December 2017

RESULTS 2017 INJECTION TRIAL

Poverty Bay Managed Aquifer Recharge Pilot

Submitted to:
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Gisborne District Council

Report Number: 1415771_7403-025-R-Rev1

REPORT

Golder Associates

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LIST OF ABBREVIATIONS AND UNITS

Abbreviation/Unit	Name
ASR	Aquifer Storage and Recovery
ASTR	Aquifer Storage Transfer and Recovery
DBP	Disinfection by-product
g	Grams
g/m^3	Grams per cubic metre
GDC	Gisborne District Council
Golder	Golder Associates (NZ) Limited
HAAs	Halogenated acetic acids
HANs	Haloacetonitriles
km	Kilometre
L/s	Litres per second
m	Metre
MAR	Managed Aquifer Recharge
MAP	Mean Annual Precipitation
m bgl	Metres below ground level
m btoc	Metres below top of casing
m RL	Metres above Relative Level (i.e., m above mean sea level)
m^2/day	Metres squared per day
m^3/day	Cubic metres per day
NTU	Nephelometric Turbidity Units
THMs	Trihalomethanes
µS/cm	Micro Siemens per centimetre – measure of electrical conductance
XRD	X-Ray Diffraction
XRF	X Ray Fluorescent

1.0 INTRODUCTION

1.1 General

Golder Associates (New Zealand) Limited (Golder) has prepared this report for Gisborne District Council (GDC) to present the results of the first injection trial in winter 2017 as part of the Poverty Bay Managed Aquifer Recharge (MAR) pilot project. This report includes the technical information and analysis from the monitoring and data collection prior to, during and after the injection trial. The report also provides initial conclusions on the effectiveness of the MAR scheme and lists recommendations for the design, operations and monitoring of next year's trial as well as considerations for expansion to a full MAR scheme.

1.2 Project Background

The long-term water availability in the Poverty Bay area (Figure 1) is a potentially limiting factor in future regional development. Irrigation for horticultural purposes is one of the main uses of water across the Poverty Bay Flats and a substantial proportion is derived from groundwater. GDC identified declining groundwater level trends in the Poverty Bay area as an environmental and water supply reliability issue. These trends are linked to increasing groundwater abstraction for irrigation purposes.

Water management options in the Poverty Bay region are now being considered by GDC with the aim of improving water security for all users against a background of declining groundwater level trends in response to increased demand and predicted future climate change. MAR is one option under consideration and involves the replenishment of the aquifer ensuring sustained yields from the aquifers beneath the Poverty Bay Flats.

GDC has initiated the Poverty Bay MAR pilot project and commissioned the installation of a Makauri Aquifer injection well, headworks and filter system, which was completed in May 2017. The Makauri Aquifer was selected for the MAR pilot project due to its relatively high usage, declining groundwater level trends, broad extent and good transmissivity. Waipaoa River water is sourced via an existing infiltration gallery at Kaiaponi Farms and after filtering injected into the Makauri Aquifer at the MAR site.

1.3 Purpose and Objectives

The Poverty Bay MAR pilot project is intended to investigate if a MAR scheme can help reverse declining groundwater levels and improve yields of the Poverty Bay aquifers. The following technical matters are to be investigated to assess the success of MAR in Poverty Bay:

- Whether the injection scheme has a clear benefit in reversing declining groundwater level trends.
- Whether the installation, operation and maintenance of an injection scheme is economically viable.
- Whether sufficient and good quality water is available for injection into the aquifer in the irrigation off-season.
- Whether adverse effects of the injection scheme on groundwater flows and levels as well as on groundwater quality are small and can be mitigated.

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Data and information collected for the first aquifer injection trial during winter 2017 are used to assess these matters and are described in this report. This report therefore includes the following:

- A brief description of the groundwater resource and long-term issues.
- An overview of installation, operation and maintenance issues.
- Assessment of effects on groundwater levels, flows and quality based on monitoring results.
- Recommendations for investigations as part of next year's injection trial and for possible future expansion to a full Poverty Bay MAR scheme.

This report is prepared to fulfil the following resource consent (DW-2016-107113-00) requirement:

> *39) By 31 December of each year when the injection trial has been undertaken the consent holder shall prepare a report describing the trial activities that have taken place, the monitoring data obtained and any trial activities planned for the upcoming year. This report shall be provided to the GDC Manager and the Community Liaison Group.*

Resource consent documents are included in Appendix A of this report.

The economic viability of a full Poverty Bay MAR scheme is to be reviewed in a business case. This is beyond the scope of this study.

1.4 Previous Work

Investigations for the Poverty Bay MAR project span a period between 2014 and present. This report builds on information provided in the various previous reports listed below. Where relevant, information from these reports has been summarised in this report.

Envirolink

Initial investigations were undertaken as part of Envirolink, a regional council driven funding scheme administered by the Ministry of Business, Innovation & Employment (MBIE). The work included the development of and indicative water balance tool to assess the long-term efficacy of a MAR scheme to reverse declining groundwater level trends. The results are included in these reports:

- Poverty Bay Groundwater Management, MAR Feasibility Stage 1A – Conceptual Model – Golder 2014a
- Poverty Bay Groundwater Management, MAR Feasibility Assessment and Goldsim Groundwater Management Tool (Stage 1B) – Golder 2014b

Poverty Bay MAR pilot project

The results of more recent investigations and a description of the Poverty Bay MAR pilot infrastructure and testing are included in these reports:

- Poverty Bay Managed Aquifer Recharge, Pilot Trial – Hydrogeology and Water Quality – Golder 2015
- Poverty Bay Managed Aquifer Recharge, Pilot Trial – Kaiaponi Site and Source Water Options – Golder 2016
- Poverty Bay Managed Aquifer Recharge, Pilot Trial Options Analysis – Golder 2016

Resource consent (DW-2016-107113-00) includes the following reporting conditions:

36) *[..] The Consent Holder shall not commence works authorised by this consent until the Management Plan has been certified in writing by the GDC Manager acting in a technical certification capacity. [..]*

[..]

38) *Following the pre-injection trial of 10,000 m^3 the consent holder shall provide a report to the GDC Manager on the performance of this preliminary trial, with particular reference to the water quality and water quantity effects that arose. Any updates to the Management Plan referred to in condition 35 that are required based on the results of the preliminary trial shall be made and re-certified in writing by the GDC Manager. The commencement of the main trial shall not commence until this reporting and potential re-certification (if required) has been completed.*

Therefore, the following reports have been completed to fulfil these resource consent requirements:

- Kaiaponi Managed Aquifer Recharge Pilot Project, Pilot Trial Management Plan – Golder 2017a
- Poverty Bay Managed Aquifer Recharge Trial, Initial Injection Test – Golder 2017b

1.5 Report Overview

This report presents a summary of the MAR pilot scheme and the results of the injection trials completed in 2017. Following this introduction, an overview of the aquifer hydrogeological and geochemical characteristics and trends (Section 2.0) is provided, followed by an overview of the abstraction, injection and filtering infrastructure, and details of the monitoring programme (Section 3.0). The next section describes the results and interpretation of the 2017 aquifer injection trial (Section 4.0). A discussion section is included in the report in which issues and options for consideration for future MAR scheme development are described (5.0). This is followed by a section which lists the conclusions and recommendations (Section 6.0) for continuation of the MAR trial and long term operation of a MAR scheme in the Gisborne area.

2.0 AQUIFER CHARACTERISTICS AND TRENDS

2.1 General

This section provides an overview of the aquifer characteristics and the changes in groundwater levels, flows and water quality over the past decades. A description of how these changes affect the long-term availability of good quality Makauri Aquifer water is also included in this section.

2.2 Description of MAR Site and Surrounding Area

2.2.1 Topography and land use

The Poverty Bay MAR pilot project site is located on the Poverty Bay flats approximately 10 km northeast of Gisborne. The injection well (GPE066) is installed on the Kaiaponi farm property at 598 Bushmere Rd (Figure 1 and Figure 2). The Kaiaponi farm and surrounding area is predominantly used for horticulture. The land is on the relatively flat Waipaoa River valley floor, surrounded by hills to the northeast and southwest. The Waipaoa River valley narrows northwest of the site near Ormond (Figure 1).

The Poverty Bay MAR pilot study area is roughly bounded by the Waipaoa River in the west and south and by Tucker Road to the north and east as shown in Figure 1 and Figure 2.

2.2.2 Climate and rainfall

Gisborne has a temperate climate with average daily maximum temperatures above 20 ºC between December and March and average temperatures from June to August approximately 10 ºC at Gisborne Airport. Average annual rainfall at Gisborne Airport is 987 mm. There are clear seasonal effects with 30 % of the annual rainfall falling in the winter months from June to August, and around 20 % of rain in the summer months from December to February (NIWA 2016).

More rainfall than average has already fallen in 2017 as shown in Figure 3. Further analysis of the rainfall records between 1989 and 2017 of rainfall stations in Gisborne (Waihirere, Glanavon or WG (site 2796) and Gisborne Aws (site 2810); location shown in Figure 1) confirm that most rainfall falls between March and August (Figure 4).

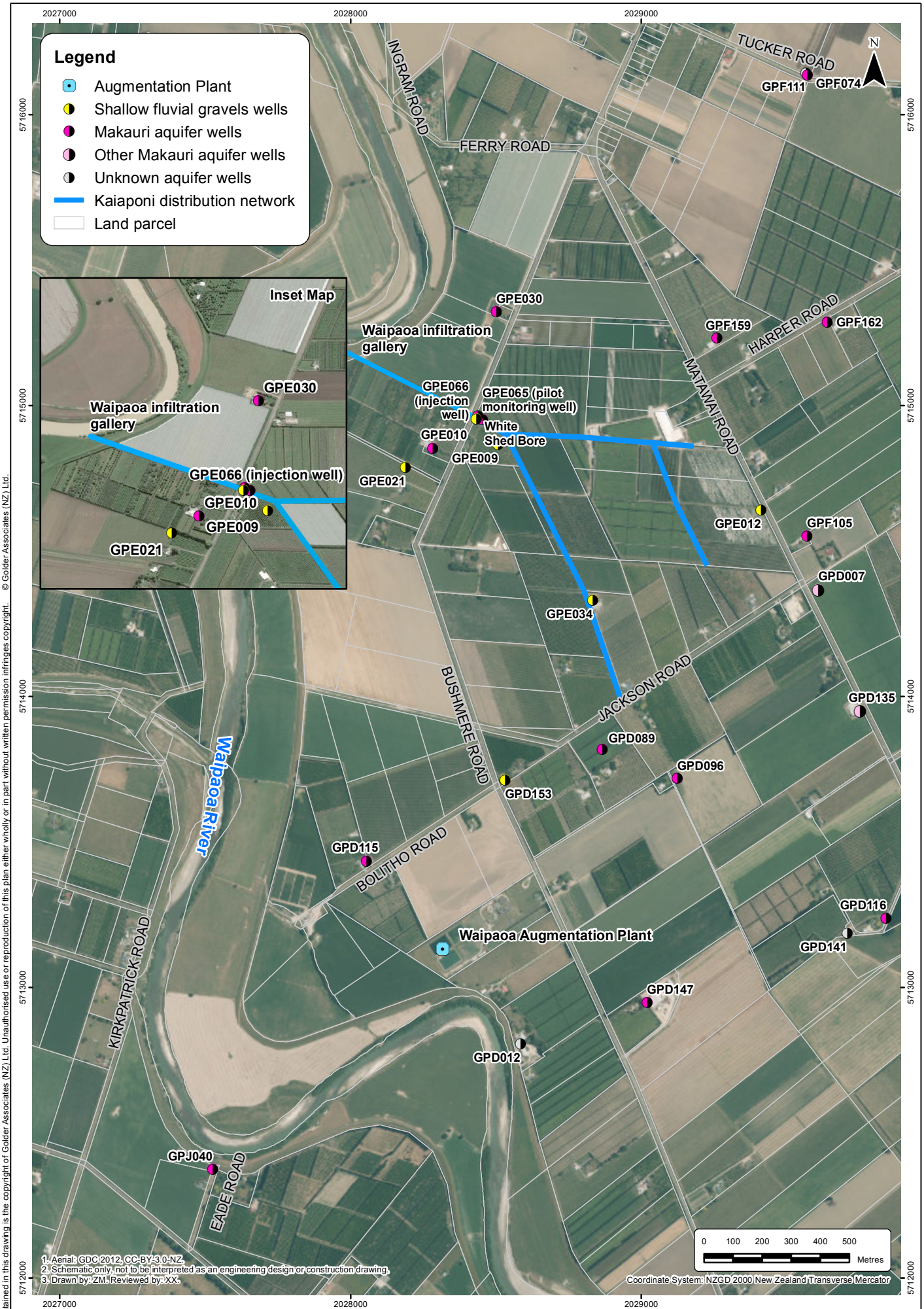
As a result of climate change the winter rainfall in Gisborne is expected to decrease in the future (MfE 2016).

2.2.3 Surface water

The nearest surface water body is the Waipaoa River at approximately 400 m from the injection well GPE066, from which the injection water is sourced. Jacobs (2017) modelled mean flows and mean annual 7-day low flows and these are listed in Table 1.

Table 1: Modelled flow statistics (after Jacobs 2017).

River Monitoring Site	Mean Daily Flow (m^3/s)	Mean Annual 7-day Low Flow (m^3/s)	Distance from MAR Injection Well GPE066 (km)
Kanakanaia Bridge (upstream from MAR site)	43.4	2.9	17
Matawhero Bridge (downstream from MAR site)	49.5	3.1	5



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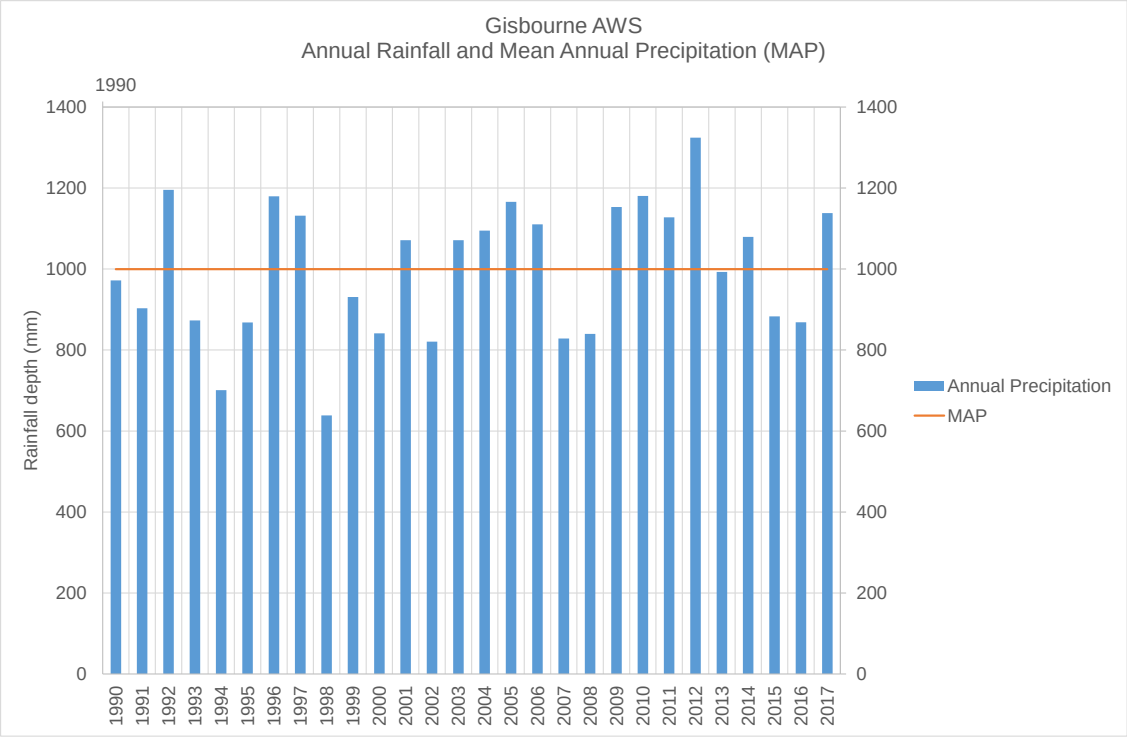

Figure 3: Annual rainfall in the Gisborne area (1989 - 2017).

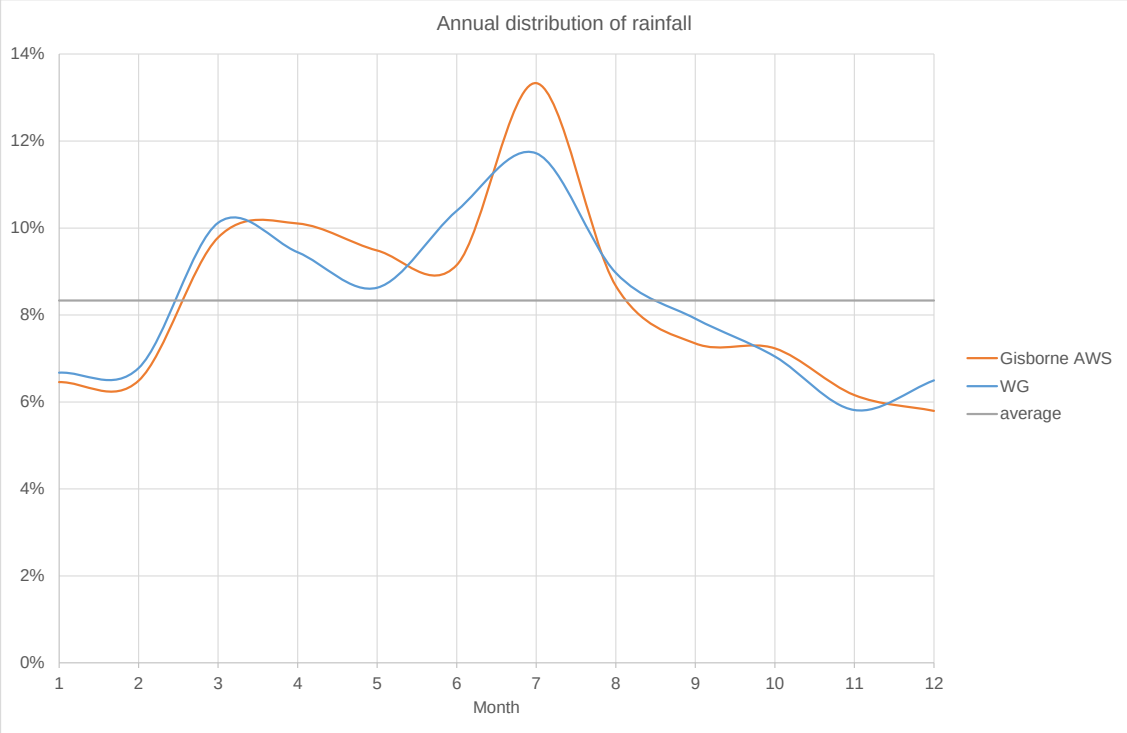

Figure 4: Annual rainfall distribution in Gisborne, based on Waihirere, Glanavon or WG (site 2796) and Gisborne AWS (site 2810) data from (1989 - 2017).

2.2.4 Waipaoa Augmentation Plant

The Waipaoa Augmentation Plant is located 1.8 km south of the MAR injection well (GPE066). The augmentation plant was commissioned in 1991 as an alternative supply to augment the Waingake water supply. The use of this site to source MAR injection water has previously been considered, but this has not been further investigated because of expected high operational costs (Golder 2016). The plant has the ability to produce water volumes up to 720 m^3/hr or 17,000 m^3/day (GDC 2008). GDC holds resource consent to take up to 13,392 m^3/day from the Waipaoa River at the plant. GDC established a minimum Waipaoa River flow of 600 L/s at the Matawhero Bridge and 1,300 L/s at the Kanakanaia Bridge, below which restrictions may be applied.

2.3 Geology

The basement rocks of the Poverty Bay area consist of Tertiary age sandstone and siltstone (GNS 2012). Tectonic tilting and deformation of the basement rocks has led to the development of a sedimentary basin beneath the Poverty Bay Flats. This sedimentary basin was filled with Quaternary age sediments consisting of alluvial and estuarine sands, gravels and silts. The basement depth was provisionally interpreted by GNS to be relatively shallow in the area west of the Waipaoa River (40 m to 50 m below mean sea level) and within the Gisborne urban area (35 m below mean sea level).

Since the last ice-age, the beach front has transgressed inland preventing the fluviatile gravels from being deposited through to the modern day coast. Along the coast, sand has been deposited to depths of approximately 20 m. An extensive estuary was present behind the dunes in pre-historic times, reaching inland as far as Ormond. Swamp and estuarine deposits from this time form a low permeability silt layer over the previously deposited delta gravels (GNS 2012). Rivers have subsequently cut down into and reworked some of the sediments. In addition, volcanic ash deposits from the Taupo Volcanic Zone are inter-bedded within the alluvium.

2.4 Hydrogeology

Five main aquifers have been delineated within the Quaternary deposits (GNS 2012) as described in the following sections. These include three shallow aquifers which are hydraulically linked to surface water bodies and two deeper aquifers. A conceptual cross section of the Poverty Bay flats aquifers is shown in Figure 5. The aquifers are mutually separated by confining layers of silts and clays (Taylor 1994).

2.4.1 Te Hapara Sand

A beach and dune sand deposit forms an unconfined aquifer in the southern area of the Poverty Bay Flats. The sands were initially deposited during a coastal advance and are up to 20 m thick. This aquifer is predominantly recharged by rainfall with some through-flow from the Shallow Fluvial Aquifer and the Waipaoa Gravel Aquifer (Taylor 1994). The Te Hapara Sand aquifer laterally transition to the north into the Shallow Fluvial Aquifer and are not present in the injection trial monitoring area.

2.4.2 Shallow Fluvial Aquifer

The Shallow Fluvial Aquifer is an unconfined aquifer consisting of pumice, sand and gravel deposits up to 10 m thick. This aquifer is hydraulically connected to, and locally recharged from, the Waipaoa River. The Shallow Fluvial Aquifer and the less extensive Waipaoa Gravel Aquifer are often considered as one aquifer system (GNS 2012).

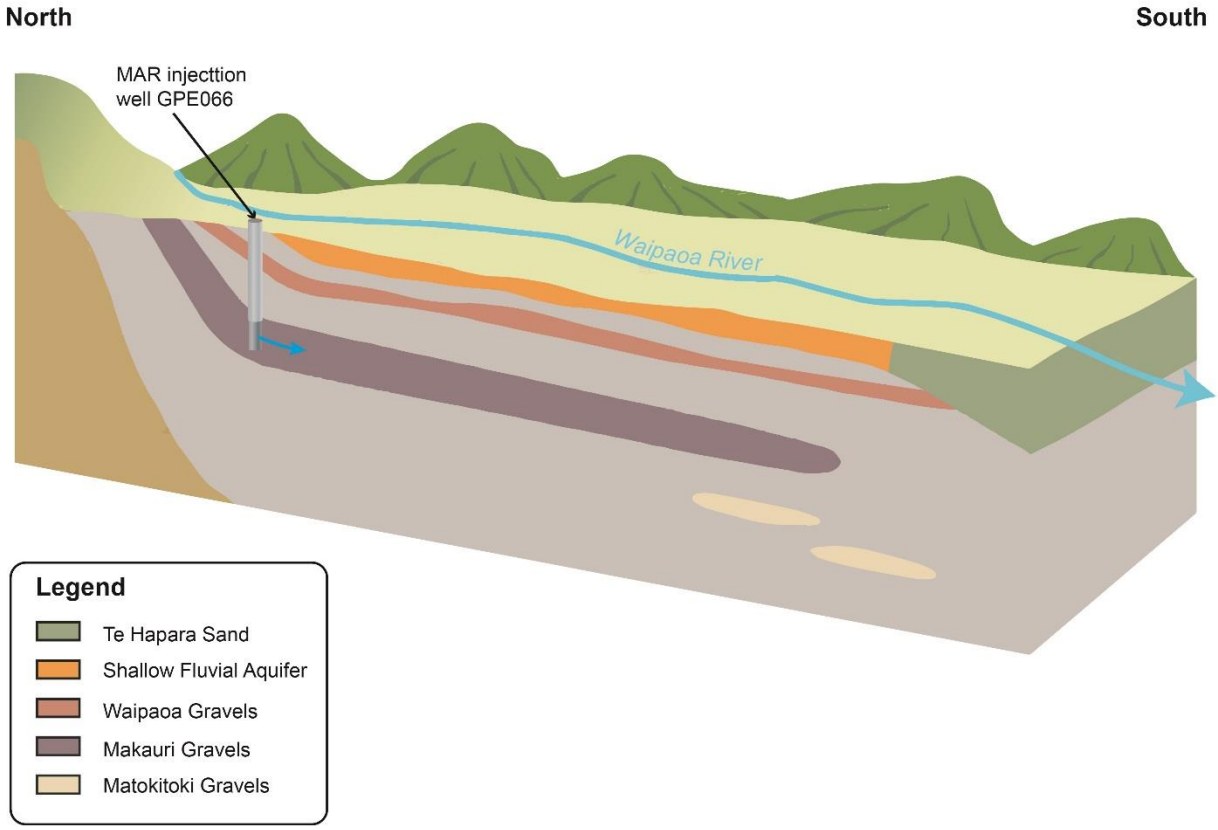

Figure 5: Conceptual cross section Poverty Bay flats aquifers (confining layers of silts and clays marked grey).

2.4.3 Waipaoa Gravel Aquifer

The Waipaoa Gravel Aquifer consists of localised fluviatile gravel deposits from the Waipaoa River, approximately 10 m to 30 m below the ground surface. At its southern end, this aquifer inter-fingers with the Te Hapara Sand (Figure 5). The Waipaoa Gravel aquifer is considered to be recharged from the river, and possibly from rainfall and deeper aquifers (GNS 2012). This aquifer has a transmissivity of 250 to 500 m^2/day. With a thickness of approximately 20 m (Rosen and White 2001), this would amount to a nominal range in hydraulic conductivity from 12 to 25 m/day.

2.4.4 Makauri Gravel Aquifer

The Makauri Aquifer is the aquifer in which water is injected during the injection trial described in this report.

