Groundwater Ecosystems	NIWA
2012	Comments from Ngāti Kahungunu Iwi Incorporated on HBRC's Draft Change 5	Ngāti Kahungunu Iwi Incorporated
2012	Submission from Ngāti Kahungunu Iwi Incorporated on HBRC's Proposed Change 5	Ngāti Kahungunu Iwi Incorporated

2012	Submission from Te Taiwhenua o Heretaunga on Proposed Plan Change 5 to the RPS	Te Taiwhenua o Heretaunga
2012	The Stage 1 Report on the National Freshwater and Geothermal Resources Claim, Wai 2358	Waitangi Tribunal
2014	Statement of Evidence by Stephen Swabey ENV-2013-WLG-000050	Hawke's Bay Regional Council
2015	Decision [2015] NZEnvC50 - ENV-2013-WLG-000050	Environment Court
2015	Groundwater level changes in the Heretaunga and Heretaunga Basins from 1994 – 2014	Hawke's Bay Regional Council
2015	Hapū Management Plan - Mana Ake - Nga Hapū o Heretaunga	Te Taiwhenua o Heretaunga
2015	Heretaunga Plains Groundwater Management and Investigations	Hawke's Bay Regional Council
2016	Groundwater Quality State of Environment: State and Trends	Hawke's Bay Regional Council
2016	Spatial Oxygen-Flow Models for Streams of the Heretaunga Plains	Hawke's Bay Regional Council
2016	Heretaunga Tamatea deed of settlement + documents schedule	Heretaunga Tamatea and the Crown
2017	Modelling Effects of Increased Groundwater Allocation on Stream Flows in the Heretaunga Plains	Hawke's Bay Regional Council
2018	Aquifers	Hawke's Bay Regional Council
2018	Cultural Values Table	Hawke's Bay Regional Council

Discussion

Purpose of report

1. The purpose of this report is to assist the RPC members to determine whether any of the values of the Heretaunga aquifer are outstanding for the purposes of the National Policy Statement for Freshwater Management (NPSFM).
2. This report presents the summarised findings of the values attributed to the Heretaunga aquifer in those documents referred to in Table 1, above. In accordance with decisions made by the RPC in June 2017, economic and consumptive use values have not been discussed in detail in this report.
3. The report will focus on the cultural values associated with the aquifer system, its groundwater ecosystem and its natural characteristics, not its productive qualities.

Overview

4. The Heretaunga aquifer is a major aquifer system underlying most of the Heretaunga Plains. The aquifer system is a significant resource for Hawke's Bay, with 161 million m^3 of water consented for domestic, municipal, industrial, horticultural and agricultural use, annually. Up until recent years, it has provided untreated drinking water to the cities of Napier and Hastings.
5. The Heretaunga aquifer system is mostly an alluvial system that infills a fault-bound depression that is around 900 metres deep or more. The aquifer system, including peripheral valley aquifers, covers an area of approximately 510 km^2. Travel time of water through the aquifer system varies considerably taking up to 7 years in some parts, to decades and hundreds of years in others.
6. Three major surface water bodies, being the Ngaruroro, Tutaekurī and Tukituki rivers, and numerous other smaller rivers and streams flow over and beside the Heretaunga Plains. There is a strong hydraulic connection between the Heretaunga aquifer and these surface water bodies. The vast majority of recharge to the Heretaunga aquifer system is via recharge from the Ngaruroro River.
7. The Heretaunga aquifer is a living ecosystem which is home to various unseen ecological communities. The aquifer ecosystems itself, as well those surface water ecosystems connected to the aquifer, have intrinsic value, are biologically diverse, and provide important ecosystem functions, such as water purification and flood control.

Location

8. The Heretaunga Plains comprise an area of around 300 km^2 on the east coast of the North Island. The aquifer system underlies most of the Heretaunga Plains, from Napier and the Hawke's Bay coast in the northeast, to Maraekakaho, Roys Hill and Taradale in the west, and Bridge Pa, Pakipaki and Pukahu in the south.

9. Figures 1 and 2 below show the general extent of the Heretaunga Plains aquifer system and the key waterways which flow over the Heretaunga plains, including their typical summer patterns.

Figure 1: Heretaunga plains aquifer system – general extent

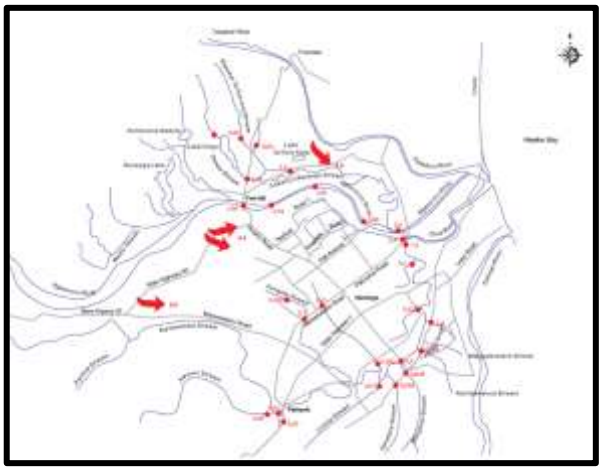


Figure 2: Heretaunga aquifer system -rivers and streams

Cultural values

10. The Heretaunga aquifer has long been regarded as a taonga of Ngāti Kahungunu and is part of Heretaunga Tamatea's traditional rohe.

11. The Heretaunga aquifer was known by Ngāti Kahungunu as the Heretaunga Ararau Haukūnui, being a large water resource, represented in the many rivers, creeks, and small tributaries fed by underground springs, springs of water, swampy ground, swimming holes, rock pools and quick sands. These areas supported an abundant supply of fish and water fowl, and was a primary food resource.

12. The importance of the aquifer is reflected in the whakatauki that represents Ngāti Kahungunu pride: Heretaunga ararau; Heretaunga haukūnui; Heretaunga hāro te kāhu; Heretaunga takoto noa.

13. In this play on words, Heretaunga ararau stands for both the myriad of waterways through the great swamps and the myriad of hapū that they linked together on the shore. Haukūnui describes the waters as a system of repo or swamps, awa or rivers and puna or springs, the life giving waters from deep within the earth. Hāro te kāhu sees the whole through the eyes of the soaring hawk, the plains standing solitary below, takoto noa, needing no other embellishment.

14. Ngāti Kahungunu has made various submissions to the regional council outlining the importance of the aquifer, not just from a traditional cultural perspective, but from a contemporary economic viewpoint.

15. Attachment 1 contains a more detailed explanation of the cultural values associated with the Heretaunga aquifer.

Aquifer characteristics

16. The Heretaunga aquifer system, including peripheral valley aquifers, is around 510 km^2 in size and consists of gravels, sands, silts, clays and shells deposited as a result of river and marine processes over the last 250,000 years. Its productive aquifers are generally within the non-marine river gravel deposits with the

deposition of finer marine sediments forming the confining layers. The aquifer system is relatively unconfined west from around Flaxmere becoming progressively confined to the east by a wedge of marine sediments.

17. The Heretaunga aquifer system comprises a number of aquifers, including:

    - The Ngaruroro-Tutaekuri aquifer system (main aquifer under the Heretaunga Plains – approx. 300 km^2)
    - The Tukituki aquifer system (eastern coastal margin of the plains)
    - The Moteo Valley aquifer system (are formally occupied by the Tutaekuri River)
    - The Valley aquifer systems (before the Ngaruroro and Tutaekuri rivers cross)
    - The peripheral limestone aquifer system (hills on the southern and western margin of the plains).

18. The Heretaunga aquifer system is primarily recharged by the Ngaruroro River at the western margin of the Heretaunga Plains. A major recharge zone occurs between Roys Hill and Fernhill, with a minor recharge zone occurring from Maraekakaho to Roys Hill. Surface water infiltrates into the unconfined aquifer, and then downward and horizontally through the subsurface to recharge deeper confined aquifers.