This aquifer constitutes a series of gravel layers covering most of the Poverty Bay Flats area and extending up the Waipaoa Valley past Kaitaratahi (Figure 1). The gravel layers are considered to have been deposited as delta deposits when the river was down cutting into gravel terrace deposits upstream of Te Karaka (Taylor 1994). The aquifer has a thickness of 3 m to 20 m, with the thickest gravel layers in the middle of the basin and thinning towards the coast. Lithological logs from bores near the coast indicate a thin gravel layer is locally present in this area at approximately 66 m below ground level (GNS 2012). The Makauri Gravel Aquifer is the most extensive of the five main aquifers. The groundwater in the Makauri Aquifer is estimated to be approximately 100 years old by Taylor (1994).

Samples of aquifer material obtained from the 69 m to 72 m layer and the 85 m to 92 m deep gravel layers intersected in the MAR injection well (GPE065) were analysed for their elemental and mineralogical composition, as described in Golder (2017b). High calcium concentrations were measured in both samples and were consistent with the presence of limestone in the aquifer. Arsenic and sulphur were only present at low concentrations, which suggested that it is unlikely for there to be any significant sulphide sulphur-bearing minerals in the local aquifer. Results of the mineralogical analysis showed the samples were quartz-dominated with some calcium carbonate, most likely from shell fragments and limestone.

Hydraulic testing of the Makauri Gravel Aquifer has produced relatively high transmissivity results compared to the other Poverty Bay aquifers (750 m^2/day to 2,500 m^2/day; Taylor 1994). Aquifer test results of some of the nearby wells included in the monitoring programme (Section 3.7) are listed in Table 2.

Table 2: Aquifer parameter estimations for nearby wells included in the monitoring programme.

Well ID	Distance to injection well GPE066 (m)	Well depth (m bgl)	Maukari Aquifer Thickness (m)	Transmissivity (m^2/day)	Hydraulic conductivity (m/day)	Storage coefficient (-)
GPD089	1,210	85.3	4.5	1,155	257	0.0012
GPD115	1,576	75.1	3.5	456	130	n/a
GPF074	1,630	79.2	12.1	2,312	191	0.00027
GPF159	864	83	9.0	1,000	111	n/a
GPD135	1,650	71.0	5.8	424	73	0.00027
GPD007	1,312	70.1	n/a	383	n/a	n/a

Note: based on initial injection trial data, wells GPE034 and GPF111 do not appear to be screened in the Makauri Aquifer, although these wells have been classified as such previously (Golder 2014b).

A transmissivity of 600 to 800 m^2/day (and hydraulic conductivity of 200 to 260 m/day assuming an aquifer thickness of 2.95 m) was estimated from constant (abstraction) rate aquifer testing of the newly installed MAR injection well GPE066, with wells GPE065, GPE010 and GPE030 used as observations wells (Golder 2017b). A storage coefficient range of 2.0×10^{-5} to 3.0×10^{-4} was estimated from the same aquifer test. Further analysis of groundwater level responses in the same wells to the full injection trial between June and September 2017 suggest transmissivities 500 and 630 m^2/day, with lower values to the north and west and higher to the south and east (Appendix B).

There is little information available on possible leakage from underlying or overlying aquifers through confining clay and silt layers into the Makauri Aquifer. Golder (2014) estimated a leakage parameter (K'/B') value of 0.00005 day^{-1} to 0.0005 day^{-1}, or a vertical hydraulic conductivity (K_v) of 0.002 m/day to 0.02 m/day, based on aquifer test data from well GPF147 (outside the injection trial monitoring area) and nearby well GPF074, respectively. Further analysis of groundwater level responses in wells GPE065, GPE010 and GPE030 to the full injection trial between June and September 2017 suggest a leakage (K'/B') range of 2.5×10^{-5} to 1.6×10^{-4} day^{-1}, which would suggest a vertical hydraulic conductivities (K_v) of 0.001 to 0.006 m/day assuming leakage occurs from overlying aquifers and the thickness of the overlying confining layer being approximately 38 m (Appendix B).

2.4.5 Matokitoki Aquifer

The Matokitoki Aquifer consists of a deep gravel layer (100 m to 200 m below ground surface) deposited during the last glaciation. In some places the gravels lie directly upon basement rocks (Taylor 1994). The aquifer has an unknown extent and may actually occur as a series of disconnected gravel lenses rather than a continuous feature (GNS 2012). The silts that act as aquitards overlying the aquifer appear to thin toward the north. The aquitard may become leakier inland, allowing water recharge from the overlying Makauri Aquifer (Aqualinc 2012).

2.5 Makauri Aquifer Groundwater Levels, Flow and Recharge

2.5.1 Recharge and abstraction

NIWA (2010) estimated a total groundwater recharge (land-based and Waipaoa River inflow) of 38.7 M m^3/year over an area of 135 km^2 in Poverty Bay, which amounts to a recharge of approximately 290 mm/year across the area. This is slightly less than one third of the annual rainfall in the area. A portion of the groundwater recharge (some 5 %) is abstracted for water use, primarily for irrigation. Table 3 provides an indication of the Poverty Bay groundwater use. The largest annual abstraction volume of 1.5 M m^3 is from the Makauri Aquifer which is generally the most productive aquifer in Poverty Bay. The actual abstraction from the Makauri Aquifer is much less than the consented volume of take, which is 4 Mm^3 per irrigation season (Table 3).

Table 3: Poverty Flats aquifer water usage.

Aquifer	Consented volume (m^3 per day)	Consented Rate of take (L/s)	Actual total use (m^3/year)	Daily consented x 120 days (m^3/year)	Use compared to allocation (%)
Shallow Fluvial	8,975	156	112,119	1,077,000	19
Te Hapara	5,846	111	80,890	701,520	17
Waipaoa	2,747	48	116,380	329,640	25
Makauri	33,794	491	1,472,020	4,055,220	33
Matokitoki	18,350	222	77,664	2,202,000	7
Unknown	745	12	24,312	89,400	38
Total	**70,457**	**1,040**	**1,883,386**	**8,454,780**	**25**

Note: Source GDC (2013).

Recharge to the Makauri Aquifer beneath the Poverty Bay Flats east of the Waipaoa River appears to be primarily derived from southward flows within the aquifer from the Waipaoa River valley north of Ormond (the recharge of this northern part of the aquifer is not well understood) and from downward leakage from the Waipaoa Gravel Aquifer, other shallow aquifers and the Waipaoa River. In addition, upward seepage from the Matokitoki aquifer and possibly lateral flow from the basement rocks marked by the hills surrounding the Poverty Bay flats. Golder (2014a) provides indications of the total recharge of the Makauri Aquifer, which was incorporated in Goldsim water balance modelling. A total recharge of 2.2 Mm^3/year was assumed in the modelling scenarios for the Poverty Bay Flats area east of the Waipaoa River.

Whilst the annual recharge of the Makauri Aquifer is larger than the total abstraction from it (Table 3), it is relevant to note that this recharge mainly occurs in the winter season and not during the irrigation season. This has led to the gradual decline of summer Makauri Aquifer water levels and over time will affect the aquifer yield.

2.5.2 Groundwater levels and long-term trends

The gradual decline in groundwater levels of the Makauri Aquifer has long been acknowledged. Barber (1993) reviewed groundwater levels in Makauri Aquifer monitoring wells between 1982 and 1992 and identified an ongoing drop in aquifer hydraulic head resulting from increased water abstraction. Barber concluded that the aquifer recharge rate was not keeping up with the rate of abstraction. In a review of groundwater level data from the Poverty Bay Flats, White et al. (2012) concluded that groundwater elevations in five out of eight wells exhibit a statistically-significant decreasing trend. The rate of decline identified ranged from -0.02 m to -0.1 m per year between the commencement of data collection and 2011.

A trend of increasing summer groundwater abstraction from the Makauri Aquifer has caused the long-term declining trend in overall groundwater levels as well as in seasonal low levels. This is clearly visible in the groundwater level records from Makauri Aquifer well GPJ040 (Figure 6). There is an overall increase in groundwater abstraction, not just higher abstraction during dry years. Although the overall trend in groundwater levels is declining, winter recharge appears to be sufficient to recover groundwater levels the following winter.

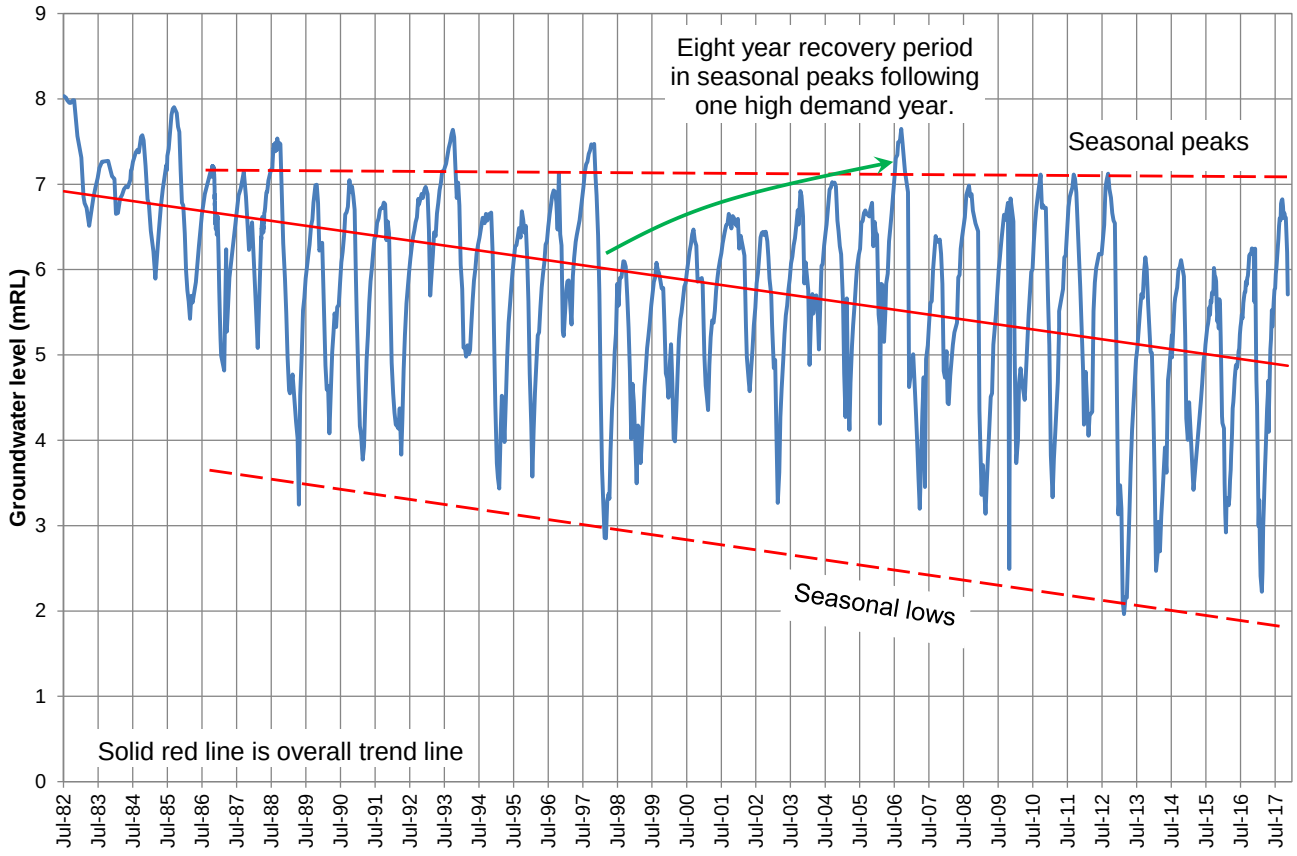

Figure 6: Long-term groundwater level trend in Makauri Aquifer well GPJ040.

Abstracted volumes from the Makauri Aquifer during drought years already appear to exceed the annual recharge for the aquifer. The Makauri Aquifer is reaching a limit in its capacity to recover, as shown by the extended recovery period following drought seasons. Water abstraction from the Makauri Aquifer is significantly less than the allocated volumes (Golder 2014b). Further increases in water abstraction from the aquifer will lead to further declines in groundwater levels and ultimately a decline in aquifer yield.

Further analysis of the last 4 years shows that the winter groundwater level rise corresponds to the winter rainfall in the same year (Figure 7). It would appear that the Makauri Aquifer responds reasonably fast to recharge events. This is a pressure response. Groundwater flows are relatively low and the groundwater relatively old (Section 2.4.4). Nonetheless, the relationship between annual rainfall and recharge for the Makauri Aquifer may be reasonably indirect; groundwater pressure response may be governed by indirect effects such as river recharge and lower rates of pumping in a wet year.

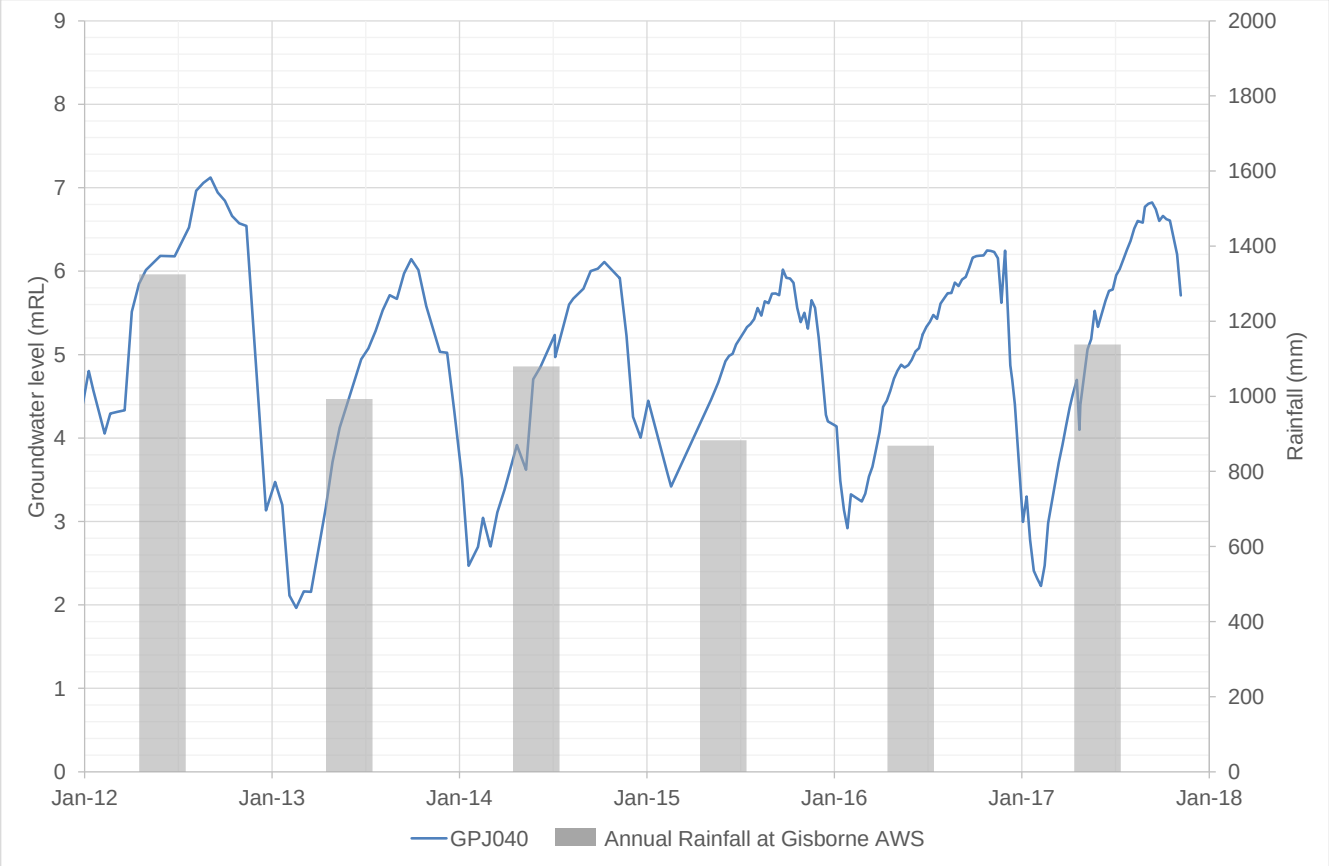

Figure 7: Annual rainfall and groundwater level fluctuation in 2013 - 2017 period (annual rainfall is projected on the first quarter of the year).

Less information is available on groundwater levels in the Shallow Fluvial Aquifer. In Figure 8 the groundwater levels observed in the last 3 years are shown for Shallow Fluvial Aquifer screened wells in the Poverty Bay MAR monitoring area. Although seasonal fluctuations do occur, they are much less pronounced as the seasonal response recorded in the Makauri Aquifer.

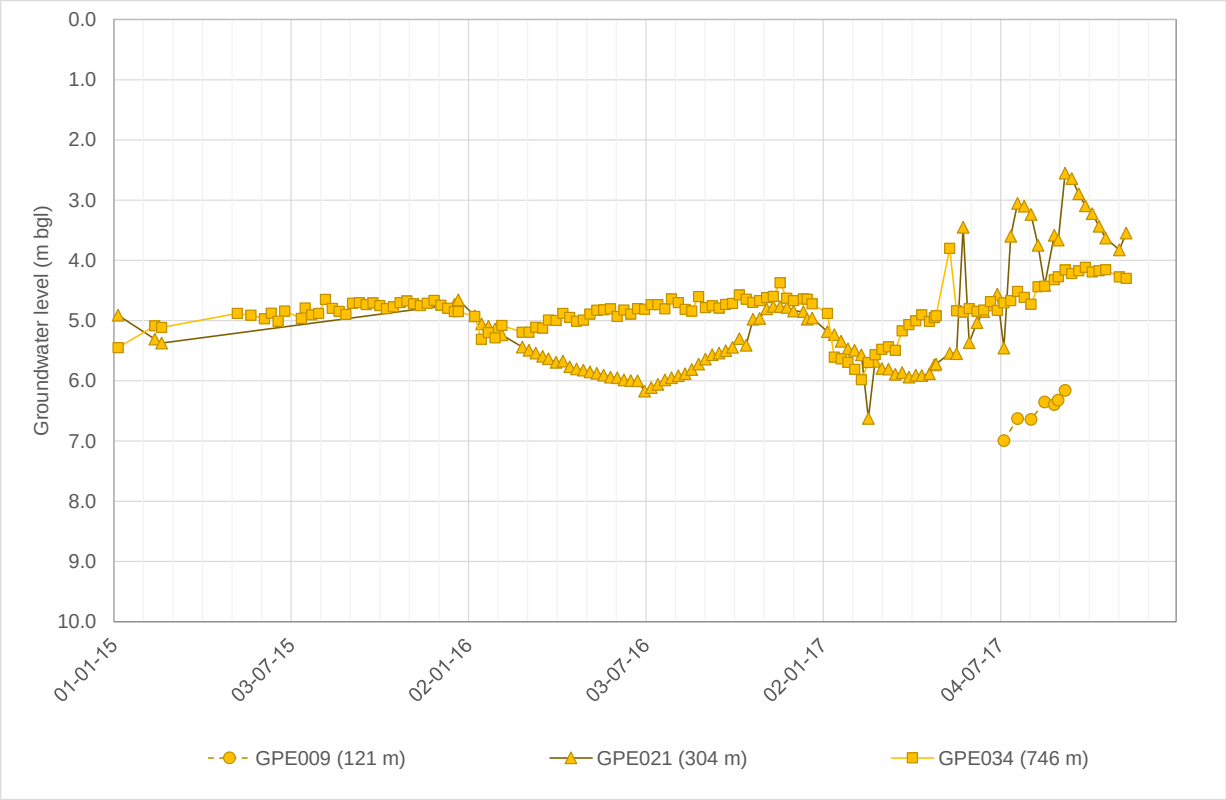

Figure 8: Groundwater level fluctuations in Shallow Fluvial Aquifer in 2015 - 2017 period.

2.5.3 Groundwater contours and flow direction

Groundwater level contours have been derived by kriging for Makauri Aquifer groundwater levels recorded in August 2008, which represents a mid-winter situation (Golder 2014b). The contours have been projected onto the MAR monitoring area as shown in Figure 9. Groundwater flows perpendicular to the groundwater contours and there is a general flow towards the south. The flow direction near the MAR injection well (GPE066) appears to be southwestern. In the summer, when abstraction for irrigation occurs, the groundwater contours change significantly as shown in Figure 10. The January 2009 contours in Figure 10 represent a summer situation in which the groundwater flows towards the centre of the area under the influence of irrigation abstraction wells.

The summer groundwater levels appear to be drawn down to below median sea level in the summer and the contours in Figure 10 suggest groundwater flows eastwards in the middle of area and northwards from the south side towards the centre of the area. Although winter groundwater flows reverses the summer northward flow, this reversal may not be sufficient to avoid saline water from entering into the Makauri Aquifer, either from the West Saline Aquifer (Section 2.6.3) or from the sea

Figure 9: Groundwater contours and flow near injection site in August 2008 (winter season).

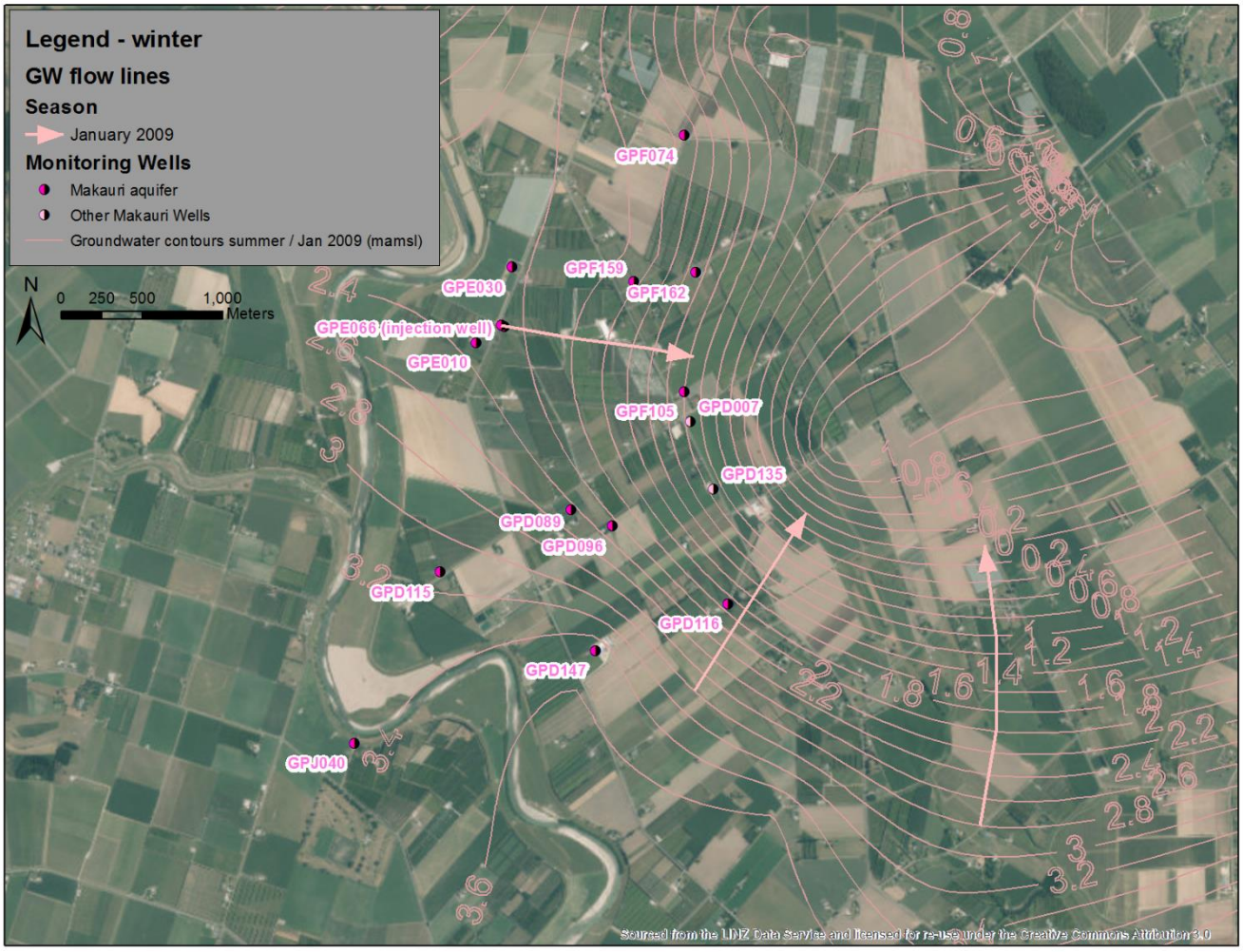

Figure 10: Groundwater contours and flow near injection site in January 2009 (irrigation season).

2.6 Groundwater Quality and Geochemistry

2.6.1 General

In this section the groundwater quality and geochemical characteristics of the Makauri Aquifer (i.e. the receiving aquifer for MAR injection water) prior to injection are summarised.

2.6.2 Available information

The Poverty Bay Flats area groundwater was characterized by Golder at multiple stages through the planning and resource consenting process to support the Poverty Bay MAR pilot project. Groundwater quality was first described on a regional basis in the Stage 1B feasibility assessment report (Golder 2014b), and later in more detail for the Makauri Aquifer in the hydrogeology report (Golder 2015). The most detailed assessment was undertaken for the selected MAR pilot site on the Kaiaponi farm (Golder 2016).

Preliminary water quality data from samples collected at the MAR injection and monitoring wells (GPE066 and GPE065 respectively) during an initial injection test were presented in June 2017 (Golder 2017a), prior to Golder commencing the main injection trial that is described in this report (Section 4.0).

Makauri Aquifer groundwater was also characterized from samples collected at three privately owned wells (GPD089, GPD115, and GPD116) located within less than 1.6 km of both the MAR injection well (GPE066) and a previously-proposed injection location on Bushmere Road (Golder 2015). The data from GDP115 were used as a basis for the water quality assessment and groundwater quality modelling undertaken in support of the Assessment of Environmental Effects (Golder 2015).