19. The Tutaekuri and the Tukituki rivers recharge the relatively shallow aquifer systems in the northern and southeastern parts of the Heretaunga Plains. None of the aquifer systems have been identified as being completely isolated.

20. The groundwater derived from the Ngaruroro River flows quickly through the unconfined sector of the aquifer towards the coast with groundwater in the confined section moving as little as 2 metres per day.

21. A cross section of the Heretaunga Aquifer is contained in Attachment 2.

Recreation values

22. There are no recreational values associated with the Heretaunga aquifer itself, however the aquifer system does provide an important supporting function to recreational activities undertaken on rivers and streams hydraulically connected to the aquifer system.

Ecology values

23. Aquifers are living ecosystems which are dependent on the subterranean presence of water. Aquifer ecosystems provide a diversity of habitats, such as sand, gravel, fractured rock and karst systems that are home to various unseen ecological communities. Attachment 3 contains a diagram of a naturally functioning groundwater ecosystem.

24. These ecosystems include all of the life present in the physical space of the aquifer system, from microorganisms, such as bacteria, fungi and archaea, to primitive invertebrate animals (protozoa, nematoda stygofauna and troglofauna) and advanced invertebrates. These communities interact with each other and their non-living environment and perform natural ecological processes in the absence of light.

25. Groundwater life is rarely seen. This is because access is difficult and bores are usually designed to exclude all but water. This means there is limited understanding of aquifer ecosystems. Despite this, literature suggests that most aquifers support significant biodiversity with complex life persisting to substantial depths.

26. The different components of the Heretaunga aquifer's ecosystem are discussed in more detail below.

Microorganisms

27. Microscopic organisms are commonly known as microorganisms or microbes and are an important part of an aquifers ecosystem. The microbial communities generally have significant biodiversity and can adapt to living in nutrient-poor and anaerobic conditions found in deep and/or confined aquifer systems. Because of this, some microbial communities found in aquifers grow slowly and have a low tolerance to rapid changes.

Stygofauna and troglofauna

28. Subterranean life is divided into two classes of animals, stygofauna and troglofauna. Stygofauna refers to all aquatic fauna in a groundwater environment, and troglofauna are associated with caves and spaces above the water table, but still part of the aquifer system. There are no known cave or karst systems associated with the Heretaunga aquifer system so it in unknown if troglofauna are present in this aquifer system.

29. Stygofauna are aquatic animals which live in groundwater. They have adapted to life underground (i.e. no body pigments, no or very small eyes, elongated bodies, elongated antennae), survive on a limited food supply and are extremely energy efficient. Stygofauna feed on plankton, bacteria and plants found in streams and are thought to live longer than other terrestrial species

30. Stygofauna are important for several reasons. They are intrinsically significant as individual species, particularly where they have a restricted geographical range. These species are known as short-range endemics, which provide insights into evolutionary processes. Stygofauna also cycle nutrients within groundwater systems, and assist with keeping the finer pore spaces in the aquifer open, by ingesting and digesting bacteria, allowing water to flow through these tiny spaces.

31. While few studies have been undertaken looking into aquifer ecosystems in New Zealand, it is believed that New Zealand's stygofauna is widespread and diverse, with high endemism. This is largely because New Zealand's geological past has led to long term separation of habitats and populations, which drives high diversity particularly when many species are confined to very restricted geographical ranges.

32. In isolated aquifers and geological units stygofauna have no opportunity to migrate to another location which results in high diversity. In the Heretaunga aquifer system, none of the aquifers appear to be totally isolated, which suggests stygofauna species distributions, including any short range endemics, will be relatively widespread through the whole aquifer system.

Karst and spring systems

33. Studies indicate that major karst and spring systems associated with underground aquifers generally provide a very large habitat for complex, interconnected interstices ideal for the bacteria and invertebrates.