2.6.3 Characterisation of Makauri Aquifer water quality

General description

The Makauri Aquifer contains groundwater with high conductivity and a circum-neutral pH that is present in a confined limestone-bearing gravel aquifer. Anoxic and chemically reducing conditions occur in the aquifer due to the presence of organic materials, which are slowly decomposing.

Decomposition of organic matter is a biogeochemical process in which oxidants are consumed to convert organic carbon compounds to carbon dioxide and water. In a near-surface environment these reactions would proceed with oxygen from the atmosphere, or dissolved in water. However after oxygen has been consumed and re-supply is constrained, reduction of other chemical species (i.e. electron acceptors) dissolved in the groundwater or present in the sediment occurs. These chemical species include dissolved oxidized nitrogen species (such as nitrate), sediment-bound metal oxides (iron and manganese oxides), and dissolved sulphate. After all available oxidants are depleted, organic matter may start to methanogenically degrade to produce methane and carbon dioxide. These conditions are typically observed through very low concentrations of dissolved oxygen, the presence of ammonia rather than the oxidized forms of nitrogen (nitrate and nitrite), the presence of dissolved metals such as iron and manganese that would otherwise precipitate as metal oxides, and low concentrations of sulphate.

As shown by the water quality monitoring results described in this section, the Makauri Aquifer exhibits all these characteristics and is best described as confined, anoxic, and methanic groundwater.

West of the Waipaoa River the Makauri Aquifer is classified as saline and largely unsuitable as a source for irrigation. Golder understands there are no horticulture irrigation abstractions in this area. The area is referred to as the ‘West Saline Aquifer’ (Barber 1993).

Table 4: Summary of Makauri Aquifer groundwater and Waipaoa River water quality.

Parameter	Units	Median (GPD115)[1)]	GPE065 and GPE066 (median)[2)]	Waipaoa River (median)[3)]
Water Quality Parameters				
pH	s.u.	7.1	7.3	8.00
Temperature	°C	15	16	12
Turbidity	NTU	7	53	3.1
Electrical Conductivity	µS/cm	1,110	1,318	487
Total Dissolved Solids	g/m^3	720	815	320
Total Alkalinity	g $CaCO_3/m^3$	520	690	150
Hardness	g $CaCO_3/m^3$	420	525	190
Disinfectants				
Free Chlorine	g/m^3	< 0.05	0.07	-
Major Ions				
Calcium	g/m^3	140	180	66
Chloride	g/m^3	68.5	120	0.09
Magnesium	g/m^3	16.9	20	7.1
Potassium	g/m^3	8.85	9.05	2.5
Sodium	g/m^3	83	88	23
Sulphate	g/m^3	< 0.5	0.1	80
Nutrients				
Nitrate	g/m^3	< 0.002	0.0048	0.002
Nitrite-N	g/m^3	< 0.002	0.005	-
Total Ammoniacal-N	g/m^3	3.7	2.0	0.0077
Dissolved Reactive Phosphorus	g/m^3	< 0.004	-	0.026
Metals				
Aluminum (dissolved)	g/m^3	< 0.003	-	-
Aluminum (total)	g/m^3	< 0.0032	-	-
Iron (dissolved)	g/m^3	1.56	4.25	0.0075
Iron (total)	g/m^3	4.77	6.05	0.09
Manganese (dissolved)	g/m^3	0.66	0.90	0.015
Manganese (total)	g/m^3	0.57	0.93	0.013

Notes:

1) Median GPD115 water quality is based on both GDC's long term irrigation monitoring program (a median value is presented for the period March 1992 through September 2013, in which there are >50 data points) and additional samples collected in May 2015.

2) Median GPE065 and GPE066 water quality is based on five results from samples collected between March and May 2017.

3) Median Waipaoa River water quality is based on 10 samples collected from the MAR Headworks Outlet between June and September 2017

Makauri Aquifer water quality characteristics

Table 4 provides a comparison of the long-term monitoring data at GPD115, which is based on more than 50 samples collected between March 1992 through September 2013, with groundwater quality in the MAR pilot trial area, which is based on five samples from wells GPE065 (MAR monitoring well) and GPE066 (MAR injection well) collected between March and May 2017. The similarities in groundwater quality between these wells supports the continued use of both the long-term and current groundwater quality data from GPD115 to assess the Makauri Aquifer.

Piper diagram and comparison of water types

A comparison of the major cations and anions distribution in water samples from the MAR injection well (GPE066) and a collection of other wells screened in the Makauri Aquifer is presented as a Piper diagram in Figure 11. A Piper diagram can be used in the identification and classification of different water types. The major cation and anion distributions in groundwater samples from wells within five kilometres of the injection well are very similar to the sample obtained from the MAR injection well (GPE066).

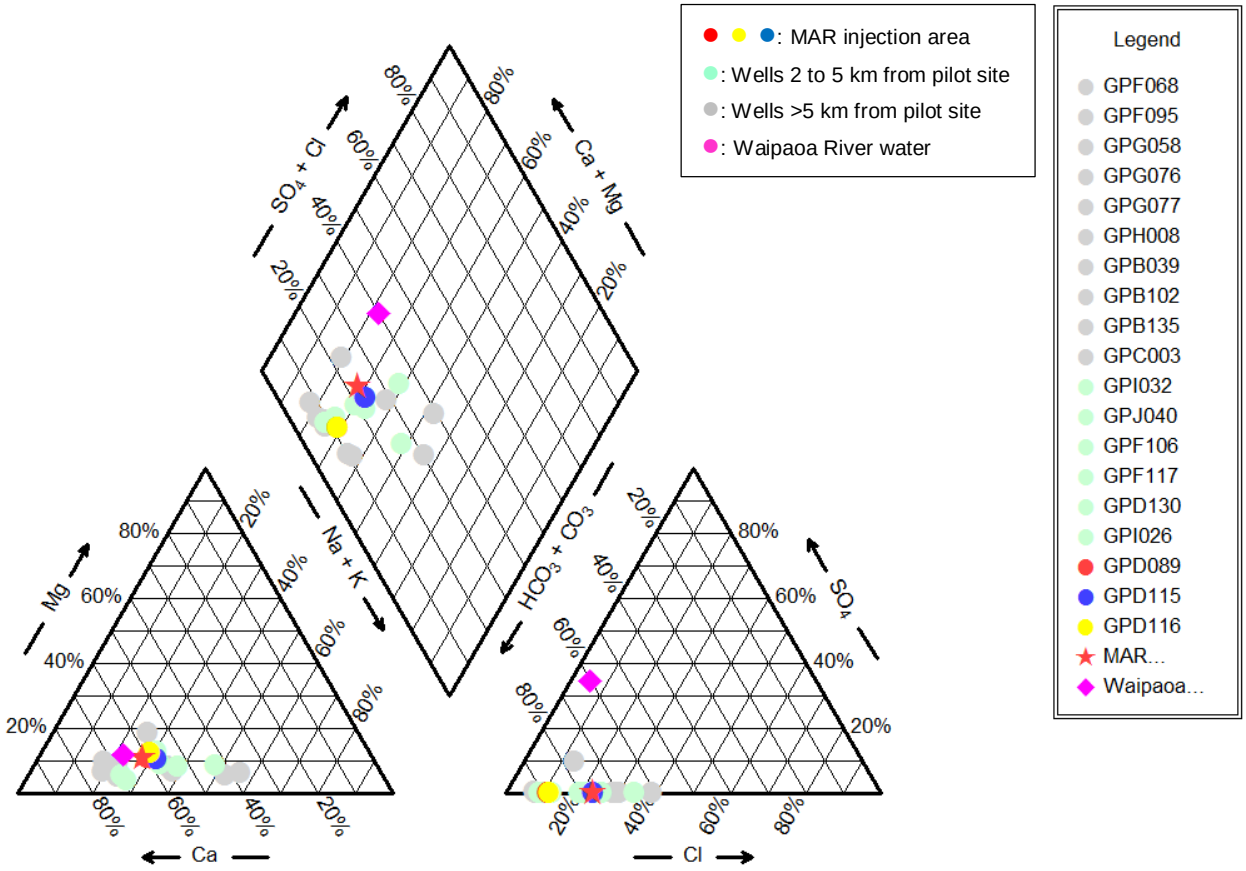

Figure 11: Major ion characteristics for water from wells screened in the Makauri Aquifer.

Figure 11 demonstrates the Makauri Aquifer groundwater at each of these wells originates from a similar source and interacts with generally the same substrate materials in the confined gravel aquifer as the relative concentrations of most water quality parameters are reasonably similar. Waipaoa River water is of different chemical composition with major ions at notably lower concentrations than Makauri Aquifer water (Section 2.6.4).

Groundwater in the Makauri Aquifer has a generally stable pH at a neutral to alkaline level (pH 7.3 at GPE065 and GPE066 prior to the MAR trial, and pH 7.0 to 7.3 for the past decade at GPD115) and is classified as a "very hard" water according to the elevated concentrations of calcium and magnesium (hardness typically >400 g $CaCO_3/m^3$).

Long-term trends in groundwater quality

Most major cations and anions have generally stable concentrations in the local groundwater, as shown in time series plots for water quality parameters included in Appendix C. These results are generally consistent with the water quality at the MAR monitoring well and injection well.

The local groundwater type at the MAR pilot well is classified as Ca-HCO_3 based on the elevated concentrations of calcium and alkalinity related to leaching of limestone-bearing sediments present in the Makauri Aquifer, or at the source of the groundwater. Groundwater samples collected at GPD115 during the last decade (i.e. 2005 through 2015) were assessed in Golder (2016) and showed that the water type had remained generally consistent.

A long-term increasing trend is observed at GPD115 and GPD147 for the chloride concentrations (Figure 12). GPD147 could possibly be screened in the underlying Matokitoki Aquifer. Chloride concentrations increased from 50 g/m^3 to 140 g/m^3 at GPD115 during the period from 1992 to 2013. Chloride concentrations ranged from 110 to 120 g/m^3 at the MAR monitoring well (GPE065) between March and May 2017. Calcium, potassium, and sodium concentrations also increased over this long-term monitoring period, but to a lesser extent, where potassium shows a slight decline (Figure 13). The increase in concentrations coincided with a general increase in electrical conductivity for the same period. Some of these long-term changes in major ion concentrations appeared to be limited to certain constituents or localized to individual wells; for example, although an increase in chloride concentrations was detected in water from GPD115 and GP147, concentrations at GPD089 and GPD116 remained similar to pre-2005 levels at GPD115.

Although not confirmed, one possibility is that more saline water originating from deeper depths (e.g., the underlying and substantially more saline Matokitoki Aquifer) or from 'West Saline Aquifer' is drawn into the Makauri Aquifer near GPD115 and GPD147 over time and has caused groundwater locally to become more saline. Cation exchange reactions alter the groundwater composition and therefore can be used as indicators to assess whether re-freshening or salt water intrusion takes place (Appelo and Postma 1994). With cation exchange, the larger divalent calcium ions (Ca^{2+}) on sorption complexes such as clay minerals in aquifer formation materials are replaced by the monovalent sodium ions (Na^{+}). Chloride is unaffected by this process. The net effect is that chloride and calcium concentrations increase in groundwater, while sodium concentrations remain initially stable. At a later stage in this process, the sodium concentration will also increase when all calcium ions have been removed from the sorption complexes and the saline water continues to accumulate.

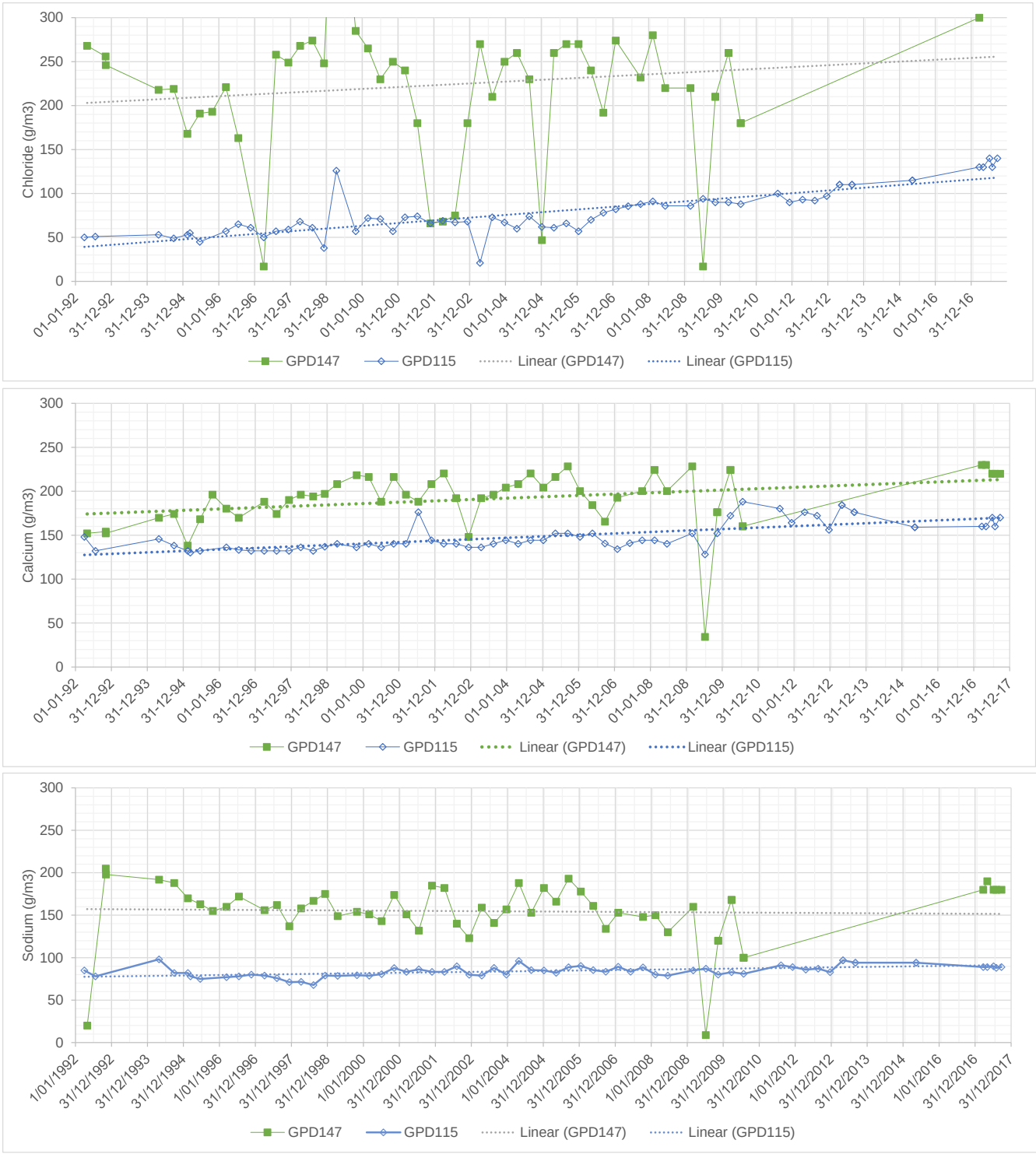

Figure 12: Long-term trend in chloride, calcium and sodium in GPD115 and GPD147.

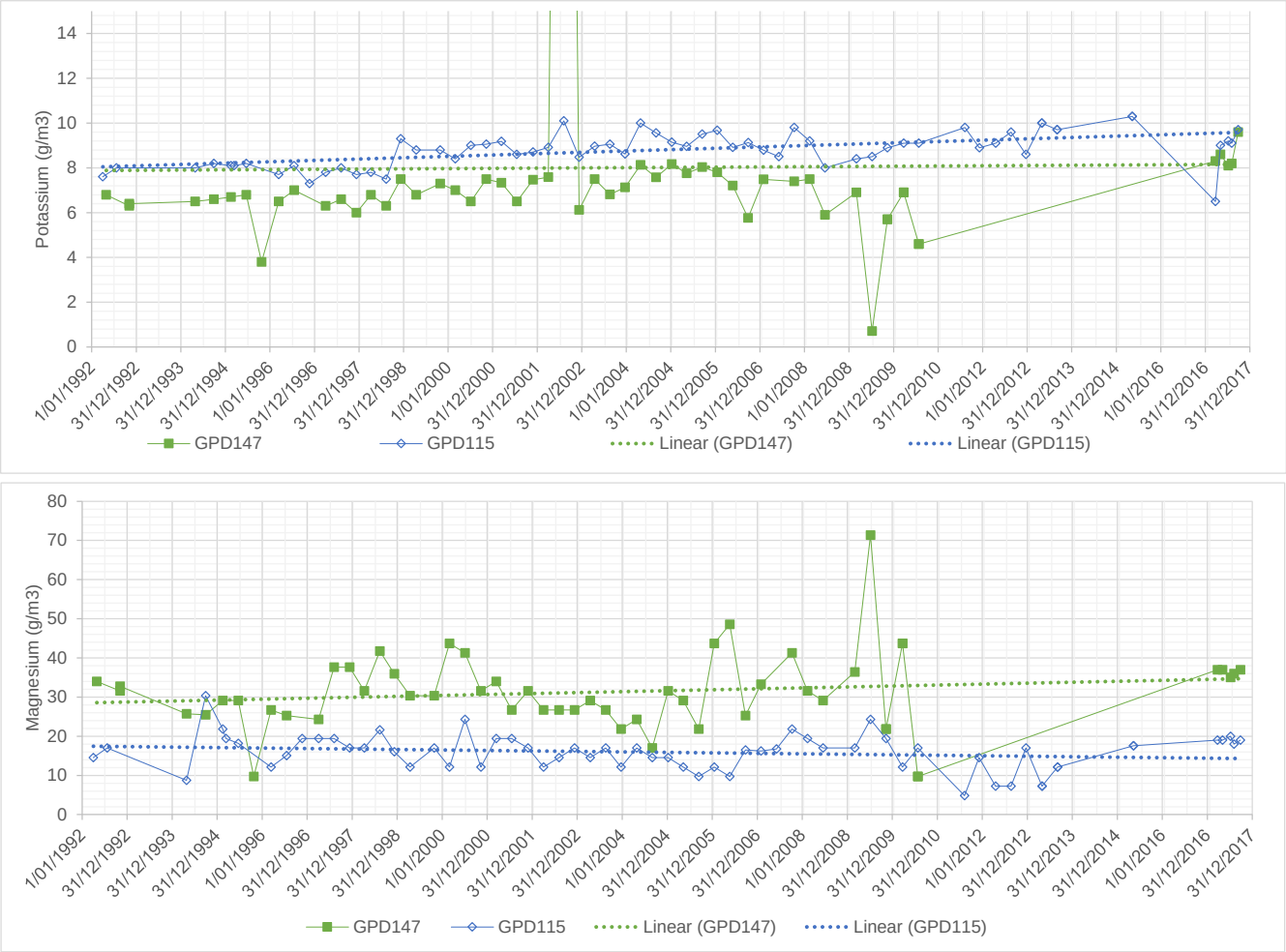

Figure 13: Long-term trend in potassium and sodium in GPD115 and GPD147.

Redox conditions in the Makauri Aquifer

The local groundwater at the MAR monitoring well is chemically reducing, consistent with the previous characterization of the aquifer presented by Golder (2014, 2016, and 2017). Groundwater samples collected prior to any injection activities typically contained low to negligible concentrations of dissolved oxygen and had low oxidation reduction potential values. Sulphate was also typically not detected in groundwater at the MAR monitoring well or any of the irrigation wells nor was nitrate nitrogen. Ammoniacal nitrogen was also the only nitrogen detected in samples from these wells, which is consistent with ammonium mobilised from decaying organic matter during methanogenesis and remaining in the reduced form, or nitrate that enters the aquifer being reduced.

The low sulphate concentrations in water from almost all the groundwater wells that were evaluated previously suggests that reducing conditions and dissolved methane are present in the Makauri Aquifer beneath much of the Poverty Bay Flats. Waipaoa River water differs notably as this water is aerobic and contains high sulphate concentrations. Ammoniacal nitrogen concentrations are lower than in Makauri Aquifer water and nitrate nitrogen is higher (Section 2.6.4).

It should be noted that while the presence of organic carbon and high partial pressure of carbon dioxide in the aquifer supports the biogenic production of methane (i.e. methane produced by near-surface biologically-mediated reactions), additional sources of methane are also possible, including from a thermogenic origin where methane is produced by reactions occurring on the order of kilometres below the earth's surface. Methane seeps have been identified off the coast of Gisborne and therefore, although unconfirmed on a local basis, thermogenic methane may be present in the Makauri Aquifer.

Metals concentrations in the Makauri Aquifer are dominated by the geochemically reducing and slightly alkaline groundwater, and may be summarized as follows based on the long-term water quality at GPD115 and the more recent water quality monitoring undertaken at the MAR monitoring well GPE065.

- Total and dissolved concentrations of iron and manganese in long term monitoring data at GPD115 indicated that most iron was present in the solid phase (i.e. on average dissolved concentrations were 10 % of the total) and most manganese was dissolved. These two metals are typically sensitive to changes in the oxidation state of the water and would typically form metal oxide precipitates at a neutral pH in oxygenated water. However, given the anoxic state of the Makauri Aquifer, it is unlikely that secondary iron or manganese oxide phases would exist, and a more likely explanation is that these metals oxidized and precipitated in the time between collecting the groundwater samples in the field and filtering them in the laboratory. Based on the geochemical conditions, it is reasonable to assume that most iron and manganese would remain dissolved in the Makauri Aquifer. Filtering samples immediately after collection is included as a recommendation in Section 6.3.
- Total iron concentrations in groundwater samples from the MAR pilot well in March and May 2017 were similar to the historical range at GPD115. Dissolved iron (3.4 g/m^3 to 5.5 g/m^3) comprised approximately 60% of total iron (5.4 g/m^3 to 8.3 g/m^3). A sample collected in April 2017 contained low dissolved iron concentration and was considered erroneous, and possibly located to sample oxidation during sampling.
- Manganese concentrations were generally stable at GPD115 over time (0.49 to 1.17 g/m^3) and occurred at a similar concentration at the MAR monitoring well GPE065 between March and May 2017 (0.86 to 0.95 g/m^3). The MAR monitoring well samples showed that approximately 90 % of manganese was dissolved (i.e. dissolved concentrations ranged from 0.88 to 0.92 g/m^3 while total concentrations ranged from 0.86 to 0.95 g/m^3).
- Aluminium was typically not detected (<0.003 g/m^3) or detected only slightly above the detection limit in long term monitoring at GPD115. No detectable dissolved aluminium and low total aluminium concentrations were reported in the May 2015 samples at GPD115 and therefore samples from the MAR monitoring well were not analysed for aluminium.
- Arsenic was detected in groundwater at all Makauri Aquifer wells sampled prior to the injection trial, including at the MAR monitoring well (total arsenic: 0.0068 to 0.0096 g/m^3 in March through May 2017). Dissolved arsenic comprised more than 80% of total arsenic, which was consistent with arsenic remaining both soluble and unabsorbed to metal oxide minerals (which also remained soluble) in the chemically reduced groundwater.
- Concentrations of other metals including dissolved antimony, beryllium, cadmium, chromium, copper, lead, selenium, tin and uranium did not exceed their respective detection limits and dissolved barium, boron, lithium, molybdenum and zinc concentrations were generally low and consistent in local groundwater at the three wells in Makauri Aquifer groundwater during the May 2015 sampling event described in Golder (2016). These metals were not identified as constituents of concern for further baseline sampling activities at the MAR monitoring well.

Analysis of metals in local groundwater generally indicated the water was of good quality, although in some cases may possibly have contained some fine suspended clay or colloids.

Disinfection by-products, pesticides, and pathogens

Three groundwater samples collected at wells GPD089, GPD115 and GPD116 in May 2015 were tested for parameters that may lead to formation of disinfection by-products (DBPs) including dissolved organic carbon, chlorine, and chloramines (Section 3.7.4). A single groundwater sample collected from well GPD115 was tested for DBPs to provide a baseline for the Makauri Aquifer prior to construction of a pilot injection well. The results of these analyses were previously presented in Golder (2015), and included:

- Free chlorine was detected at a low concentration (0.06 g/m^3) in groundwater at GPD116 and not detected at GPD115 and GPD089.
- Analysis of chloramines (i.e. mono, di and trichloramines) detected dichloramine at a low concentration (0.08 g/m^3) in groundwater at GPD116.

No halogenated acetic acids (HAAs), haloacetonitriles (HANs), or trihalomethanes (THMs) were detected in the groundwater sample obtained from GPD115.

Since the groundwater in the Makauri Aquifer is approximately 80 to 100 years old (Taylor 1994), it is considered unlikely that it would contain pesticides, or other industrial chemicals that may be released by agricultural activities that currently occur on the land surface. Golder's review of historical water quality data that included pesticide analyses in the Poverty Bay Flats area (sourced from ESR 2014), indicated no pesticides were detected in groundwater samples obtained from the two wells that were located within 5 km of the MAR trial site and greater than 20 m deep.

Pathogens, including E.*coli* were not detected at the MAR monitoring well prior to the injection trial (<1.6 cfu/100 mL) and are considered unlikely to occur in the confined groundwater aquifer, or survive for more than a short time if they are introduced to groundwater during injection operations. Published experimental results and groundwater quality monitoring data for a range of sites found that E.*coli* can typically only survive for a few months in groundwater (Edberg et al 2000).

2.6.4 Waipaoa River water quality characterisation

The Waipaoa River water had a circumneutral to alkaline pH (7.70 to 8.10 during MAR trial), and is classified as a calcium-bicarbonate water type, like the Makauri Aquifer groundwater. The Waipaoa River water is exposed to aerobic conditions and in equilibrium with atmospheric gases. As shown in Table 4, the river water contained alkalinity (130 to 160 g/m^3), calcium (55 to 73 g/m^3), chloride (8.1 to 11 g/m^3), magnesium (6.1 to 8.1 g/m^3), potassium (2.4 to 2.9 g/m^3), and sulphate (61 to 92 g/m^3) at concentrations that were consistent with surface water draining a limestone-bearing catchment.