34. Notable examples, include the major karst systems under Mounts Owens and Arthur in Tasman, which are the longest and deepest cave systems in the southern hemisphere, and the Te Waikoropupū Springs which are the largest and clearest freshwater springs in New Zealand. Both areas have significant hydro-geological features which provide for extremely high and unique biodiversity values in these areas.

35. While, a number of rivers, streams and springs are hydraulically connected to the Heretaunga aquifer system, there are no known large freshwater 'blue' springs, such as the Te Waikoropupū Springs, or major karst systems in this area.

Water age

36. Groundwater generally moves from a recharge area to a discharge area. The course taken by water moving through the aquifer is called a flow path and varies depending on the thickness and the spatial extent of the aquifer system. The age and flow path of groundwater plays an important ecological role in supporting the aquifer's ecosystem.

37. Groundwater gets older along a flow path, with groundwater quality varying with depth. In most aquifer systems, groundwater flows faster horizontally than vertically. This means groundwater typically flows more rapidly through the upper parts of an aquifer, and groundwater gets older with depth.

38. Rates of groundwater movement in the deeper Heretaunga Plains aquifer vary significantly, and can take decades to hundreds of years from the input point in the west of the aquifer to the eastern part of the aquifer system. Conversely, the groundwater flows through the unconfined section of the aquifer system can be fast moving and in the order of hundreds of metres per day towards the coast.

Groundwater dependant ecosystems (rivers, streams, wetlands and springs)

39. Groundwater dependant ecosystems are those ecosystems which need inputs of groundwater to maintain their current structure and functions and can include rivers, streams, wetlands and springs.

40. Three major rivers flow across the Heretaunga Plains, being the Lower Tukituki River, the Tutaekuri River and the Ngaruroro River. Other surface water bodies known to be hydraulically connected to the Heretaunga aquifer system and the three major rivers, include low land streams such as the Raupare Stream, Awanui Stream, Karewarewa Stream, Karamū River and Irongate streams, Mangateretere Stream and Tutaekuri-Waimate Stream.

41. There is clear interaction between the groundwater and surface water bodies which flow over the Heretaunga Plains, with a number of streams being spring dominated and fed from groundwater. The

majority of groundwater leaving the Heretaunga Plains aquifer system returns to spring-fed streams and rivers in the lower plains

42. The water quality and quantity and the ecology of the Heretaunga aquifer system is important to the ecological health of those surface water bodies with strong hydraulic connections to the aquifer system. i.e. poor aquifer health, or decreased water quantity, may impact on water levels or water quality in highly connected surface water bodies.

Water Quality

43. Groundwater quality in aquifers across New Zealand varies. It depends on a range of factors such as nearby land uses, the soil composition above the water table, the geology of the aquifer and the groundwater residence time.

44. Hawke's Bay Regional Council regularly monitors the quality of groundwater in the Heretaunga aquifer at twenty two sites. The primary aim of this monitoring is to ensure the groundwater meets health and aesthetic based standards, as opposed to protecting the biodiversity values of the aquifer ecosystems.

45. The water quality of the Heretaunga aquifer system with regard to 'health and aesthetics' and 'ecosystem health' is discussed further below.

Water quality – health and aesthetics

46. The quality of groundwater in the Heretaunga aquifer system is measured against the New Zealand Drinking Water Standards to ensure the water is suitable for human consumption.

47. Overall, most monitoring sites comply with the New Zealand Drinking Water Standards (DWSNZ) for the key chemical water quality parameters[1]. The exceptions are elevated concentrations of iron, manganese, ammoniacal-nitrogen, hardness and phosphorus which occur in the deeper parts of the aquifer system (deeper than 50 metres) and are thought to be naturally occurring. Microbiological non-compliance was found for *E.coli* at 20% of the monitoring sites, in the 5-year monitoring period between 2009 and 2014.

48. In 2018, elevated concentrations of arsenic were found in groundwater samples from several private bores drawing water from the Heretaunga aquifer. The elevated arsenic levels are naturally occurring and local to specific bores and do not occur consistently throughout the Heretaunga aquifer system.

49. Each of the water quality parameters measured as part of HBRC's programme are summarised in more detail in Table 2, below. This data has been obtained directly from the 5 yearly State of the Environment Report 2009 – 2014.

Table 2: Water Quality – Heretaunga aquifer (2009 – 2014)

Water quality parameter	Compliance /non-compliance with DWSNZ guidelines
pH	Groundwater at all sites falls within the optimum guideline pH range of 7 to 8
Total Dissolved Solids (TDS)	The TDS concentrations at all sites are below the guideline value of 1000 mg/L.
Total Hardness	87% of the sites have total hardness levels below the guideline value of 200 mg/L.
Iron and Manganese	Ninety one percent of sites comply with the maximum accepted value for manganese, and fifty seven percent of sites comply with the aesthetic guideline value for manganese[2]. The two sites which exceed the maximum accepted values for manganese are located in deeper parts of the aquifer system and the elevated concentrations are thought to be naturally occurring. Eighty seven percent of the sites comply with the guideline value for iron. Two Monitoring bores exceed the aesthetic guideline value, with concentrations thought to be natural occurring. Elevated iron and manganese levels are a characteristic of aquifer systems where reducing (oxygen-poor) conditions exist naturally. The combined effects of reducing conditions and

[1] HBRC does not monitor for all chemical water quality parameters in the NZDWS.

[2] Aesthetic determinant = manganese concentrations at a level which can adversely affect the water's taste, odour, colour, clarity or general appearance.

	a long residence time of the groundwater in the aquifer encourage dissolution of iron and manganese present in aquifer materials. Monitoring indicates that the confined aquifer system mostly has mean residence times of approximately 36 years, with the deep aquifer systems having mean residence time of greater the ninety years
Nitrate-Nitrogen	All sites comply with the short-term and long-term maximum accepted value in the DWSNZ.
Ammoniacal-N	96% of monitoring sites on the Heretaunga Plains aquifer system comply with the DWSNZ aesthetic guideline value of 1.5 mg/L. One deep bore exceeded the guideline value, which is thought to be naturally occurring.
Phosphorus (Soluble Reactive Phosphorus - SRP)	Phosphorus levels at sites are generally less than 0.05 mg/L. However, several monitoring bores in the deeper parts of the aquifer system have elevated phosphorus, which is likely to be related to long residence times, which has enabled enough time for phosphorus to leach from minerals in the aquifer matrix.
Sulphate	All sites have sulphate levels below guideline levels of 200 mg/L.
Sodium and Chloride	All sites have sodium and chloride levels below aesthetic guideline levels for sodium and chloride.
Microbiological Indicator (*E. coli*)	Seventy percent of monitoring sites complied with the DWSNZ level. Twenty percent of monitoring bore had 1 cfu/100 mL in the 5-year period of monitoring, with two bores having more than one detection (six and four detections, respectively).

Water quality – ecosystem health

50. The geology of an aquifer has a significant effect on the natural water chemistry within an aquifer system. This means the 'natural water quality' within each aquifer system varies. For example, if dominant rock types present in the aquifer has soluble materials, such as limestone, the groundwater will have higher concentrations of ions, than in aquifers with less soluble materials such as insoluble quartz pebbles. Additionally, the chemical makeup of groundwater with longer residence time will be completely different to that of water with low residence time.

51. Over a period of time the fauna and microbial communities living in an aquifer become highly adapted to its living space and its natural water quality. This means the 'optimal' state of water quality required to protect each aquifer system is different, and might not necessarily correlate with the New Zealand Drinking Water Standards. For example, the water quality parameters for ecosystems with aquifers with brackish water will be completely different to that of freshwater aquifers.

52. To date, no monitoring or investigations have taken place looking into the standard of water quality required to protect the biodiversity value of the ecosystems living the Heretaunga aquifer system.