Compared to the Makauri Aquifer groundwater, and except for chloride and sulphate, most major ions were measured in the Waipaoa River water at concentrations about 30 % of the levels in the groundwater. Chloride was more than an order of magnitude lower in the Waipaoa River water than the Makauri Aquifer groundwater. Sulphate concentrations were substantially higher in the Waipaoa River than the anoxic Makauri Aquifer groundwater, where sulphate is chemically reduced. Based on the relative concentrations of the major ions (especially the cations calcium, magnesium, sodium, and potassium), which are shown on the Piper diagram in Figure 11, the Waipaoa River water originates from a source that is reasonably similar to the source of Makauri Aquifer groundwater.

Constituents that were present in the injection water, and can be expected to occur based on its surface water source, included the nutrients nitrate (0.002 to 0.0047 g/m^3) and total phosphorus (0.02 to 0.04 g/m^3), total organic carbon (2.1 to 3.6 g/m^3), total suspended solids (0.75 to 22 g/m^3), turbidity (0.60 to 22 NTU), and E.*coli* (<1.6 to 280 cfu/100 mL).

The metals arsenic (0.00063 to 0.00083 g/m^3), iron (0.02 to 0.49 g/m^3) and manganese (0.01 to 0.03 gm^3) were measured at low concentrations.

2.6.5 Stygofauna in the Makauri Aquifer

The groundwater community is composed of a range of species belonging to bacteria, fungi, protozoa, along with macroinvertebrates, called stygofauna. Stygofauna are highly adapted to living in groundwater ecosystems and play an important role in nutrient cycling, as well as serve as indicators of groundwater health. Stygofauna are sensitive to changes in groundwater quality and integrate changes in water quality over longer time periods than discrete water samples. In anaerobic systems, high concentrations of ammonia, iron, hydrogen sulphide and methane can be toxic to many species (Middelburg and Levin 2009).

While over 500 species of stygofauna have been identified in New Zealand groundwater systems, challenges with studying groundwater ecosystems means that these communities are not well understood compared to communities in Australia or the United Kingdom (Scarsbrook et al. 2003).

A one-off sampling of well GPE010 by NIWA in August 2017, found little evidence of a stygofauna community. Changes in water quality, as a result of aerobic river water injection, is likely to result in a habitat that is more suitable to support a stygofaunal community. Both stygofaunal diversity and biomass may increase as a result of the injection process. Increased stygofauna numbers could assist with controlling biofilm biomass (through grazing), although the degree to which this would be beneficial is uncertain.

3.0 INJECTION INFRASTRUCTURE AND MONITORING

3.1 General

The type of MAR technology used in the Poverty Bay MAR pilot project is referred to as Aquifer Storage Transfer and Recovery (ASTR). ASTR entails the injection of water into an aquifer through an injection well and the recovery of this water some distance downgradient, after the injection water has passed that distance through the aquifer. For the Poverty Bay MAR pilot project the Waipaoa River was selected as the source of injection water.

This section includes a description of the construction details of the injection well, the monitoring well, the water abstraction and injection infrastructure, and the filter and treatment systems. A summary of pumping testing undertaken on the MAR injection well has also been included, as well as an overview of the aquifer response monitoring programme.

3.2 Abstraction and Injection Resource Consent

GDC has resource consent (DW-2016-107113-00) to abstract up to 22 L/s, 1,901 m^3/day and a total volume of 110,000 m^3 (10,000 for pre-trial injection and 100,000 for the main injection trial) from the Waipaoa River at the Kaiaponi irrigation intake site between 1 May and the following 30 September of each year. The same rates and volumes can be injected into the Makauri Aquifer through injection well GPE066.

The abstraction can only occur when the flow at Kanakanaia bridge and Matawhero bridge (Figure 1), as measured by GDC is greater than 4 m^3/s. Injection of river water is not permitted when E.*coli* concentrations are above 100 cfu/100 ml or turbidity level is above 100 NTU in the source water.

3.3 Waipaoa River Infiltration Gallery

The water for injection is sourced from the Waipaoa River via abstraction from the existing Kaiaponi infiltration gallery (Figure 14). This infiltration gallery is located 555 m northeast from the MAR injection well (GPE066) and approximately 1.6 km north of the Waipaoa Augmentation Plant site (Figure 2). The infiltration gallery is used for the Kaiaponi water supply system, which supplies irrigation water to the Kaiaponi farm. The gallery is screened between 2 m and 5 m below the base of the river in the underlying gravels (Golder 2017a).

Kaiaponi Farms can abstract up to 50 L/s and 4,000 m^3/day for irrigation in the summer. The water distribution pipeline is predominantly 150 mm in diameter and can provide a flow rate between 10 L/s and 25 L/s.

Figure 14: Kaiaponi infiltration gallery for Waipaoa River water abstraction (looking eastwards).

3.4 Injection Well Water Supply

Water supply for the injection well is provided via a 150 mm pipe that runs from the infiltration gallery towards the injection well headworks across Bushmere Road (Figure 2) and connects into the Kaiaponi irrigation line as shown in Figure 15. Valves V1, V2 and associated piping connects the injection well to the irrigation supply line and allows the flow to be shut off from continuing to the Kaiaponi farm irrigation system.

The rate of flow (L/s) supplied to the MAR injection well is mainly controlled by the speed of the river infiltration gallery submersible pump (37 kW) which is manually set via the micro drive control. The actual flow supplied to the injection well will therefore reduce as backpressure builds up within the filters that pre-treat the injection well water (Section 3.5). In other words there is currently no direct control of the river infiltration gallery pump speed to meet a set-point flow.

It can be seen from Figure 15 that there are additional piping, valves, flowmeter and a hydro-cyclone which allows the flow off-take to be redirected back into the irrigation line or else discharge. This piping is not part of the water supply to the injection well. However, there is a sampling port (SPI) that is used for collecting water samples down-stream of the hydro-cyclone.

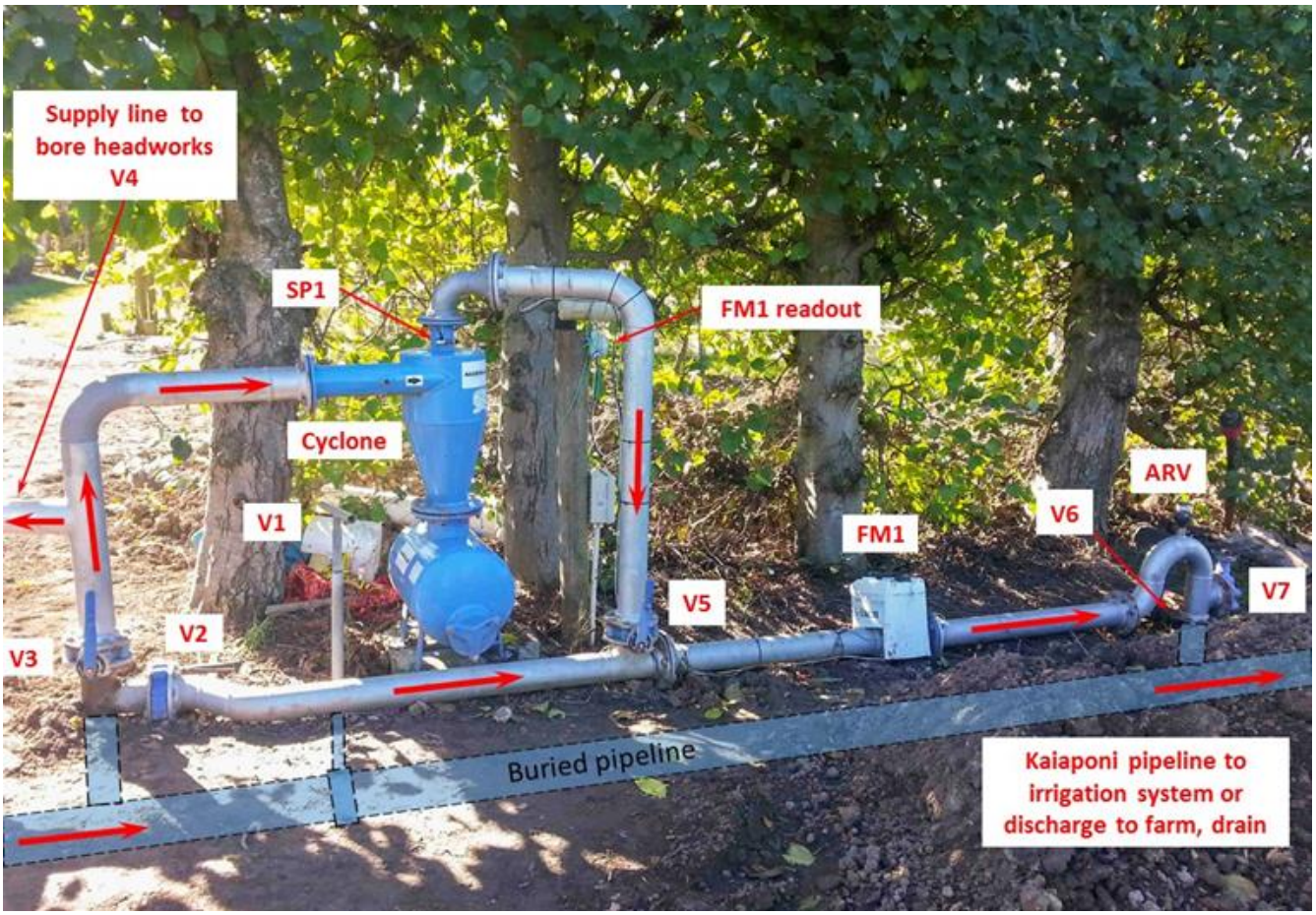

Figure 15: Injection well water supply connection to the Kaiaponi irrigation supply line.

The system that directs flow to the injection well is shown in Figure 16 below. This system includes a 130 micron filter bank system (described in Section 3.5 below), inline pressure gauges, flow meters and pressure tank ahead of the inlet to the injection well (described in Section 3.6). It can be seen from Figure 16 that the piping and valving arrangement allows for flow exiting the filter bank (via Valve V10) to be diverted away from the well and discharged to a farm drain. Furthermore, the backwash flushing flows from the well submersible pump and filter bank during flushing cycles can also be directed to the same drain via valves V11 and V8 respectively.

Figure 16 indicates the location of the chlorination shed, which houses equipment for chlorine dosing of the injection well water supply. It also contains continuous monitoring instruments that receive a pilot flow of sampled water prior to entry to the injection well. This allows for continuous monitoring of injection water properties including, temperature, turbidity and electrical conductivity, pH and free chlorine concentration.

In addition to the above water quality parameters, Figure 16 indicates other key parameters that are monitoring and recorded continuously including water line pressures PG1 and 2) and flows (FM2 and 3). There is also real time monitoring of the water level (distance below ground) within the injection well.

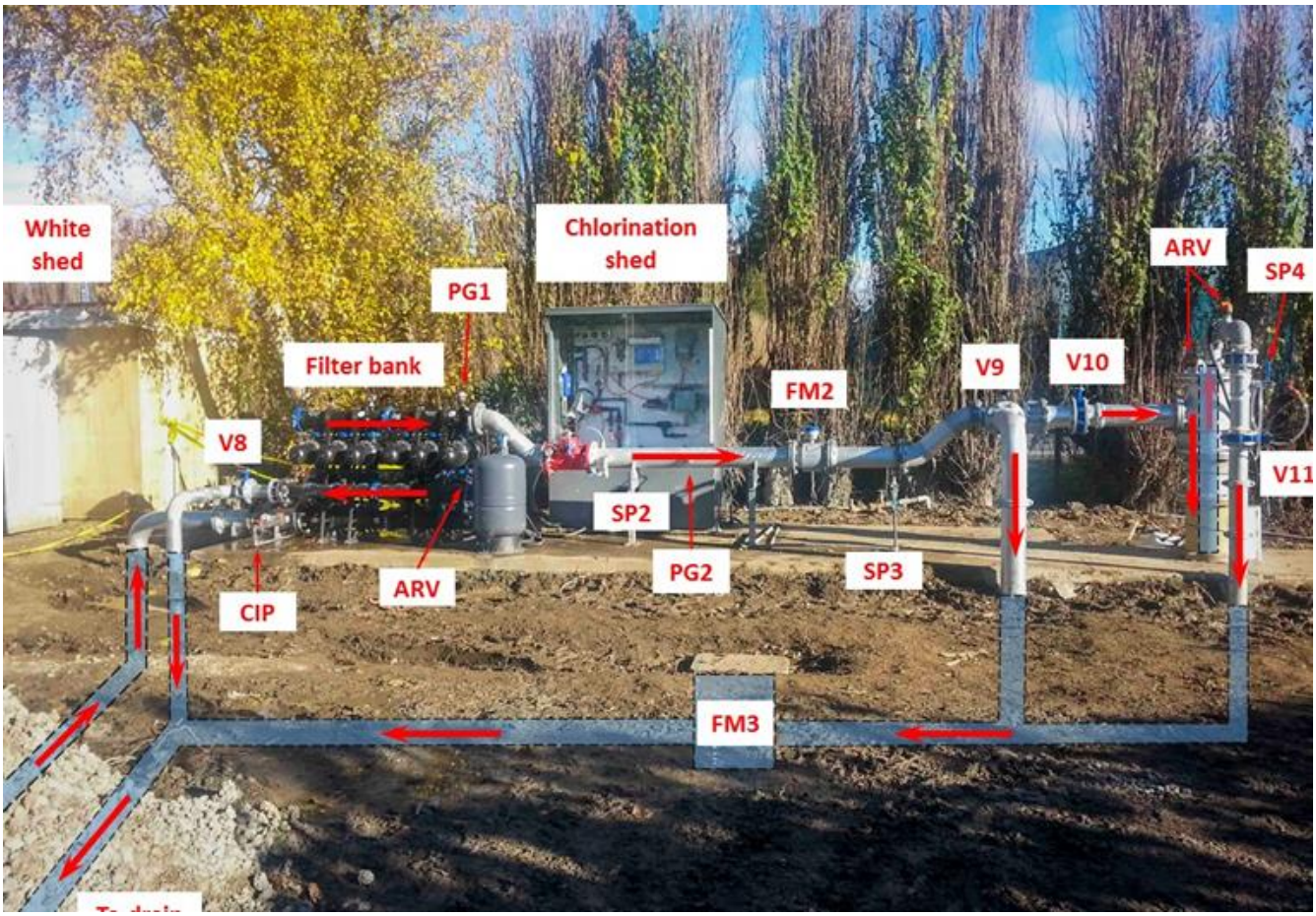

Figure 16: Piping and equipment layout for supply and diversion of flows to the injection well.

3.5 Filtering and Dosing of Injection Water

The rate of physical clogging of injection bore from suspended solids is reduced by action of the design of the infiltration gallery, which is buried approximately 4 metres below the Waipaoa River. Therefore, in-stream water undergoes some filtering as it enters the infiltration gallery that supplies the Kaiaponi farms irrigation system. During high river flows the disturbance of river bed and high in-stream turbidity levels results in higher levels of turbidity and associated suspended solids within in the pumped flow (i.e. 18 to 25 L/s during the irrigation season) from the infiltration gallery (extracted via a Tsurumi submersible pump with a 37 kW motor).

Further removal of suspended solids from water supplied to the MAR injection bore is achieved using the filter bank system (shown in Figure 16). The filter bank is a Alkal Spinklin Disk Filter (Model: 2”-3” Spin KlinTM) that uses 130 micron rated filter discs and can operates up to pressures of 10 Bar.

The pipeline between the filter bank and injection bore has a pressure sustaining valve (SP2), which is used to create further back pressure required for the filter bank to complete black flushing cycles. These clear the filter discs of sediment and enable operation of the system at a lower pressure. Because the micro-drive at the infiltration gallery pump fixes the pump speed, the flow rate decreases as sediment builds up within the filters, and then increases again following back-flush operations.

The potential for clogging of the injection well from the formation of biofilms can also occur given the presence of nutrients and dissolved organic carbon that was measured within the water supplied to the injection well during the 2017 injection trial period. Chlorine dosing of the injection water post the filter bank system was carried for the second phase of the 2017 injection period, but as discussed later in this report, there appear to be no need for chlorine injection to remove any biofilms and this dosing was instead performed to assess effectiveness of reducing E.*coli* counts and also to assess the potential for measurable organo-chlorine compounds (OCs) to be generated within the Makauri Aquifer water. From the perspective of reducing E.*coli* counts there was no clear need for this, secondly there was no measurable detection of OCs at the nearby monitoring well.

3.6 Injection and Monitoring Well Installation

3.6.1 Injection well and pilot monitoring well

Drilling of the pilot monitoring well (GPE065) at Kaiaponi Farm was completed on 31 March 2017. The injection well (GPE066) was completed on 10 May 2017. Development of this well was carried out through a process of pumping and surging on 27 April 2017. Both wells were installed by Honnor Drilling Ltd. Copies of the driller's logs are provided in Appendix D. Relevant technical specifications of the injection well and MAR monitoring well are listed in Table 5. Photos of the well screen, sump and screen leader are shown in Figure 17. The completed injection well (GPE066) and onsite MAR monitoring well (GPE065) are shown in Figure 18.

Table 5: Well structure summary.

Parameter	Monitoring well	Injection well
GDC identification number	GPE065	GPE066
Easting (NZTMX)	2938345	2938328
Northing (NZTMY)	6276377	6276389
Distance from injection well (m)	23	-
Bore depth (m bgl)	92	73.5
Screened interval (m bgl)	69.2 – 72.6 (total length of 3.4 m)	69.5 – 72 (total length 2.5 m)
Casing internal diameter and material	50 mm PVC	300 mm steel with 250 mm PVC liner
Screen internal diameter and material	50 mm PVC	250 mm Stainless Steel
Screen slot size (mm)	1.0	2.5
Height of casing above ground level (m)	0.72	1.3
Static water level depth (m bgl)	8.74	7.45

The lithological sequence encountered during drilling of the injection well and monitoring well was logged by Honnor Drilling (Appendix C). A generalised lithological sequence of the MAR site is listed in Table 6. The lithology of the Poverty Bay flats varies considerably and it is not always possible to identify aquifers. The Makauri Aquifer is generally more distinctive and Golder considers both the MAR injection well (GPE066) and monitoring well (GPE065) are screened in the Makauri Aquifer. The Shallow Fluvial Aquifer was not encountered.

Figure 17: MAR injection well (GPE066) screen shown in left photo; sump and screen leader shown in right photo.

Figure 18: Completed MAR injection well (GPE066), headworks, filter bank and control systems shown in left photo; MAR monitoring well (GPE065) shown in right photo.

Table 6: Lithological sequence of Poverty Bay MAR site (aquifers indicated in yellow; confining layers indicated in grey).

Top of unit (m bgl)	Base of unit (m bgl)	Description	Interpretation
0	1	Topsoil	Aquitard
1	26	Clay	
26	31.2	Gravel	Aquifer (possibly Waipaoa Gravel Aquifer)
31	69	Clay	Aquitard
69	72.6	Gravel	Makauri Aquifer
72.6	84.8	Clay	Aquitard
84.8	91	Gravel	Aquifer (possibly Matokitoki Aquifer)
91	92	Clay	Aquitard

3.6.2 Hydraulic test and well performance programme

Upon completion of the well, several pumping tests and an injection tests were undertaken to assess the hydraulic characteristics of the aquifer. Full details are included in Golder (2017b) and a summary provided below.

Pumping testing

Three different pumping tests have been undertaken to assess well performance and estimate aquifer parameters:

- An air lift test was performed in the monitoring well bore on 30 March 2017 to provide an indication of the aquifer hydraulic characteristics prior to installation of the injection well. Air lifting was undertaken at an average rate of 1.8 L/s for 120 minutes.
- A stepped rate pumping test (i.e., step test) was carried out in the injection well on 4 May 2017 at four flow rates (7 L/s, 10 L/s, 13 L/s and 16 L/s). The release of dissolved gas naturally present in the Makauri Aquifer (predominantly methane) influenced the end of the step test. The gas temporarily blocked the well screen, leading to reduced flow into the well and increased well drawdown.
- A constant rate pumping test was started at 9:30 am on 5 May 2017 and recovery started on 8 May 2017 at 9:30 am. The pumping rate was controlled at 13 L/s to reduce the risk of uncontrolled drawdown in the injection well due to degassing, as occurred in the stepped rate test. Only nearby wells GPE065 (the MAR monitoring well), GPE010 and GPE030 show a clear response, all three less than 500 m from pumped well GPE066.

The results of the pumping testing suggested flow rates for injection of between 10 L/s and 22 L/s are reasonable, in advance of any injection testing. Aquifer parameter estimation is described in detail in Golder (2017b) and summarised in Section 2.4.4 of this report.

Injection testing

Two different injection tests were used to assess the well performance during injection prior to the actual injection trial in the winter of 2017:

- A series of stepped rate injection tests were undertaken between 22 May 2017 and 7 June 2017 at flows of up to 12.9 L/s. Air bubbles in the injection water caused temporary blockage of the well screen at flows above approximately 7.5 L/s, leading to rapid rises in water level within the injection well. This situation

could also be triggered by sudden changes in flows at lower injection rates. This issue was subsequently resolved (Section 4.3.1) and the test completed.

- A constant rate injection test was started on 13 June 2017 with the intention to inject 10,000 m^3 into the Makauri Aquifer. Due to premature triggering of a shut-down relay, the test finished on Monday 19 June at 3:19 am. Only a total of 8,811 m^3 was injected to the Makauri Aquifer during this test.

The results suggested that at the highest flow rate achieved (15.5 L/s) the water level in the injection well would rise to 4.2 m below the top of the well casing at the end of the full trial. In addition the natural rise in the regional groundwater pressure during the winter recharge needs to be anticipated.

3.6.3 Dissolved gas

During the pumping tests a significant volume of gas was released from the discharged water as bubbles within the stilling basin adjacent to the injection well. Based on general knowledge of the aquifer chemistry, it was initially assumed that the primary components of the discharged gas would be methane and carbon dioxide (Section 2.6).

The Health and Safety procedures for this initial test program were modified as soon as the gas discharges from the aquifer water were identified, to manage any risk resulting from methane degassing. Testing of the gas above the basin and in the mouth of the discharge pipe did not identify a critical lack of oxygen (Golder 2017b).

3.7 Injection Trial Monitoring Programme

3.7.1 Monitoring objectives

The purpose of the injection trial monitoring programme is to collect data and information required to assess effects on groundwater levels, flows and water quality. This is used to identify possible short-term and long-term adverse effects of the MAR injection trial and to support decisions for current and future trial management and operation. It also helps to address community concerns.

Table 7 provides an overview of all groundwater level, flow and water quality monitoring that was undertaken prior to, during and after the injection trial in 2017. Further details of the monitoring is included in the sections below.

3.7.2 Groundwater levels, temperature and injection flow monitoring

The intended effect of the MAR project is to stabilise the summer groundwater level decline by raising groundwater levels in the winter season. Monitoring groundwater level response to injection flows provides information on the effectiveness of the project and can also be used to better understand the aquifer's hydraulic characteristics.

Groundwater levels have been recorded for decades in several wells in the Poverty Bay MAR monitoring area including GPD115, GPF074, GPD147, GPD116 and GPJ040. Groundwater level recording commenced in 2015 in the remaining sites listed in Table 7, except for the MAR injection well (GPE066) and monitoring well (GPE065) which were completed in May and March 2017 respectively. Prior to, during and after the injection trial, monthly groundwater levels were recorded in 17 wells in the area surrounding the MAR site, of which 13 are believed to be screened in the Makauri Aquifer and the remaining in either overlying or underlying aquifers.

Automatic water level loggers, which also record temperature, are installed in the MAR injection wells and the four nearest Makauri Aquifer wells (Table 7) and record every 15 minutes. A flow meter in the injection well headworks records injection flows every 15 minutes. The automatic data recordings from the MAR injection well (GPE066) and monitoring well (GPE065) are sent to a remote server via telemetry and displayed on the Scottech Envirodata website.

Table 7: MAR injection trial aquifer monitoring programme 2017.

Monitoring site (distance from injection well)	NZTMX	NZTMY	Depth (m)	Water level monitoring[1)]	Water quality monitoring - type and frequency[3)]	Water quality monitoring - period
Maukauri Aquifer						
GPE066 (injection well)[2)]	2028438	5714964	72.0	Manual: fortnightly Automatic: every 15 min	Full suite weekly / bimonthly / monthly	8 May - 6 Oct
GPE065 (21 m)[2)]	2028454	5714952	72.6	Manual: fortnightly Automatic: every 15 min	Full suite weekly / bimonthly / monthly	30 Mar - 6 Oct
GPE010 (190 m)	2028282	5714854	73.8	Manual: fortnightly Automatic: every 15 min	Full suite weekly / bimonthly / monthly	24 Mar - 6 Oct
GPE030 (364 m)	2028501	5715323	68.0	Manual: fortnightly Automatic: every 15 min	Full suite bimonthly / monthly	8 Sep - 6 Oct
GPF159 (864 m)	2029259	5715232	83.0	Manual: fortnightly	Full suite bimonthly / monthly	4 May - 25 Sep
GPF105 (1205 m)	2029570	5714552	71.0	Manual: fortnightly Automatic: every 15 min	None	-
GPF162 (1245 m)	-	-	-	None	Full suite bimonthly / monthly	5 May - 25 Sep
GPD096 (1422 m)	2029123	5713718	81.4	Manual: fortnightly	None	-
GPD115 (1576 m)	2028056	5713435	75.1	Manual: fortnightly	Full suite bimonthly / monthly	24 Mar - 25 Sep
GPF074 (1630 m)	2029571	5716137	79.2	Manual: fortnightly	None	-
GPD147 (2099 m)	2029020	5712947	114.0	Manual: fortnightly	Full suite bimonthly / monthly	24 Mar - 25 Sep
GPD116 (2225 m)	2029842	5713237	76.2	Manual: fortnightly	Full suite bimonthly / monthly	24 Mar - 4 Aug
GPJ040 (2745 m)	2027527	5712374	80.0	Manual: fortnightly	None	-
Overlying or underlying aquifers						
GPE021 (304 m)	2028190	5714787	7.6	Manual: fortnightly	None	-
GPE034 (746 m)	2028832	5714331	70.0	Manual: fortnightly	None	-
GPD153 (1256 m)	2028532	5713712	0.0	Manual: fortnightly	None	-
GPE012 (1025 m)	2028585	5712805	60.9	Manual: fortnightly	One off for full suite	24 Mar
GPF111 (1631 m)	2029565	5716143	79.2	Manual: fortnightly	None	-
Whiteshed Bore	2028432	5714955	18.0	None	One off for major cat&an and E.*coli*	24 Mar
Waipaoa River						
MAR Headworks outlet	2028438	5714964	-	-	Full suite bimonthly / monthly	16 Jun - 12 Sep

Note:

1) Water level monitoring started in March 2017 and is ongoing. Automatic water level loggers started in April 2017.

2) Water level, injection flows, conductivity, pH, chlorine, temperature, turbidity and battery voltage are recorded every 15 minutes and displayed on the Scottech Envirodata website.

3) Full suite of parameters includes major cations and anions, E.*coli* and chlorination by-products testing. Bimonthly sampling and testing occurred prior to injection and monthly during and after injection.

3.7.3 Groundwater quality monitoring

The injection water is sourced from the Waipaoa River and has a significantly different composition to the Makauri Aquifer groundwater (Section 2.6). The most notable difference is that the river water is oxic and Makauri Aquifer water is anoxic. Furthermore, the overall mineral content of the river water is less than that of the Makauri Aquifer groundwater. Groundwater quality sampling and laboratory testing was undertaken to collect information on possible chemical and biological reactions that can affect the groundwater quality (refer to Section 2.6 and Section 4.5 for further details).

Water quality samples were tested for the major cations and anions (Ca, Mg, K, Na, Cl, SO_4, alkalinity and TDS), nutrients (NOx, NH_4, TP and DRP), dissolved metal fractions (Fe, Mn and As), organic matter content (TOC) and fine particle content (TSS and turbidity). Field testing of pH, dissolved oxygen and conductivity was also undertaken at the same time samples were taken. A full suite of testing as indicated in Table 7 also includes testing for pathogens (E.*coli*) and disinfection by-products (DPBs, see Section 3.7.4). Water quality sampling and testing was undertaken monthly between March and June 2017. During and after the injection trial the sampling and testing was undertaken fortnightly for most monitoring wells and this will continue until December 2017. Water quality sampling and testing was done weekly during the trial in wells GPE066 (injection well), GPE065 and GPE010.

Automatic conductivity, turbidity and chlorine recorders are installed in the MAR injection well (GPE066) and record a measurement every 15 minutes. This information is send to the remote server and presented on the Scottech Envirodata website.

The analysis of the initial injection trial, which lasted for two weeks in June 2017, suggested that the injection water plume would migrate about 420 m into the aquifer (Golder 2017b) and therefore not reach most of the monitoring wells. Although most of the monitoring wells may not receive the injection water in 2017 and no response is anticipated, there are several benefits from monitoring water quality in the wider area:

- If injection water break-through does occur, this can be identified and followed by the on-going monitoring programme
- Changes in groundwater flow caused by the injection trial could cause different water to pass through existing wells and changes in water quality may be recorded, even if the injection water does not reach a particular well.
- Provide assurance to the community and GDC that the MAR injection test is undertaken in a controlled manner. Water quality test results can be used to confirm whether possible issues with abstraction infrastructure for irrigation are caused by the MAR injection trial.

3.7.4 Testing for disinfection by-products

Chlorination of injection water was applied in late-August through to mid-September 2017 to test pathogen removal effectiveness (Section 3.5). A side-effect of chlorination is the formation of disinfection by-products (DBPs) and these have been tested in samples taken from several wells during and after the injection trial (Table 7).

Halogenated DBPs, which include trihalomethanes (THM), halogenated acetic acids (HAA) and halogenated acetonitriles (HAN), are formed from the reaction of disinfectants, such as chlorine, with DBP precursors. Natural organic matter serves as the organic DBP precursor, while bromide can serve as an inorganic precursor (WHO 2000). In addition to the oxidant used, DBP formation is influenced by source water and groundwater quality (e.g., TOC, ammoniacal nitrogen, bromide, alkalinity, pH and temperature), treatment factors such as disinfectant dose and the contact time in the aquifer. The mechanisms involved in the formation of DBP, which are varied and complex, are described in detail in a report by the WHO (2000).

3.8 Injection Water Quality

A total of seven injection water quality samples (i.e. Waipaoa River water) were collected from the MAR Headworks outlet between June and September 2017 during the MAR trial. The Waipaoa River water quality, as described in Section 2.6.4, was consistent with previous characterization results and descriptions of treated Waipaoa River water from the Waipaoa Augmentation Plant (Golder 2015) and a previous assessment of Waipaoa River water quality at Kaiaponi farm (Golder 2016).

4.0 INJECTION TRIAL RESULTS

4.1 Introduction

This section includes a description of the injection trial in the 2017 winter season and includes the analysis and interpretation of the results. The information and conclusions presented in this section form the basis of the recommendations for the future continuation of the MAR injection scheme as described in Section 6.0.

4.2 Injection Trial Programme

4.2.1 Initial injection trial – June 2017

Following completion of the MAR injection well (GPE066), monitoring well (GPE065), headworks and filtering system, an initial constant injection test was undertaken for 7 days between 13 June 2017 at 08:45 am and 19 June 2017 at 3:15 pm. A volume of 8,811 m^3 was injected at an average rate of 14 L/s. Further details and an analysis of the results of this initial injection test are included in Golder (2017b). The initial injection test and reporting were used to fulfil resource consent condition 38 listed in Section 1.4.

4.2.2 Main injection trial – July to September 2017

After a cessation of injection for one month, the injection was restarted on 20 July 2017 at 9:15 am. Injection temporarily ceased a day later at 3:00 pm, but recommenced on 24 July 2017 at 8:45 am, this time to continue until cessation of the injection trial on 13 September 2017 at 11:00 am. Further details of the main injection trial are listed in Table 8.

Table 8: Poverty Bay MAR 2017 main injection trial details.

Item	Value
Trial period	20 July 2017 at 9:15 am to 13 September 2017 at 11:00 am
Total injection time (days)	52
Total volume injected (m^3)	64,018
Average injection rate (L/s)	14
Maximum injection rate (L/s)	19

The total amount of Waipaoa River water injected during the first injection trial and the main injection trial was 73,180 m^3.

Chlorination of the injection water started on 28 August 2017 and continued intermittently until the end of the injection trial on 13 September 2017. Injection water chlorine levels appear to have reached 0.5 mg/L, as recorded by the telemetered automatic chlorine logger.

4.3 Operation and Maintenance

4.3.1 Injection gas clogging

Air bubbles in the injection water (i.e., Waipaoa River water) caused temporary blockage of the well screen at flows above approximately 7.5 L/s during the initial injection trial. This lead to rapid rises in water level within the injection well. The issue has been resolved through:

- Modifying the inflow system at the well head through installation of a drop tube with a constriction at the terminal end. Instability due to air entrapment was not subsequently observed during the injection test.

- Procedures for manually operating the butterfly valves in the Kaiaponi water line off-take and the headworks have been developed to minimise the risk of abrupt changes in flow rates to the injection well. These procedures have been incorporated in the Management Plan (Golder 2017a).

4.3.2 Filter bank and injection well backwashing

The Waipaoa River carries significant loads of fine sediments which could potentially clog the abstraction and injection infrastructure. Although the river water first passes through the river bed before entering the infiltration gallery, high fine sediment loads were pulled into the infiltration gallery and subsequently transported to the MAR site, where most of it was removed by the filter bank.

During the injection trial the pressure in the filter bank and the injection well water levels were continuously monitored as a rise in pressure or water level could indicate clogging.

To keep abreast of clogging issues, a pre-emptive backwashing programme was initiated with filters automatically backwashing every 12 hours or whenever there would be a pressure differential across the filters of 10 m H_2O (i.e., 1 Bar). No pressure differential triggered backwash occurred during the 2017 trial. Injection well backwashing was undertaken manually usually on Mondays and Fridays each week (12 times in total during the main injection trial between 28 July and 11 September 2017). Backwash water was by-passed (i.e., did not enter the injection well) and discharged in an internal drain on the Kaiaponi farm. A total of 10,854 m^3 was by-passed.

4.3.3 Clogging Issues

Golder evaluated the potential for chemical, biological, and physical well clogging to occur during injection or storage through a range of processes described in Golder (2015). While mitigation measures included in the design of the injection well headworks may be used to reduce biological and physical clogging (e.g., the filter system described in Section 3.5 may prevent fine suspended sediments being injected into the aquifer and chlorine addition to injection water may prevent biological activity), chemical clogging due to iron oxide precipitation was regarded as the most likely form of clogging that could occur during the initial stages of the trial injection program, but would be less likely to affect injection operations for a larger trial or operational MAR injection scheme due to the higher flow rate of injection water and the increased distance between the well screen and the native groundwater.

Iron oxide minerals have the potential to precipitate during geochemical interactions between the oxygenated injection water and the reduced and anoxic groundwater, particularly at the outer extent of the injected water bubble where mixing with groundwater occurs. The mass of iron oxide minerals that could precipitate in the aquifer were assessed by geochemical models, which found that the mixture of injection water and groundwater is most sensitive to the concentration of iron in the receiving groundwater and the relative amounts of groundwater and injection water present at any one location.

Monitoring groundwater for low-level chemical clogging is difficult as it relies on detecting iron oxide precipitation products in groundwater at GPE065 (MAR monitoring well), or other wells further away from the MAR injection site. No such precipitate products were observed during the MAR injection trial, nor was a substantial increase in turbidity detected at GPE065. Extensive chemical clogging, to the extent that it modifies aquifer properties and reduces injection flow rates, was also not observed.

It is important to note that the metal oxide mineral precipitation reactions described here as a possible cause of chemical clogging would rely on the timeframe that oxic (i.e. oxidized) conditions are maintained in groundwater, during which competing reactions other than Fe(II) oxidation drive the consumption of oxygen. In an oxidized state, metal oxide minerals such as ferrihydrite would precipitate and also remove arsenic from the groundwater through surface sorption and incorporation. However, if the conditions in the aquifer gradually return to a chemically reducing state in which dissolved oxygen is consumed, and other species including metal oxide minerals are reduced, these minerals would dissolve and release the metals and any adsorbed species back

into the groundwater. These redox changes would be more likely to be observed at a MAR injection well or the adjacent monitoring wells for a MAR program that is only operated seasonally. The groundwater at those monitoring sites would then fluctuate between an oxic (during injection) and anoxic (post-injection; when the anoxic native aquifer water passes the monitoring wells) state.

4.4 Effects on Groundwater Levels

The timing of the 2017 MAR injection trial coincided with the Makauri Aquifer recharge that occurs every year in the winter period. Annual rainfall in 2017 year was above average (Section 2.2.2) and groundwater levels responded by a sharper rise than in previous years (Section 2.5.2). The recorded rise in Makauri Aquifer water levels was approximately 0.011 to 0.018 m per day during the main injection trial period (Appendix B). This rising background trend can obscure the groundwater level response of the MAR injection trial.

The groundwater level response to the MAR injection trial is clearly visible in Makauri Aquifer monitoring wells GPE065 (the MAR monitoring well), GPE010 and GPE030 as shown in Figure 19. Groundwater levels rise by approximately 1.3 m in GPE065 (at 21 m distance), by 1.2 m in GPE010 (at 190 m distance) and by 0.9 m in GPE030 (at 364 m distance). In the injection well (GPE066) the groundwater level rises approximately 3 m after 1 day of injection. It should be noted that well losses contribute to the rise in GPE066 well water levels. This rise is not representative of the rise in aquifer water level.

At greater distance from the injection well, there appears to be a groundwater level rise response of less than 0.2 m in GPF105 and GPE096 (Figure 19 and Figure 20). However, the ongoing background trend associated with the winter recharge obscures the response to the injection trial. None of the monitoring wells beyond some 1,500 m distance from the MAR injection well (GPE066) appear to show a response (Figure 20).

There does not appear to be any response in nearby monitoring wells screened in the Shallow Fluvial Aquifer (Figure 21).

The recorded groundwater level responses have been used to estimate aquifer parameters, including transmissivity, leakage and storativity. The results are summarized in Section 2.4.4. Further details are included in Appendix B. In general, aquifer parameter values are in line with previously reported values. Of particular note is that leakage is small and the lower end of the range of vertical conductivities derived in previous studies (Golder 2014b) appear to be more representative of conditions in the general area surrounding the MAR site.

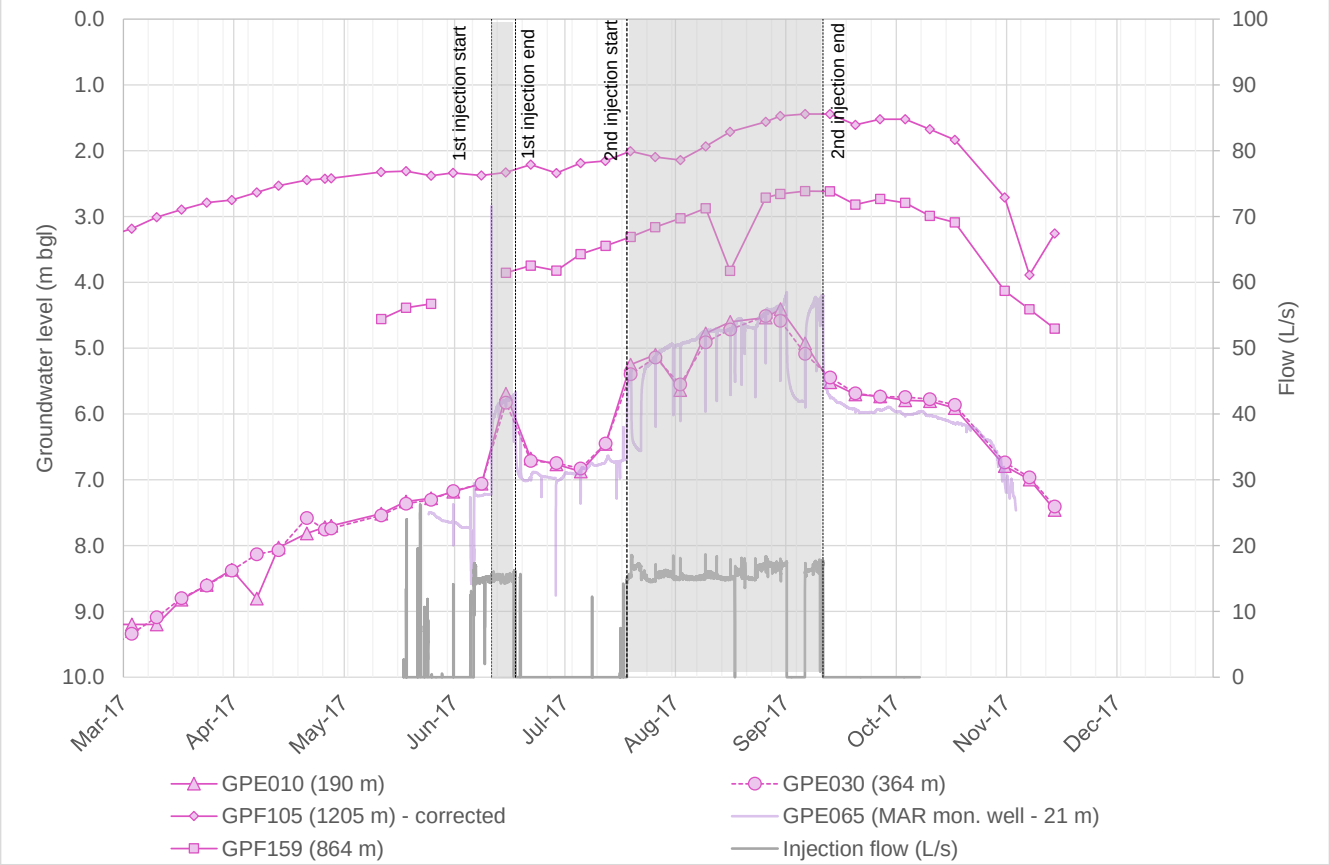

Figure 19: Groundwater level fluctuations in Makauri (injection) aquifer in 2017 injection trial period near injection well.

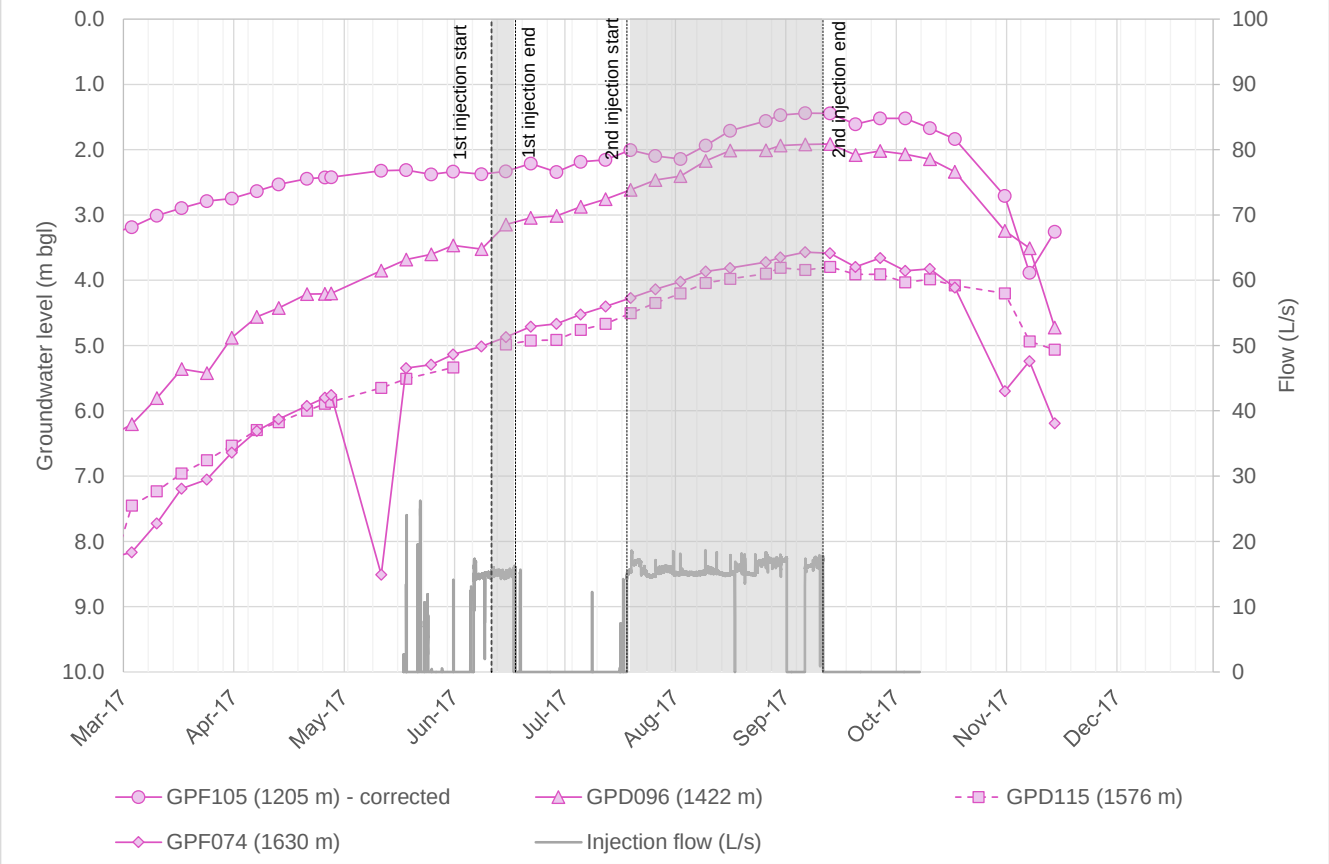

Figure 20: Groundwater level fluctuations in Makauri (injection) aquifer in 2017 trial at 1200 - 1600 m distance from injection well.

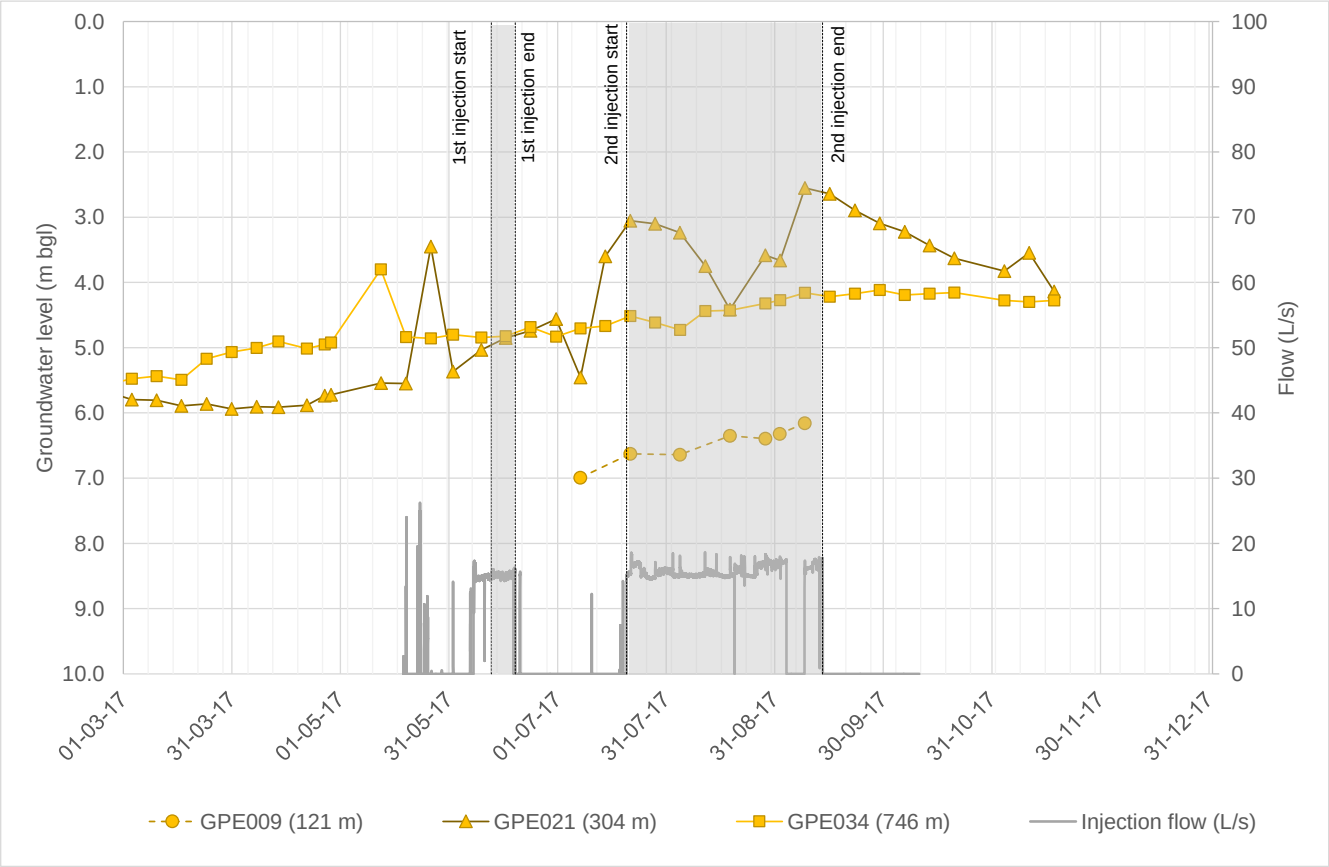

Figure 21: Groundwater level fluctuations in Shallow Fluvial Aquifer in 2017 injection trial period.

4.5 Effects on Groundwater Quality

4.5.1 Groundwater monitoring

This section presents the groundwater quality monitoring data that were collected at a series of 11 groundwater monitoring wells during the MAR trial (Table 7), nine in the Makauri Aquifer and 2 in overlying and underlying aquifers. The water quality data are presented in time series plots and a piper diagram to illustrate how the injection water affected the Makauri Aquifer immediately around the injection well, and determine whether the chemical and physical changes in the Makauri Aquifer may have implications for long-term groundwater quality.

Field water quality parameters and water quality samples were collected monthly and analysed for a suite of total and dissolved constituents, as described in Section 3.7. These groundwater monitoring data are described in this section with respect to the changes that occurred during the first and second injection periods, and the period immediately after the second injection. Groundwater quality is compared to the injection water quality (i.e., Waipaoa River water, Section 2.6.4), which was characterized during the trial with samples collected monthly from the MAR Headworks outlet.

Water quality data for selected parameters are shown in time-series graphs in Appendix C. Complete laboratory analytical reports for the samples analysed during the MAR trial are included in Appendix D.

4.5.2 Groundwater quality during injection trial

Water types and mixing

A comparison of the major cations and anions distribution in water samples from the MAR injection well (GPE066) immediately prior to (8th May, 2017) and during the MAR trials (6th June through 8th September 2017) and the injection water from the Waipaoa River water is presented as a Piper diagram in Figure 22. The major cation and anion distributions in groundwater samples from the MAR injection well shows that after first sample, which shows the undisturbed pre-injection groundwater, all subsequent samples plot together with the injection water from the Waipaoa River, indicating that groundwater at the injection well was rapidly diluted by, and then replaced by, the injected water.