Values Summary

Overarching Value	Sub-value	Description	Outstanding Yes/no	Comments
Cultural	TBC	TBC	TBC	TBC
Recreational	TBC	TBC	TBC	TBC
Ecological	TBC	TBC	TBC	TBC
Landscape	TBC	TBC	TBC	TBC
Natural Character	TBC	TBC	TBC	TBC

4. *Resource Management Plans*

The following tables list any relevant resource management plans developed by iwi, the regional council or territorial authorities. The tables include any specific provisions that apply to the Heretaunga aquifer. They do not include all of the general policies or rules that may apply. Water quality and water quantity provisions have been included as it is recognised that these aspects can significantly impact on cultural values.

Iwi and	Resource Management Plans
Kahungunu ki Uta, Kahungunu ki Tai	Marine & Freshwater Fisheries Strategic Plan
Mana Ake – An Expression of Kaitiakitanga,	Taiwhenua o Heretaunga

Regional Resource Management Plan
Schedule 4: Known Productive Aquifer Systems in the Hawke's Bay Region
Schedule 5: Heretaunga Plains Contaminated Vulnerability based on specifically modified DRASTIC factors for confined aquifer
Schedule 5a: Heretaunga Plains Unconfined Aq
Schedule 6: Ground Water Management Zones
Schedule 6b: Catchments sensitive to animal effluent disposal

Regional Coastal Environment Plan
Schedule C: Known Productive Aquifer Systems in Hawke's Bay Coastal Environment

Hastings District Plan
Appendix 59: Heretaunga Unconfined Aquifer

Attachment 2: Cross Section through Heretaunga Aquifer

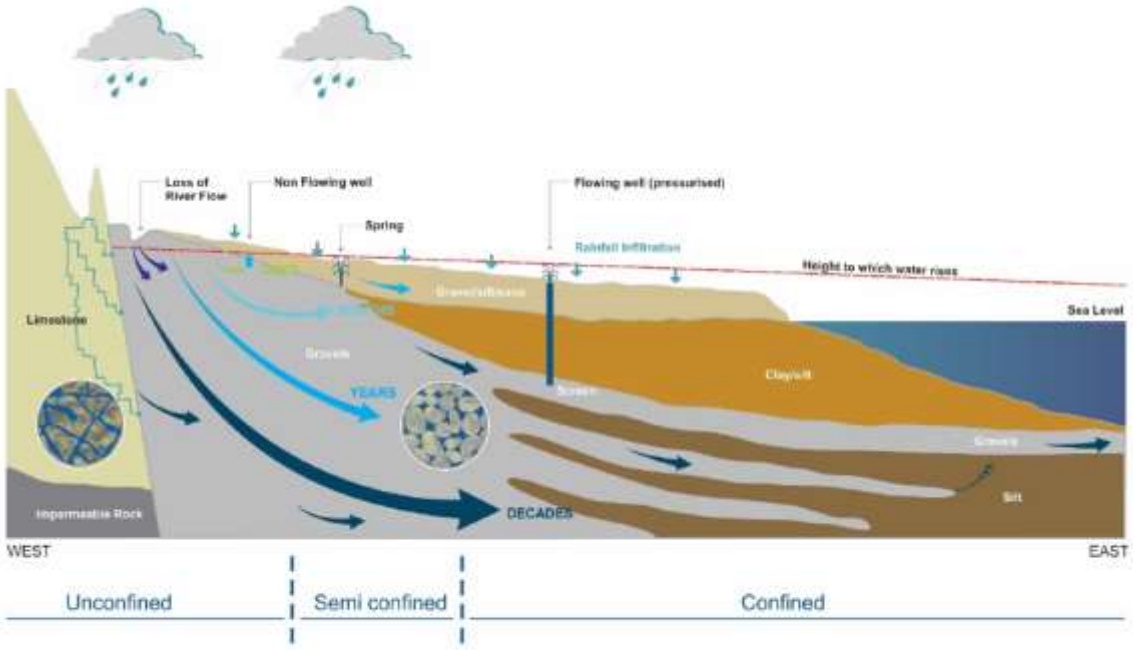


Figure 2-2: Conceptual cross section through the Heretaunga Plains groundwater system from Maraekakaho at the top of the Heretaunga Plains to the coast (Hawke Bay) The main Heretaunga aquifer system is confined by marine silt and clay.