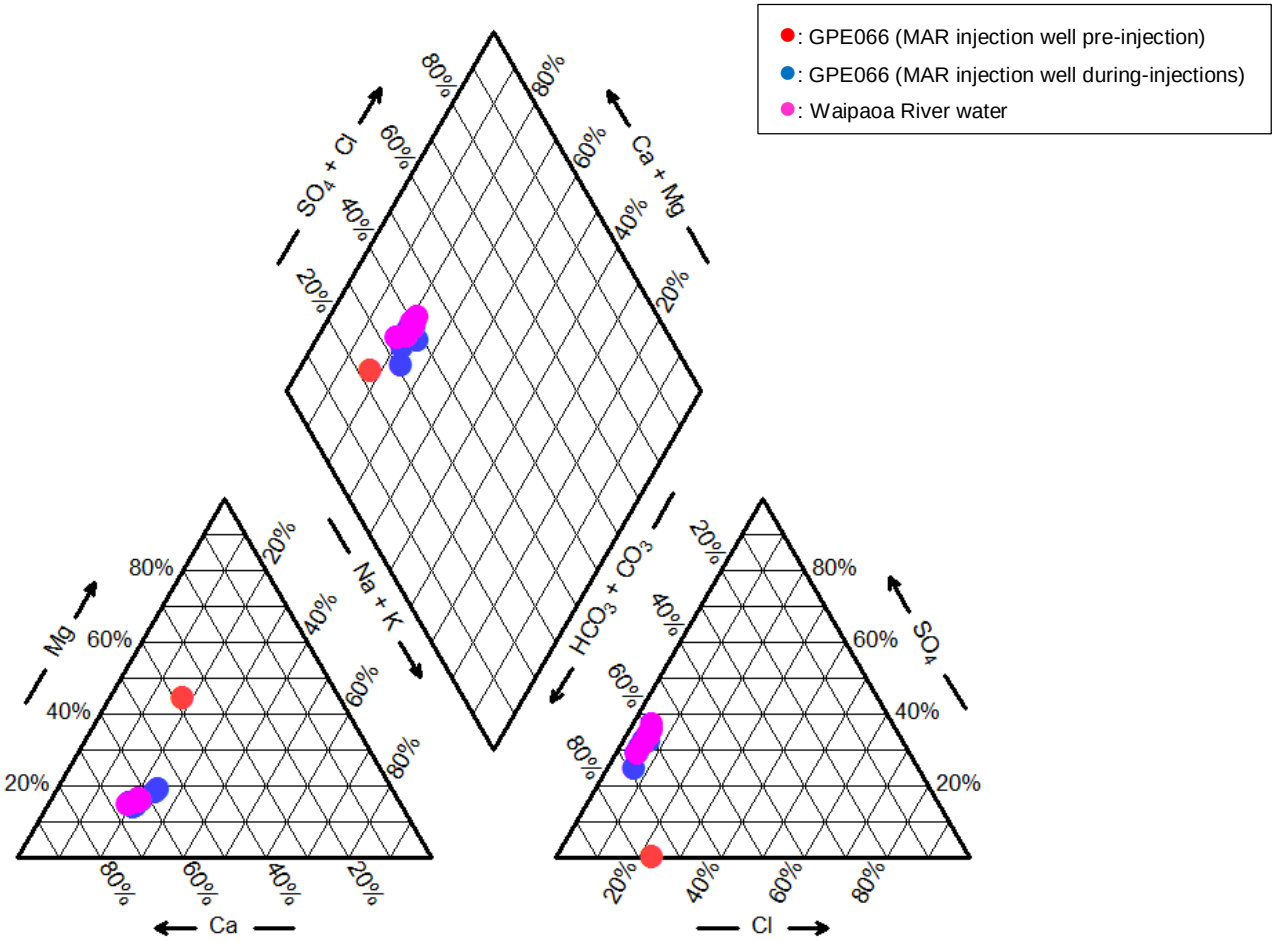

Figure 22: Piper diagram of Waipaoa River water and injection well groundwater during MAR trial.

As described in this section, the presence of the MAR injection water was only detected with confidence at the MAR injection well (GPE066) and the MAR monitoring well (GPE065) and therefore only GPE066 is shown for comparison on this Piper diagram.

Trends during injection in pH, alkalinity and major anions and cations

The alkaline Makauri Aquifer groundwater showed a sustained increase in pH at GPE066 (MAR injection well) during the trial period (Figure 23) and reached a maximum of pH 8.35, as expected for water in equilibrium with carbon dioxide at atmospheric pressure, before stabilizing close to pH 7.80 during the second injection period, which was significantly higher than the range of the adjacent monitoring wells (pH 7.0 to 7.5), but similar to the pH of the injection water.

The effects of the injection water diluting and/or displacing the groundwater was observed at GPE066 (MAR injection well) and GPE065 (MAR monitoring well) with declines in conductivity, turbidity, and temperature. The river water was colder, less turbid, and had a lower conductivity than the native groundwater.

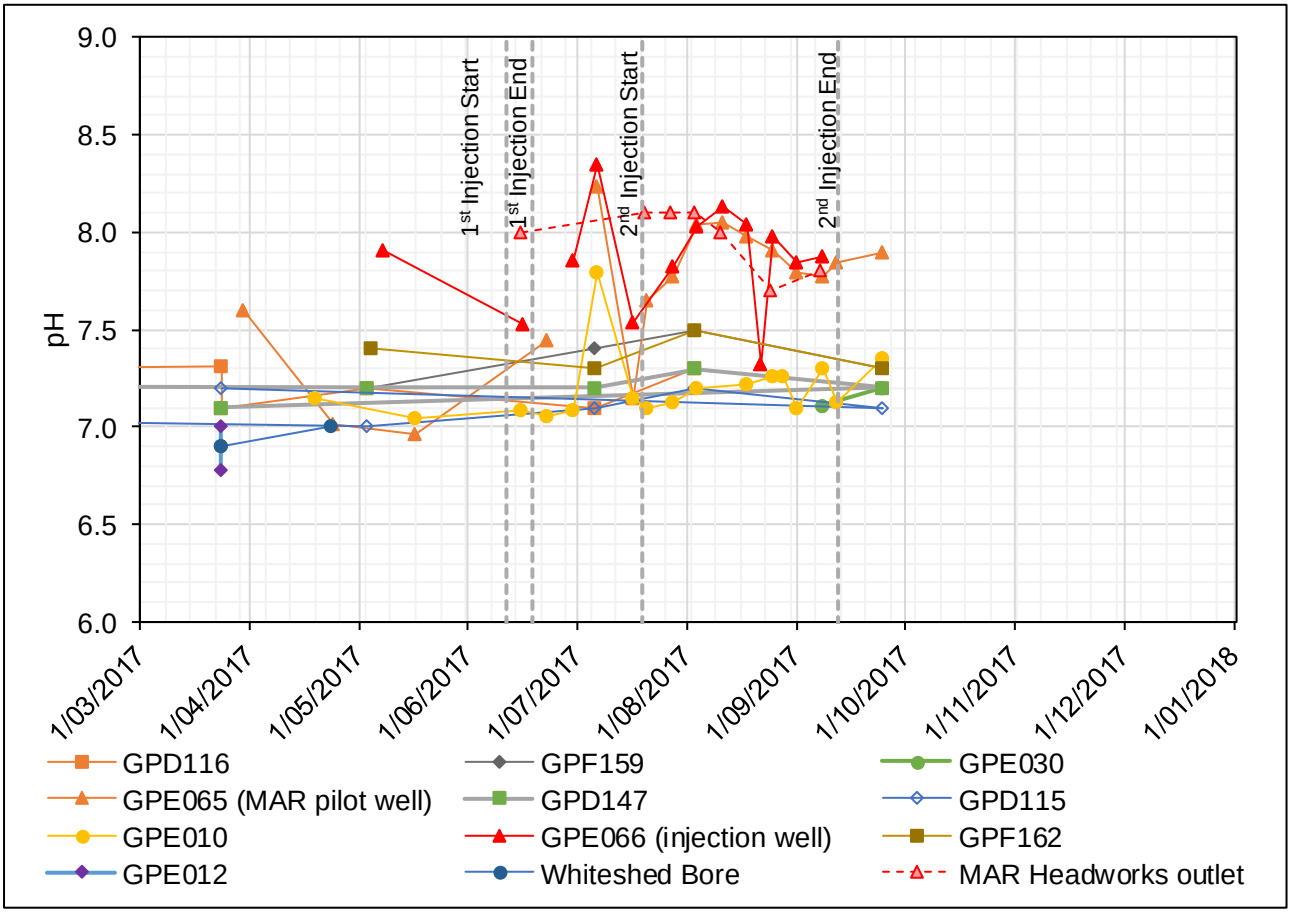

Figure 23: pH levels in groundwater during injection trial.

Groundwater at GPE066 (MAR injection well) and GPE065 (MAR monitoring well) showed relatively rapid and significant decreases in bicarbonate alkalinity (700 g/m^3 to 160 g/m^3), calcium (180 g/m^3 to 62 g/m^3), chloride (120 g/m^3 to 8.1 g/m^3), magnesium (19 g/m^3 to 7.4 g/m^3), potassium (12 g/m^3 to 2.3 g/m^3), and sodium (90 g/m^3 to 21 g/m^3) concentrations during the injection trial. The groundwater at the MAR injection and MAR monitoring well also showed rapid and significant increases in sulphate concentrations, rising from a pre-injection minimum of <0.04 g/m^3 to a post-injection maximum of 95 g/m^3 at the MAR injection well. The concentrations of these major ions at the two wells during the MAR trial were in close agreement with the concentrations in the source

water at the MAR Headworks outlet. Chloride and sulphate trends during the injection trial are shown in Figure 24 and Figure 26, respectively.

These changes to anion and cation concentrations in groundwater occurred as water at the injection well screen, and within at least a 20 m radius around the injection well, was replaced by injection water that contained substantially lower concentrations of these anions and cations (or higher in the case of sulphate). The majority of the changes in concentration occurred relatively quickly at the start of the trial, after which the concentrations appeared to stabilize for the duration of the second injection period. The more stable concentrations most likely represented an increase in the relative amount of injection water near the wells and replacement and dilution of any remaining native groundwater to the point that its influence was diminished.

As demonstrated in Figure 24 with chloride, there were no changes observed in groundwater at the next closest monitoring well GPE010, located 190 m away from the MAR injection well, or any of the other monitoring wells located further away from the MAR injection well. Chloride is an appropriate element for this comparison because it occurs at a much higher concentration in the groundwater than the injection water and due to its conservative nature (i.e. it is unreactive), the introduction of a small amount of injection water would cause dilution of the concentration in groundwater.

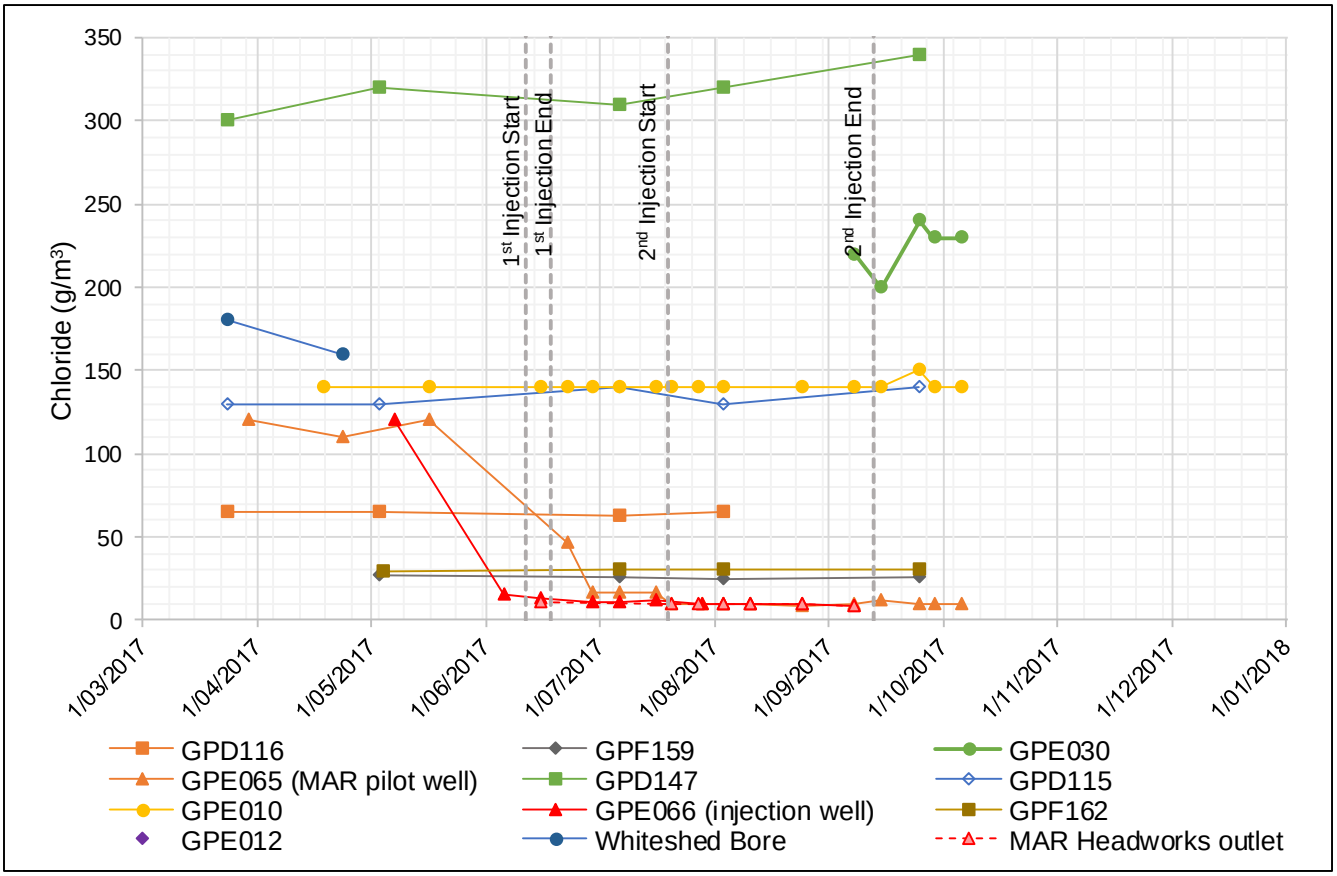

Figure 24: Chloride concentrations in groundwater during injection trial.

Redox conditions during MAR trial

Redox conditions in the Makauri aquifer changed very rapidly during the MAR trial as the oxygenated surface water initially mixed with, and then displaced, the previously anoxic groundwater from around the MAR injection well screen (GPE066) and further out at the MAR monitoring well (GPE065). Redox indicator parameters discussed in Section 2.6.3 to describe the Makauri Aquifer, such as dissolved oxygen, sulphate, nitrate, and the metals iron, manganese, and arsenic all exhibited substantial changes in concentration during the MAR trial in wells GPE065 and GPE066.

Dissolved oxygen, which normally occurs at a negligible concentration in Makauri Aquifer groundwater, showed a significant increase in groundwater at wells GPE066 (MAR injection well), GPE065 (MAR monitoring well) and GPE010 (located 190 m from the injection well) during the trial. As shown in Figure 25, dissolved oxygen concentrations at all three wells increased temporarily during the first injection before declining to low levels in July 2017. Dissolved oxygen concentrations increased again during the second injection to remain at relatively stable levels of approximately 4 g/m^3 at GPE065 and GPE010 and 6 to 8 g/m^3 at GPE066 through the month of August 2017.

The increase in dissolved oxygen concentrations at GPE010 during the injection trial was unexpected since a corresponding change in the other indicator parameters (e.g., chloride or sulphate) was not identified at this well. Further testing would be required to determine if dissolved oxygen introduced with the injection water migrated to this well, or if an alternate explanation, such as oxygen introduced during sampling, would explain these results. The water quality test results from GPE010 should be treated as suspect until more monitoring data are available from a subsequent injection trial.

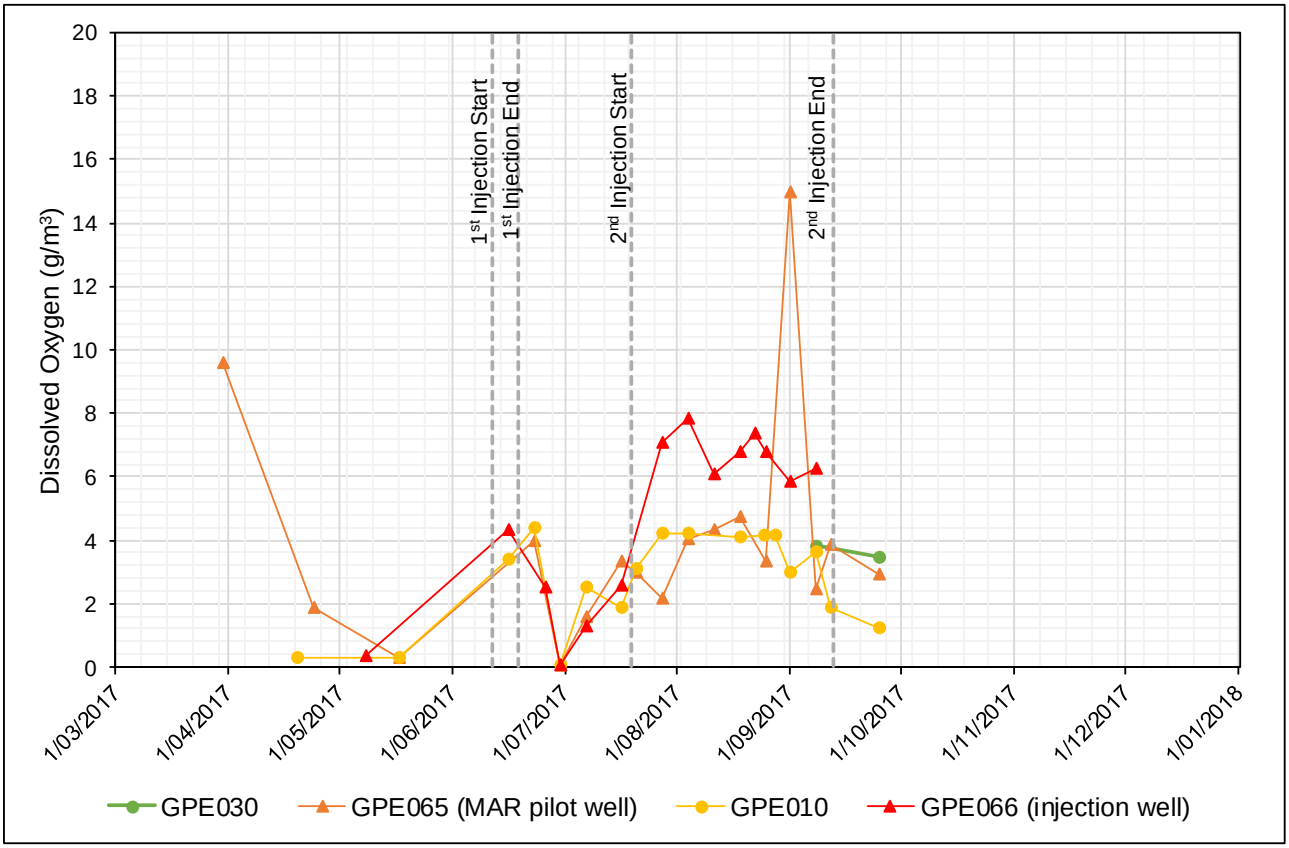

Figure 25: Dissolved oxygen concentrations in groundwater during injection trial.

A rapid and significant increase in sulphate concentrations was observed in groundwater at both the MAR injection and MAR monitoring wells immediately following the first injection (Figure 26). Sulphate concentrations increased from a pre-injection minimum of <0.04 g/m^3, a level that suggested all sulphur was present in reduced forms in the anoxic aquifer, to a post-injection maximum of 95 g/m^3 at the MAR injection well (range 60 to 95 g/m^3) and MAR monitoring well (56 to 86 g/m^3). As shown in Figure 26, the increase in sulphate concentrations at the MAR monitoring well (GPE065) occurred over about a month, with samples collected on 17 May 2017, 23 June 2017, and 30 June 2017 increasing from 0.11 to 55 to 86 g/m^3, which was similar to the concentration in the injection water at this time (92 g/m^3 at MAR headworks on 16 June 2017). No rise in sulphate concentrations was observed in any of the other monitoring wells.

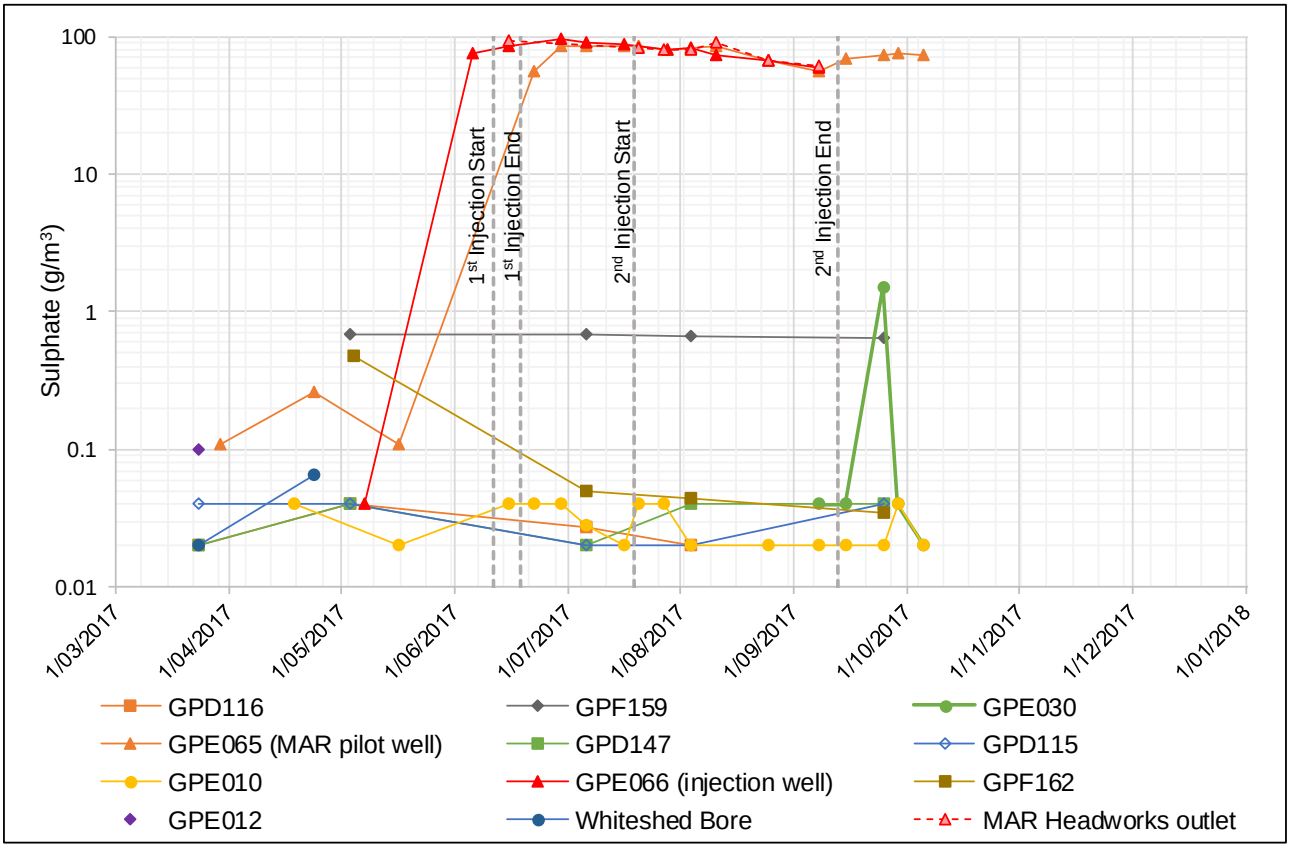

Figure 26: Sulphate concentrations in groundwater during injection trial.

Water quality samples collected during the injection trials were analysed for arsenic, iron, and manganese, which as described in Section 2.6.3, are metals that occur at detectable concentrations in the Makauri Aquifer groundwater, but would be sensitive to changes in redox conditions caused by the injection of the oxic Waipaoa River surface water into the anoxic groundwater. Dissolved iron and manganese, which typically occur in the low parts per million range in the reduced Makauri Aquifer groundwater declined to very low concentrations at GPE066 prior to the first injection (iron: from 5.1 to 0.06 g/m^3) as the pumping tests introduced oxygen to the groundwater immediately around the well screen. Time series plots of iron and manganese concentrations are shown in Figure 27 and Figure 28. During the injection trials, both dissolved and total iron and manganese concentrations declined to very low levels (less than 0.05 g/m^3 and 0.1 g/m^3 respectively), which suggests that injection water may have physically displaced the groundwater in the area around the MAR injection well, rather than caused redox changes that precipitated iron and manganese into a fine colloidal form. If iron and

manganese did precipitate, it would have occurred further away from the MAR injection well than the MAR monitoring well (21 meters), where dissolved iron concentrations declined from 5.5 to 0.0024 g/m^3.

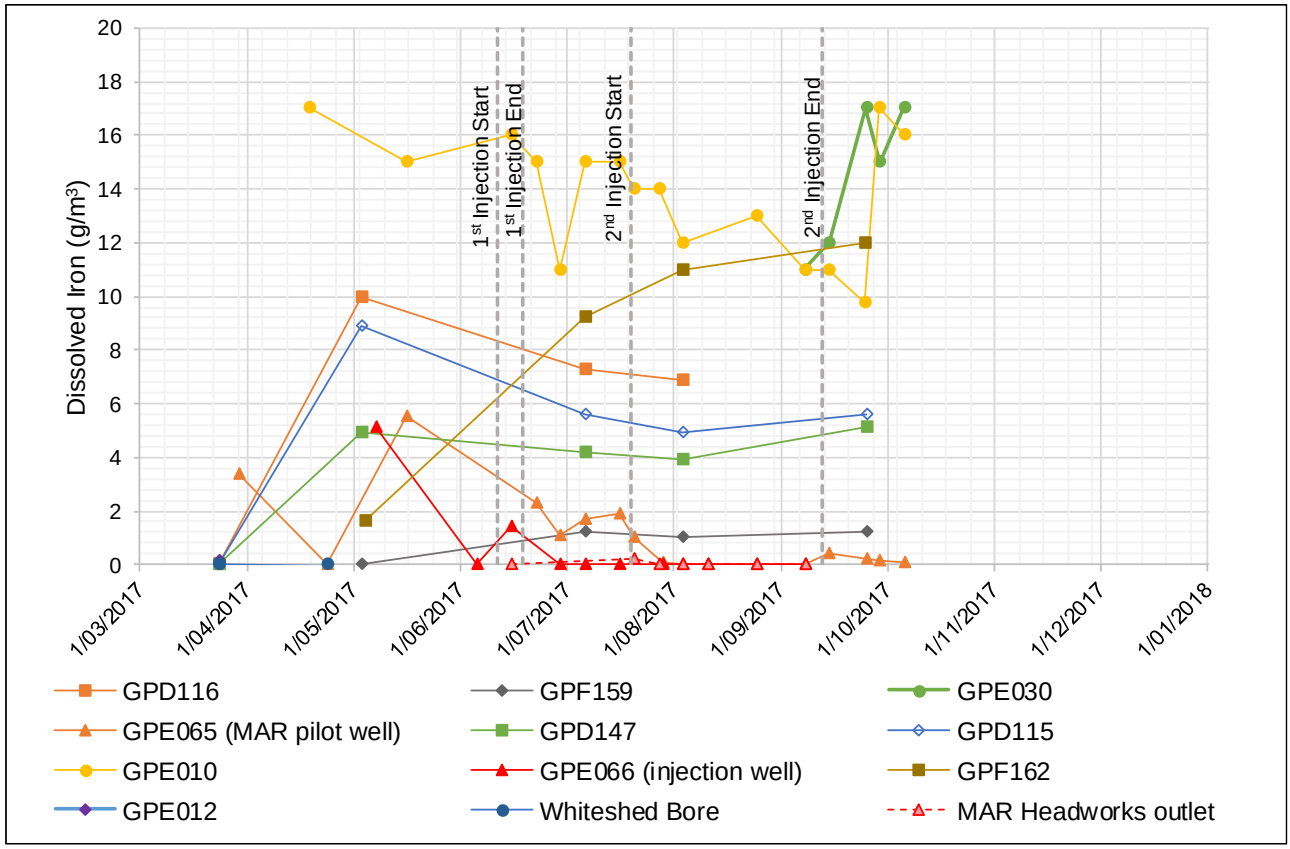

Figure 27: Dissolved iron concentrations in groundwater during injection trial.

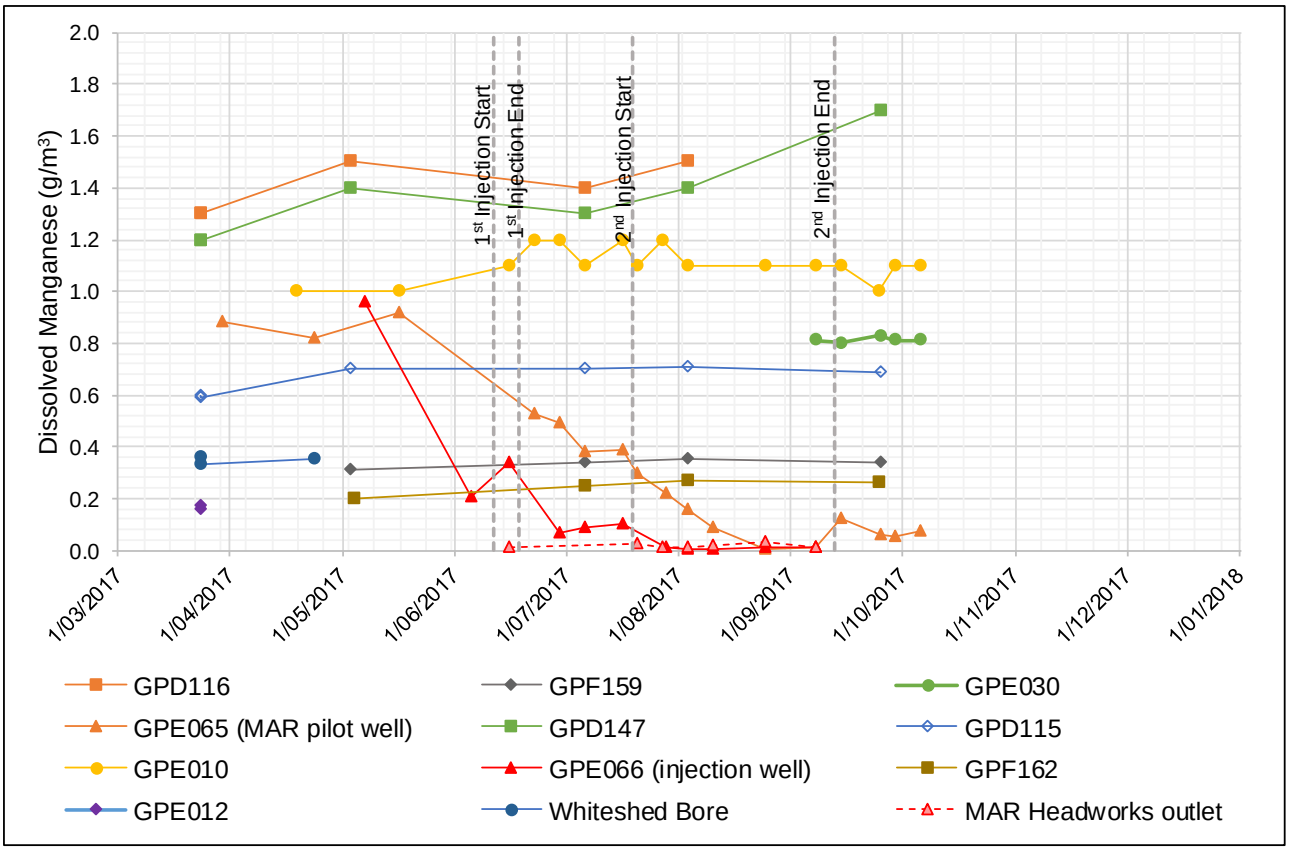

Figure 28: Dissolved manganese concentrations in groundwater during injection trial.

As shown in Figure 29, dissolved arsenic concentrations declined from 0.011 to 0.00066 g/m^3 in groundwater at GPE066, which was similar to the change in the total arsenic concentration (decline from 0.011 to 0.00067 g/m^3). This similarity between dissolved and total concentrations suggests that the arsenic present in the aquifer did not just change phase and precipitate when contacted by the MAR injection water, but that the groundwater was displaced from around both the MAR injection and MAR monitoring wells with low-arsenic injection water, which is consistent with the water quality results for conservative elements such as chloride.

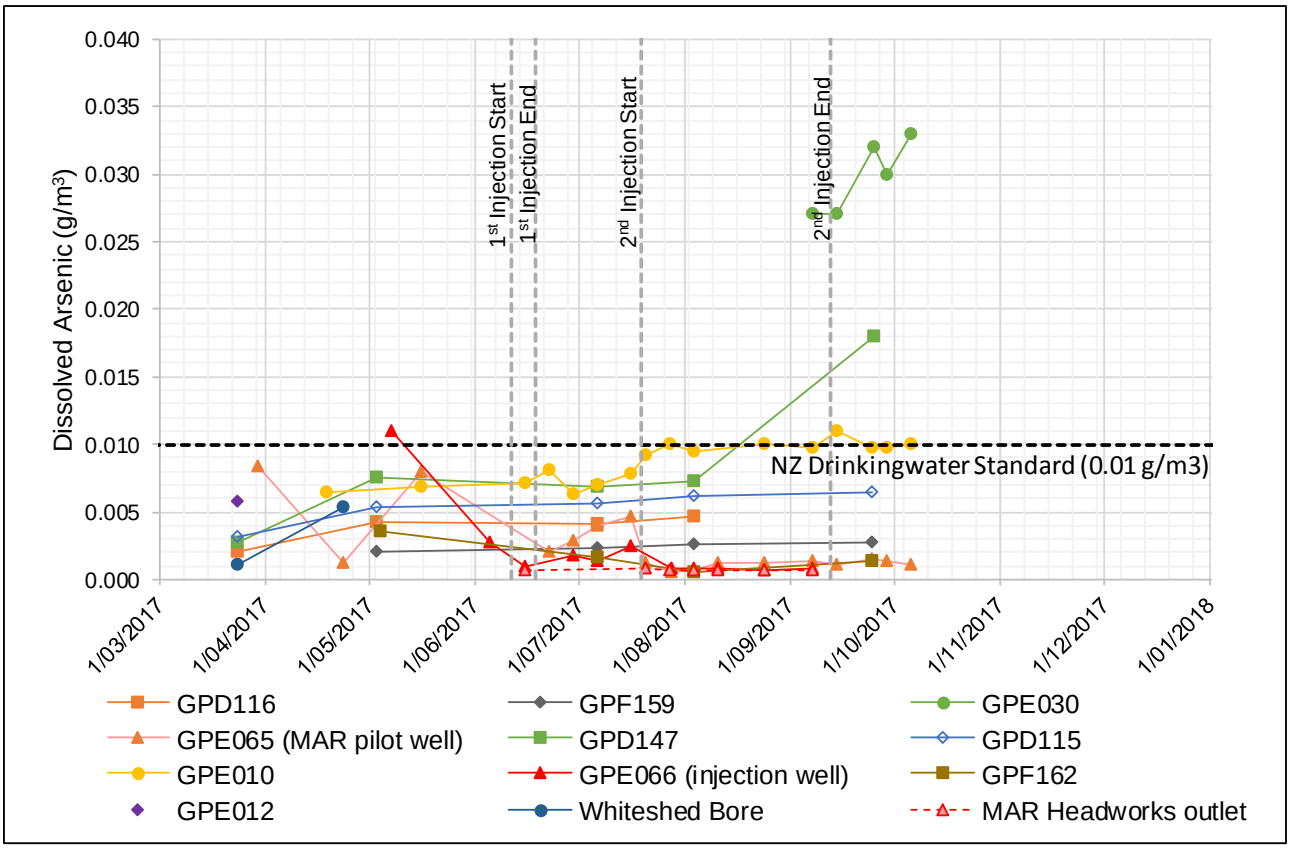

Figure 29: Dissolved arsenic concentrations in groundwater during injection trial.

Nitrate concentrations in the Waipaoa River are notably higher than naturally present in the anoxic Makauri Aquifer. As with sulphate, a rapid increase in nitrate concentrations was observed in groundwater at both the MAR injection and MAR monitoring wells immediately following the first injection (Figure 30). Nitrate concentrations increased from a pre-injection minimum of <0.002 g/m^3 (i.e., below detection limit), a level that suggested all nitrate was present in reduced forms in the anoxic aquifer, to a post-injection maximum of 0.54 g/m^3 at the MAR injection well and 0.5 g/m^3 at the MAR monitoring well.

Ammoniacal nitrogen concentrations decreased in the MAR injection well from 2.0 g/m^3 before injection commenced to 0.01 g/m^3 after injection. The MAR monitoring well gradually followed this trend and concentrations decreased from 2.1 g/m^3 pre-injection to 0.11 g/m^3 post-injection (Figure 31).

No significant change in the nitrate-nitrogen or ammoniacal-nitrogen concentrations was observed in any other well during the MAR trial.

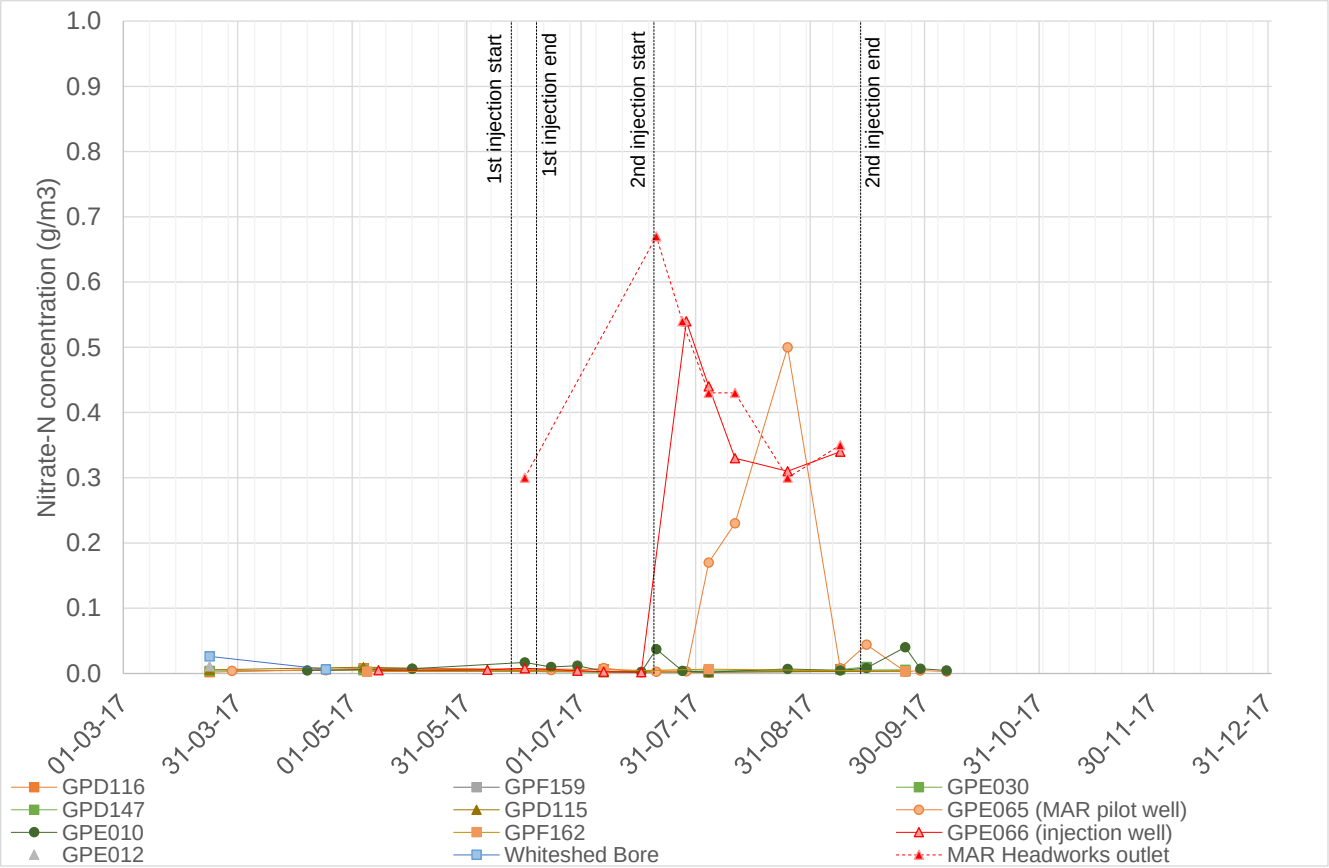

Figure 30: Nitrate-nitrogen concentrations in groundwater during injection trial.

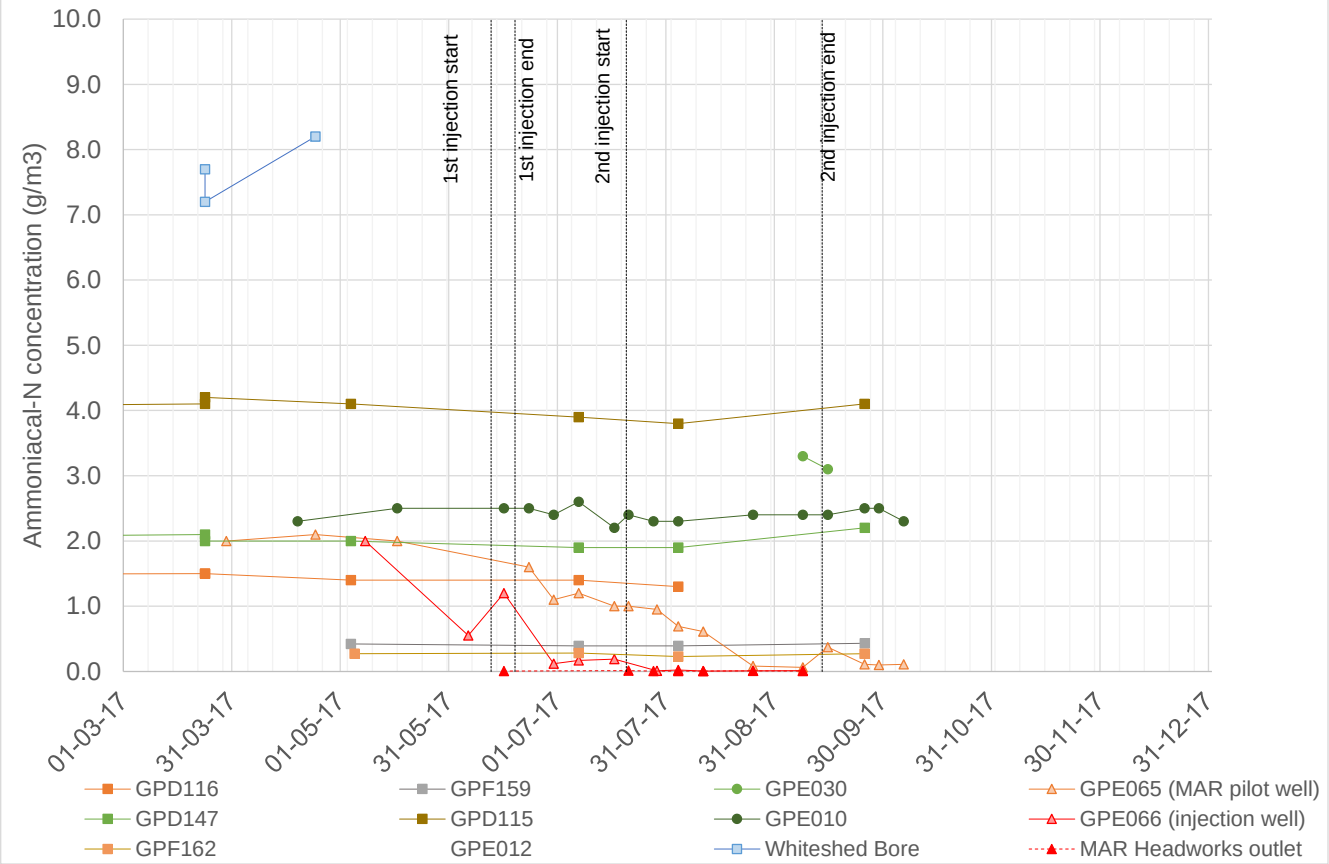

Figure 31: Ammoniacal-nitrogen concentrations in groundwater during injection trial.

Pathogens, chlorine, and disinfection by-products

E.*coli* was detected in groundwater at the MAR injection well (GPE066) during the MAR trial at concentrations ranging from the detection limit (i.e. <1.6 cfu/100 mL) up to a maximum of 160 cfu/100 mL (Figure 32).

One groundwater sample collected from the MAR monitoring well (GPE065) during the first injection trial contained 6.6 cfu/100 mL of E.*coli* and three samples collected from well GPE010 contained between 3.3 and 18 cfu/100mL E.*coli*. Given that there was no E.*coli* detected at the MAR injection well during the first injection trial, and no injection water was detected at GPE010, these results are considered suspect and contamination during or after sampling may have occurred.

As described in Section 4.2, chlorination of the injection water was started on 28 August 2017 to control the E.*coli* detected at the MAR injection well and continued intermittently until the end of the injection trial on 13 September 2017. Injection of chlorine and natural attenuation in the aquifer, appear to have controlled the proliferation of E.*coli* as concentrations stabilized and then declined, returning to the detection limit after the second injection trial on 6 October 2017.

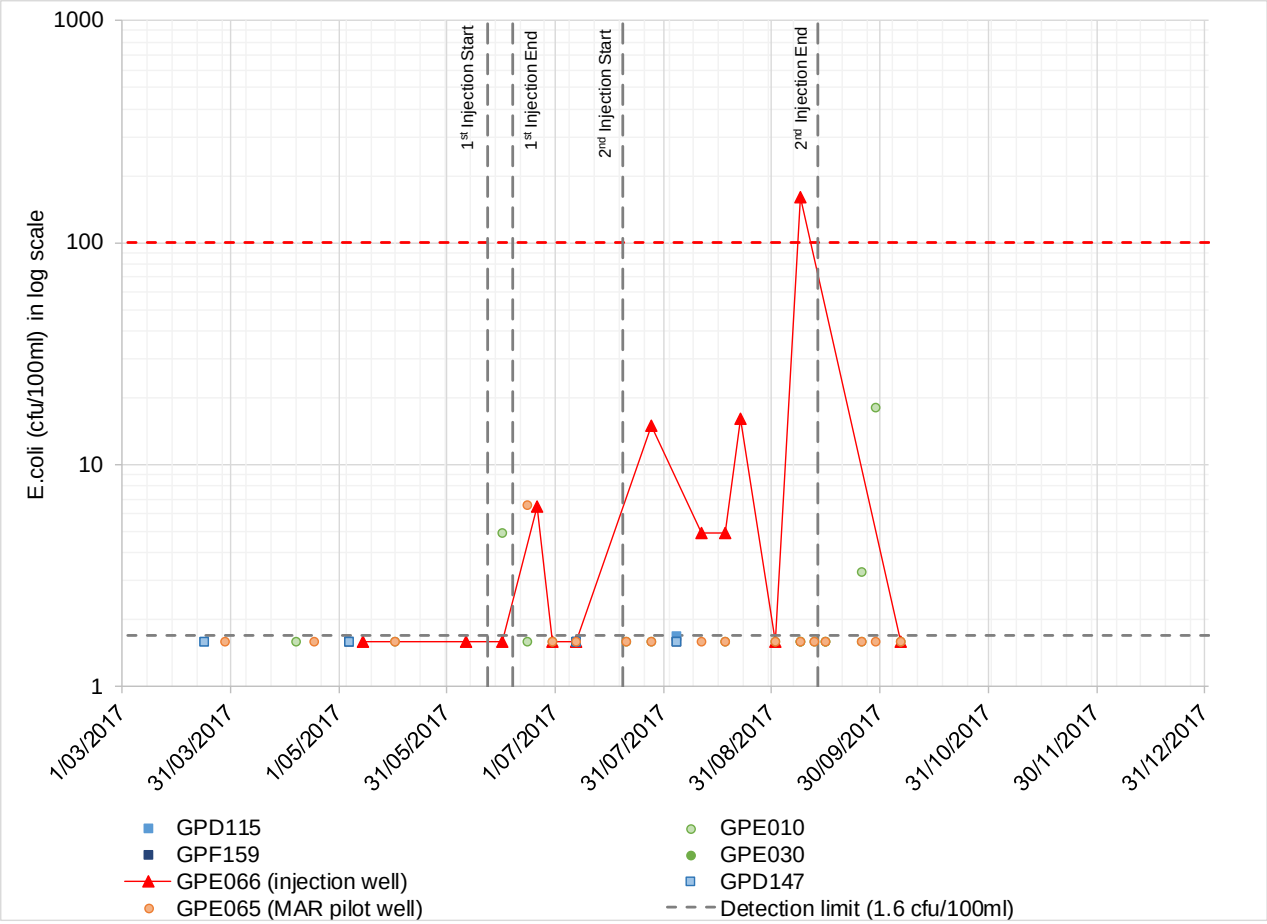

Figure 32: E.coli concentrations in groundwater during injection trial.

Chlorine concentrations in groundwater samples submitted for laboratory analysis ranged from 0.04 to 0.14 g/m^3 at the MAR injection well (GPE066; 11 samples) and from 0.03 to 0.1 gm/^{3} at the MAR monitoring well (GPE065; 13 samples) between April and September 2017. These concentrations are consistent with the results presented in Section 4.2, which showed that chlorine did not exceed 0.5 g/m^3 in the MAR injection well, as measured by the Scottech Envirodata automated logger.

Total organic carbon concentrations were similar in the injection water (2.1 to 3.6 g/m^3) to the groundwater at the MAR injection well and therefore the effects of the injection were minor, and only caused a slight dilution in TOC concentrations around the MAR injection well (decline from 5.2 to 2.3 g/m^3) during the monitoring period.

Groundwater samples collected from GPE065 (MAR monitoring well) on 25 September 2017, and GPE010 (1 and 25 September 2017) were analysed for residual chlorine and disinfection DBPs during the MAR trial. The results are presented in Appendix D and show:

- None of the three samples contained any dihaloacetonitriles, or haloacetic acids at detectable concentrations
- 1-2-4-trimethylbenzene was detected in groundwater at GPE065 (0.0017 g/m^3 on 29 September 2017).

- Toluene was detected in groundwater at GPE010 and was measured at a concentration of 0.00081 g/m^3 on 1 September 2017 and again at a concentration of 0.0022 g/m^3 on 29 September 2017. The presence of toluene at this low concentration was unrelated to the MAR trial since the injection water did not reach this well.

4.5.3 Water quality summary

The results of the groundwater quality monitoring undertaken during the MAR trial are summarized as follows:

- The Waipaoa River injection water and Makauri Aquifer groundwater originate from the same source and both have a circum-neutral to alkaline pH and the same calcium – bicarbonate water type. However, the groundwater contains much higher concentrations of most major ions compared to the river water, particularly chloride, so dilution of most major cations and anions occurs during injection. Furthermore, Makauri Aquifer groundwater is anoxic and Waipaoa River water is aerobic.
- Changes in groundwater quality at the MAR injection well (GPE066) and MAR monitoring well (GPE065) during the MAR trial showed dilution and replacement of groundwater by the injection water (e.g., chloride concentrations declined substantially as the injection water replaced the groundwater)
- The observed changes in water quality during the MAR trial were limited to the MAR injection well (GPE066) and MAR monitoring well (GPE065). Although some individual constituents changed in concentration at GPE010 and other wells, they were unique and did not confirm the presence of injection water had reached those locations by October 2017.
- E.*coli* was introduced to groundwater during the MAR trial and controlled by dosing chlorine to the MAR injection well. Concentrations of E.*coli* in groundwater at the MAR injection well returned to a non-detectable level at the end of the trial.
- Limited formation of DBPs occurred in the Makauri Aquifer during the MAR trial. Only one VOC (1-2-4-trimethylbenzene) was detected at a very low concentration.

4.6 Groundwater Flow and Injection Water Break-through

When water is injected into the Makauri Aquifer, the injection water plume will initially fan out in all directions, but is expected to quickly follow the dominant groundwater gradient. The influence of the water injection process is clearly visible in the pattern of Makauri Aquifer groundwater contours during injection shown in Figure 33 Initial estimations provided in Golder (2017b) suggest that the injection water plume could travel approximately 420 m during the full trial period at an injection rate of 15 L/s during 77 days. With more detailed information available after completion of the 2017 trial, a better estimation of travelled pathway and distance can be made, although this is still indicative.