Figure 1: Cross section thorough the Heretaunga aquifer system

Attachment 3: Typical Groundwater Ecosystem

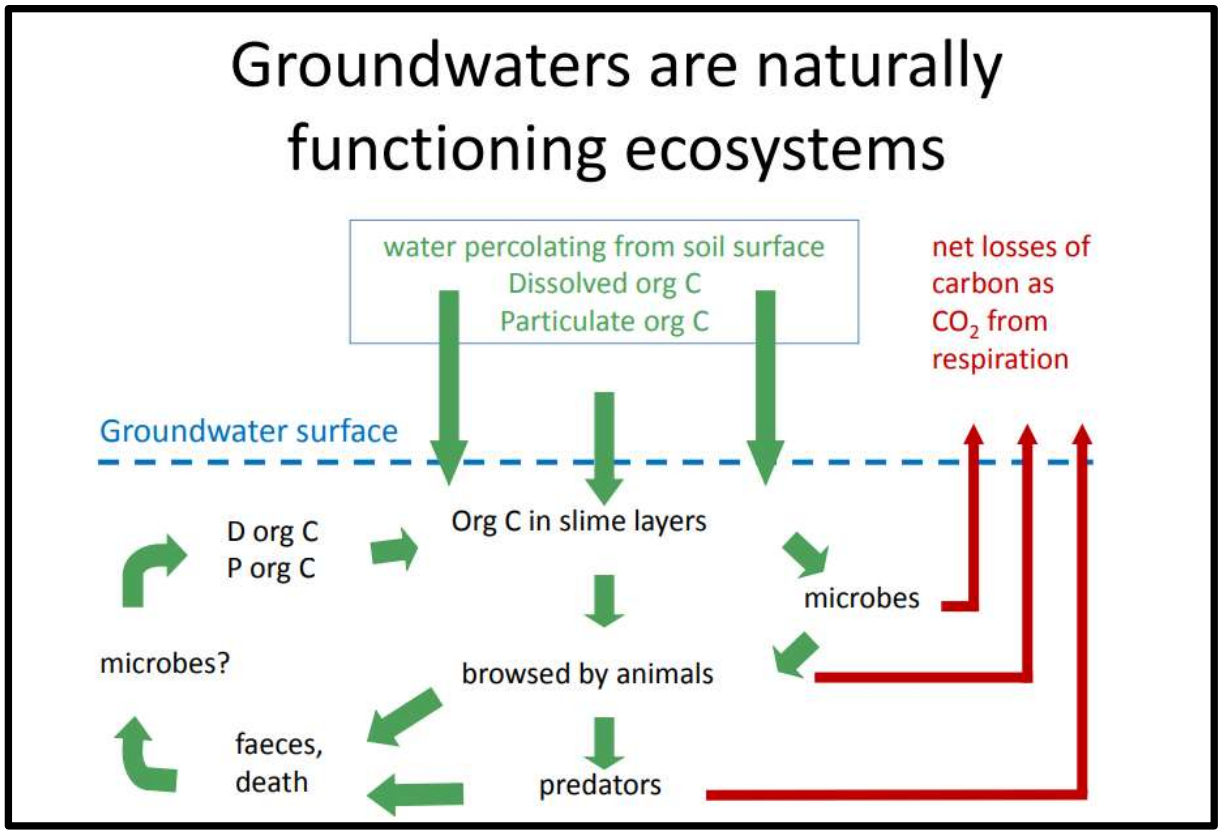


Figure 1: Typical groundwater ecosystem