Assuming isotropic conditions for the aquifer, groundwater flows perpendicular to the groundwater contours and the injection water may have initially predominantly flowed in southeastern direction away from the injection well (Figure 33). After injection ceased mid-September 2017, the groundwater contours restore to a pattern typical for a winter situation (Figure 34). The groundwater may have once again flowed in southwestern direction near the injection well. When the irrigation season starts, the Makauri groundwater abstraction causes the groundwater gradient to change and groundwater flows in eastern direction similar to the January 2009 situation as shown in Figure 10.

The changes in groundwater flow direction will cause the injection water plume to be drawn in different directions and the total travelled distance can be derived with indicative Darcy flow calculations.

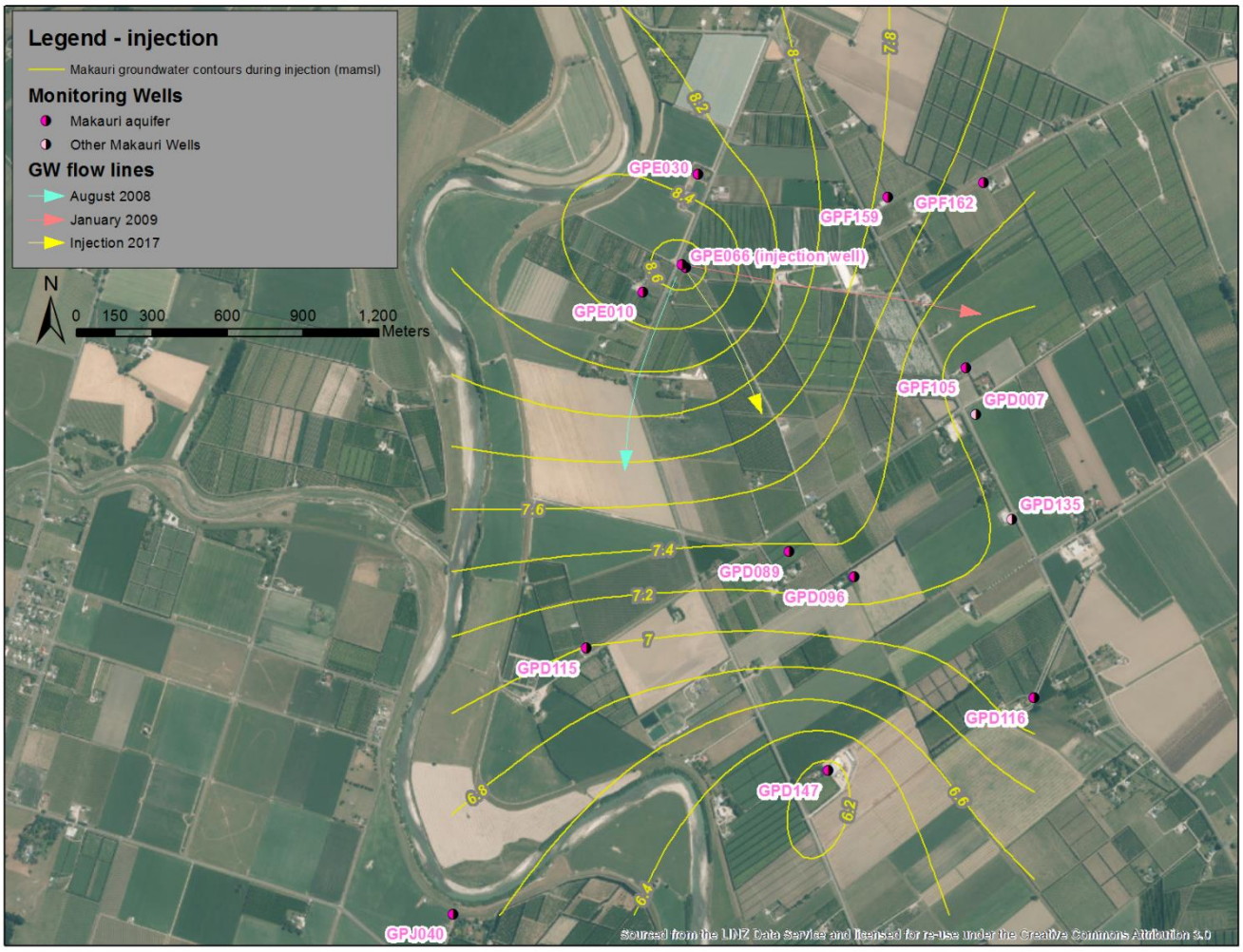

Figure 33: Groundwater contours and flow near injection site during injection trial (August 2017).

Figure 34: Groundwater contours and flow near injection site after injection trial (October 2017).

Analysis of the full trial monitoring data set suggest the injection water plume will have travelled some 226 m by the end of 2017 (i.e., some 208 days after injection commenced). Input parameter values and results are listed in Table 9.

Table 9: Indicative injection water migration calculations.

	Injection	***Post-injection***	***Irrigation Season***	***Total***
Gradient*	0.00167	0.00042	0.00105	-
Hydraulic conductivity (m/day)	220	220	220	-
Assumed effective porosity (-)	0.25	0.25	0.25	-
Effective velocity (m/day)	1.47	0.37	0.93	-
Start	6/06/2017	13/09/2017	20/10/2017	-
End	13/09/2017	20/10/2017	31/12/2017	-
Time (days)	100	36	72	208
Distance travelled (m)	146	13	67	226

* Based on groundwater contours during injection

The only monitoring well in which the injection water plume movement through the aquifer could be observed clearly was the MAR monitoring well GPE065. The sulphate concentration showed a distinct response ambient Makauri water sulphate concentrations are less then1 mg/L, while injection water is up to 90 mg/L. The injection water plume, and thus the sulphate concentration, will be subject to dispersive mixing in the Makauri Aquifer, causing lower concentrations to break through. The break-through can be simulated with the analytical formula from Domenico (1987) and results are shown in Figure 35. The Domenico (1987) solution and input parameter values are further described in Appendix E.

Break-through would have also been expected in September 2017 at 190 m from the injection well. Monitoring well GPE010 is located at this distance, but not clearly downgradient from it. Water quality monitoring does not show a break-through of sulphate in GPE010 to date, nor has this occurred in GPE030 which is located at 364 m distance from the well. This would confirm the injection water plume travels predominantly in south-eastern direction away from the injection well, as suggested by the flow analysis described above.

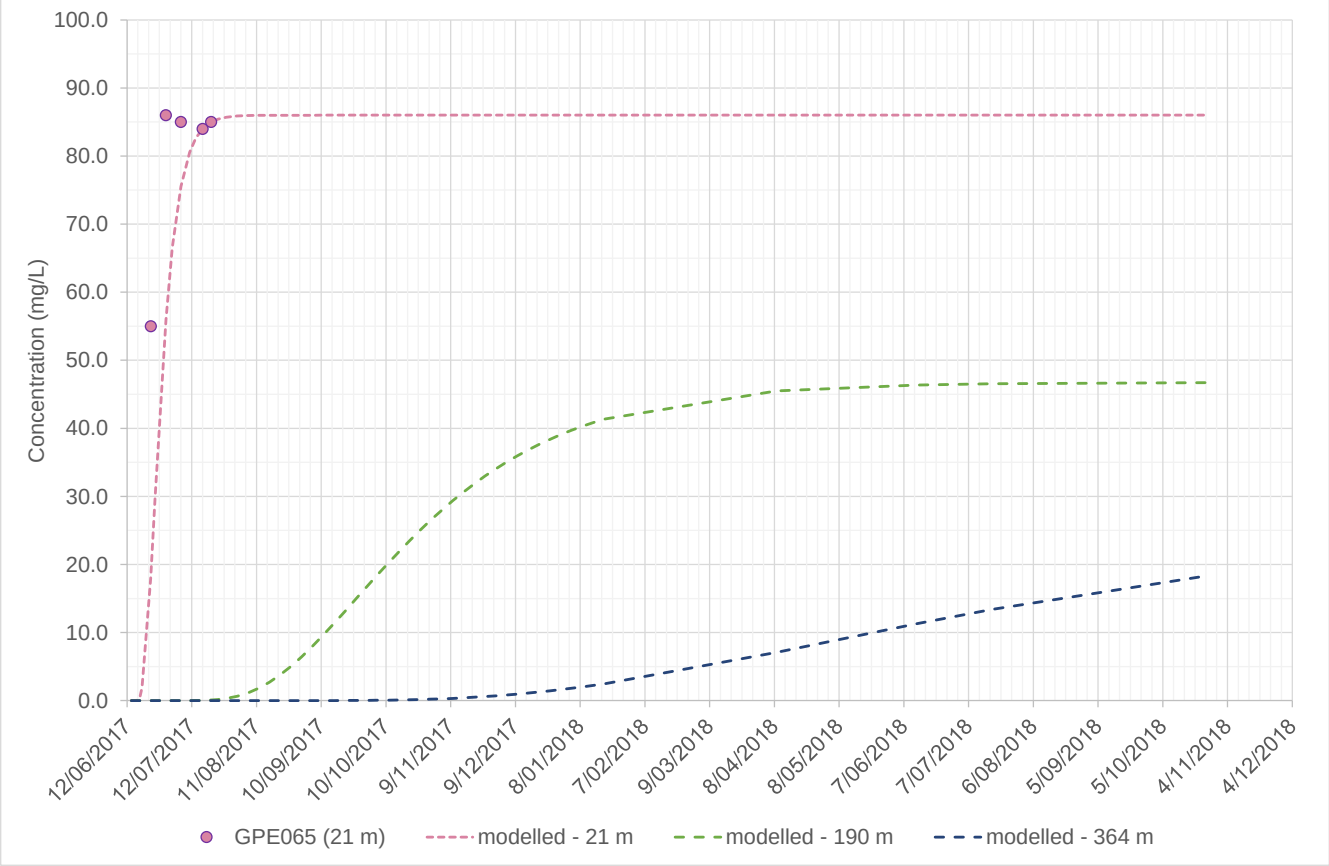

Figure 35: Modelled and recorded break-through of sulphate at several distances from the MAR injection well (GPE066).

4.7 Resource Consent Compliance

An overview of compliance with Poverty Bay MAR pilot project resource consent (DW-2016-107113-00) is provided below. Compliance with conditions in relation to the main injection trial have been addressed and include the following matters:

- Surface water take and use
- Water use monitoring
- Discharge of water to Makauri Aquifer

The conditions in relation to drilling works (conditions 1 to 15) have been addressed in the initial injection trial report (Golder 2017b) and in Section 3.6. The conditions in relation to the pilot trial monitoring and reporting (conditions 35 to 38 and 41) have been addressed in the pilot trial management plan (Golder 2017a) and the initial injection trial report (Golder 2017b). This report fulfils the requirements under condition 39 (refer to Section 1.3). It is beyond the scope of this report to address all remaining conditions (40, and 42 to 50).

Surface Water Take and Use

16) The daily quantity of water taken from Waipaoa River for the purposes of the pilot trial shall not exceed 1901 cubic metres.

17) The instantaneous rate of take from the Waipaoa River shall not exceed 22 litres per second at any time.

18) Abstraction from the Waipaoa River shall only occur when the flow at Kanakanaia and Matawhero, as measured by Gisborne District Council is greater than 4000 litres per second.

19) Abstraction from the Waipaoa River shall only occur during the period 1 May to 30 September each year for the duration of this resource consent.

20) Water shall only be used for the purpose of completing a pilot trial of injecting water into the Makauri Aquifer, or in the case of discharging water to land in accordance with the resource consent application document.

21) The total volume of water abstracted from the Waipaoa River under this consent shall not exceed 110,000 cubic metres, being 10,000 cubic metres for a pre-trial injection and 100,000 cubic metres for the injection trial.

22) Surface water abstraction shall only occur from the infiltration gallery as detailed in the application for this consent.

23) Should adverse effects in the Waipaoa River or Makauri Aquifer be identified, then the injection or taking of water by this permit shall only occur as specifically authorised by the GDC Manager.

Fully complies:

- Maximum daily take from the Waipaoa River for the purpose of the injection trial was 1,500 m^3/day at any given time during the main injection trial. The maximum recorded flow rate was 19 L/s during the main injection trial. Both are within the consented limit. However, the instantaneous flow rate was exceeded during the commissioning phase between 22 May and 24 May 2017.
- Waipaoa River flows were consistently above 4,000 L/s throughout the main injection trial period. Therefore, water abstraction from the river only occurred at river flows above 4,000 L/s. River water was abstracted for the injection trial between 12 June 2017 and 13 September 2017, which is within the consented period, and was used for the purpose of the injection trial. This purpose includes the actual injection into the aquifer and also backwashing of the filter bank and injection well.
- The total volume abstracted from the Waipaoa was 99,000 m^3, of which 8,811 m^3 was for pre-trial injection, 64,018 m^3 for the main injection trial, 10,854 m^3 for backwashing during the main trial and the remaining 15,317 m^3 for flushing and injection step testing during the commissioning phase. The water was abstracted from the Kaiaponi infiltration gallery, which is the designated river abstraction point for the Poverty Bay MAR pilot project.
- The injection and taking of water has been undertaken as authorised by GDC.

Water Use Monitoring

24) The consent holder shall install a water meter on each pump head/intake prior to the exercise of this consent. The water meter/s shall:

Water Use Monitoring

a. meet the Resource Management (Measuring and Reporting of Water Takes) Regulations 2010;

b. be installed and maintained in accordance with manufacturer's specifications, and to the satisfaction of the Gisborne District Council;

c. be installed at a location that will ensure the entire water take is measured;

d. be sealed and as tamper-proof as practicable;

e. be suited to the qualities of the water it is measuring (such as temperature, algae content and sediment content);

f. be able to be fitted with a recording device; and

g. be able to measure both cumulative water abstraction and the instantaneous rate of take to an accuracy of ± 5 %.

25) The water meter shall be verified by a suitably qualified operator within two months of the exercise of this resource consent. Within one month of verification being undertaken, the consent holder shall provide appropriate evidence of verification to the Gisborne District Council.

26) All practicable measures shall be taken to ensure that the water meter and recording device are fully functional at all times. All malfunctions of the water meter shall be reported to the Gisborne District Council within 24 hours of observation and appropriate repairs undertaken as soon as practicable following observation of malfunction.

27) The consent holder shall keep a daily record of the following information:

a. Hours pumped;

b. Abstraction rate (litres per second);

c. Quantity of water taken from the Waipaoa River (cubic metres per day); and

d. If no water is taken, the volume shall show zero (0) cubic metres.

Such records shall be available for inspection by Gisborne District Council staff.

28) The consent holder shall ensure that no later than 31 July of every year for the duration of the consent that the Gisborne District Council has been sent a complete record of all criteria required by condition 27 for the period between 1 July and 30 June of the preceding year.

Fully complies:

- A water flow meter was installed according to resource consent requirements in the injection well headworks and recorded flows each 15 minutes during the injection trial.
- Compliance with the accuracy requirements have been confirmed and calibration certificate was presented by the installer of the flow meter (Appendix G).
- Verification of the flow meter by a suitably qualified operator within 2 months of operation was not confirmed.
- Daily flow records have been kept and provided to GDC.

Discharge of Water to Makauri Aquifer

29) The rate of water injected into the Makauri Aquifer shall not exceed 22 litres per second and the total volume of water injected under this consent shall not exceed 110,000 cubic metres, being 10,000 cubic metres for a pre-trial injection and 100,000 cubic metres for the injection trial.

30) The injection of water into the Makauri Aquifer and associated controls and monitoring shall be undertaken in general accordance with the Australian Guidelines for Water Recycling – Managed Aquifer Recharge document number 24 (July 2009).

31) Water shall only be injected into the Makauri Aquifer via the injection well authorised under this consent.

32) The consent holder shall install a suitable filter/s inline before injection water enters the Makauri Aquifer to treat water prior to injection.

33) No water shall be discharged into the Makauri Aquifer if the following discharge limits have been exceeded:

    a. A concentration of E.*coli* of 100 cfu/100ml; and

    b. Turbidity of 100 NTU; or

    c. Any amended limit(s) adjusted with the approval of an independent and suitably qualified and experienced professional and certified by the GDC Manager.

34) Prior to seeking certification of any amended limits, the consent holder shall seek input from mana whenua. The consent holder shall advise, in writing, the Council of any advice received from mana whenua and how that advice has been incorporated into decision making.

Partially complies:

- Maximum daily injection flow into the Makauri Aquifer was 1,500 m^3/day at any given time during the main injection trial. The maximum recorded flow rate was 19 L/s. The total volume injected was 73,180 m^3, of which approximately 351 m^3 was injected during the commissioning phase, 8,811 m^3 was injected during the pre-trial injection and 64,018 m^3 was injected during the main injection trial. A filter bank was installed and backwashing undertaken throughout the main injection trial. A total of 10,854 m^3 was used for backwashing and was not injected into the Makauri Aquifer. Chlorination dosing was applied at the end of the main trial period for the purpose of biological control. Further details are provided in Section 3.0 and Section 4.0

- The injection of water into the Makauri Aquifer and associated controls and monitoring was undertaken in accordance with the Australian Guidelines for Water Recycling – Managed Aquifer Recharge document number 24 (July 2009). Further details are included in Appendix F.

- Injection water exceeded the E.*coli* level limit of 100 cfu/ml on one occasion, being on 8 September 2017 (Figure 32). Whilst elevated E.*coli* levels have been encountered in two nearby monitoring wells, this apparent break-through was temporary and no persistent raise in E.*coli* levels were recorded. The maximum E.*coli* level detected in the injection water was 160 cfu/ml. At this E.*coli* level Golder anticipates rapid die-off in the Makauri Aquifer and E.*coli* from this event is unlikely to be ever encountered in any of the monitoring wells surrounding the injection well, other than in the MAR monitoring well GPE065.

- Manual and automated turbidity recordings of the injection water, as recorded in the MAR injection well GPE066, have been consistently below 100 NTU. No exceedances of the consent limit has been recorded.

- No amended limits were sought for the 2017 main injection trial.

5.0 DISCUSSION AND ANALYSIS – ISSUES AND OPTIONS

5.1 Poverty Bay MAR project – the Opportunity

5.1.1 General

The 2017 injection trial for the Poverty Bay MAR pilot project showed that augmentation of the Makauri Aquifer is technically viable, with about 73,000 m^3 being injected in a single well in a relatively short period of time of 59 days. An increase in Makauri Aquifer groundwater levels during injection is clearly visible, with mounding effects recorded up to 1,500 m away from injection well. This confirms water injection into the Makauri Aquifer can contribute to the natural rise in groundwater levels during winter recharge of the aquifer.

Although there are matters to take into consideration for future trials as further discussed in Section 5.2, there were no significant issues that impeded the successful completion of the injection trial in 2017.

5.1.2 Key success factors

There are several key success factors that make the Poverty Bay MAR project a technically viable option and worth further consideration:

- The 2017 injection trial shows a substantial volume of water can be successfully injected into the Makauri Aquifer.
- With mean river flows of 49,000 L/s and minimum flows set at 4,000 L/s at Kanakanaia bridge and Matawhero bridge (Figure 1 and Table 1), it is unlikely that river flows are ever too low to supply injection water. Goldsim modelling undertaken by Golder (2014b) suggest some 600,000 m^3 of injection each winter season (approximately 46 L/s between May and September each year) would be required to stabilise the aquifer and allow for some future growth in abstraction volume.
- A full scheme could potentially have both a stabilising effect on Makauri Aquifer groundwater levels enhancing aquifer yield, as well as beneficial effects on water quality. Current irrigation abstraction appears to draw in water with higher salinity over time. Although source is not confirmed, MAR would enable a reversal of this trend and ensure the aquifer remains a source of freshwater suitable for irrigation.
- There are opportunities to combine MAR solutions with increasing reliability of drinking water supply and pursue environmental ambitions such stream flow enhancement. There are also water quality enhancement opportunities such as subsurface iron removal, which could benefit irrigators. The Poverty Bay groundwater system is generally quite reactive and there are opportunities to use the aquifers' purifying abilities to remove pathogens, TSS and certain nutrients.

5.2 Managing Risks and Improving Operations

5.2.1 Risks and mitigation

Although the 2017 injection trial shows MAR is a technically viable option to enhance water supply security in Poverty Bay, it is important that potential risks are acknowledge and proper management and mitigation strategies are put in place.

The 2017 injection trial involved injection of oxic river water into the anoxic Makauri Aquifer with a single injection well and this process has specific risks. The risks and mitigation strategies are described in further detail in this section.

Several of the issues highlighted below are not solely related to the injection process, but are likely to already occur with existing irrigation abstraction wells even without a MAR injection scheme. It is recommended to further investigate on-going clogging issues of abstraction wells in the Poverty Bay area. This would help better

understanding the risks for the MAR injection processes, but can also be used to identify if clogging issues relate to the MAR project or are in fact caused by on-going pre-exiting issues.

Biofouling clogging issues

Biofouling (i.e., growth of biomass) can occur where oxygen and nitrate in the injection water encounters methane naturally formed in the Makauri Aquifer. This can cause clogging of the injection well or of downgradient irrigation abstraction wells, if these were to attract the injection water. The risks of this are the greatest if the injection water follows preferential flow paths through the aquifer or flow paths through less reactive parts of the aquifer. The Makauri Aquifer is relatively homogenous and thin, which reduces the risks of preferential flow paths.

Mitigation strategies:

- Injection wells should be sited at appropriate distance away from irrigation abstraction infrastructure. A good understanding of groundwater flow paths is important to identify appropriate locations of injection wells.
- Ideally, the source water contains low oxygen and nitrate concentrations. This could be achieved through pre-treatment or selecting a water source that naturally has these characteristics, such as the shallower Waipaoa Gravel Aquifer, which is hydraulically connected to the Waipaoa River.

Gas clogging issues

The Makauri Aquifer naturally contains dissolved methane and carbon dioxide. A change in pressure and temperature conditions can cause bubbles to form and accumulate near the injection well, clogging the pores in the formation around the well. The formation of carbon dioxide bubbles (i.e. degassing) near the well could result in carbonate precipitation on the well screen (i.e., scaling), which leads to clogging. The well-sorted gravel matrix of the Makauri Aquifer may be relatively insensitive to these well clogging issues.

Mitigation strategies:

- A continuous instead of an intermittent injection regime could help avoid the built up of gas around the injection well to some extent. Injection pressure should be kept appropriately high. The use of submersible pumps for injection are preferred over suction pumps to prevent degassing.
- Well clogging over time should be anticipated and an appropriate well maintenance programme is required. This could include redevelopment of the well as mentioned below in Section 5.2.2.

Water quality issues

The water quality of the Makauri Aquifer could be adversely affected by possible contaminants in the source water used for injection, such as pathogens (i.e., E.*coli*), nutrients or pesticides. Furthermore, the mixing of oxic source water containing oxygen with anoxic aquifer water could in some cases cause pyrite oxidation and the release of arsenic in the aquifer. Core sample testing of Makauri Aquifer formation material has so far not identified any of the sulphide minerals that would typically be required to release arsenic, and indicated that arsenic release is unlikely to be significant (Section 2.6 and Section 4.5).

Mitigation strategies:

- Frequent source water quality monitoring for possible contaminations is recommended, including appropriate management processes to avoid contaminated source water to be injected. In addition, source water treatment in the form of a shallow settling pond that not only settles fines but also provides disinfection by sunlight, could be considered. A pond can also provide containment if contaminants are accidently drawn in from the river.

- As is also beneficial to minimise clogging issues, injection wells should be sited at appropriate distance away from irrigation abstraction infrastructure. A good understanding of groundwater flow paths is important to identify appropriate locations of injection wells.
- If contaminated source water is injected, then temporary cessation of injection followed by abstraction from the injection well could be considered to remove the contaminated water from the aquifer.
- Groundwater quality monitoring downgradient from the injection well is recommended to identify water quality issues. Designated monitoring wells (i.e., piezometers) located within the likely pathway of the injection water plume are the best way to track any on-going water quality issues at an early stage.

5.2.2 Well maintenance programme

Considering the potential for clogging issues, it is important that an injection well maintenance programme is developed, which includes regular testing of well performance and redevelopment of the well to remove clogging.

It is recommended that a stepped rate pumping test (injection or abstraction) is undertaken each year prior to the injection trial. The recorded drawdowns and flow rates can be used to assess well performance and review these against step test results from previous year. If performance has significantly deteriorated, well redevelopment can be considered. Well redevelopment can be undertaken by physical measures (overpumping, surging with a surge block, etc.) or chemical dosing to remove the blockage material. An overview of well redevelopment techniques is provided by Sterrett (1997).

5.2.3 Investigations

Further investigations into the risks, mitigation strategies and operational issues is recommended. This will help improve the MAR injection system and associated management practices as well as minimise adverse effects on the groundwater resource and downgradient users of the Makauri Aquifer. An overview of recommended future investigations are described below.

Groundwater model development

The previous modelling work with Goldsim (Golder 2014b) involved the use of an indicative water balance model that cannot be used to assess changes in groundwater flow and water quality effects. To better understand the effects of MAR on groundwater levels, flow and water quality for the current MAR injection operation and for possible expansion in the future, it is important that a 3 dimensional numerical groundwater model is developed. A 3 dimensional groundwater model can be used to identify optimal locations of monitoring wells and assess monitoring timing and frequency (i.e., it can be used to calculate the injection water plume break-through timing in various wells). In addition, it can be used to better understand long-term regional groundwater processes and associated water quality effects, assess long-term groundwater level trends and aquifer yield, and investigate the benefit of MAR to ensure a long-term sustainable yield and good groundwater quality outcome.

Information required to develop this model include the following:

- Accurate long-term groundwater level data from wells throughout the Poverty Bay area screened in different aquifers. Surveying of top of well casings and ground levels near the wells is important as the height of groundwater levels in relation the mean sea level is required. Groundwater levels are used to calibrate the groundwater model.
- Geological information and in particular accurate bore logs to develop a geological model that will form the basis of the groundwater model.
- Groundwater quality and geochemistry information of the native groundwater.

- Aquifer testing data (flow rates and recorded drawdowns, as well as derived aquifer parameter values) can be used to define aquifer characteristics.
- Accurate long-term data on groundwater abstraction rates and volumes from individual wells screened in various aquifer throughout the Poverty Bay area is important to ensure the accuracy of the model water balance and flow directions.
- Long-term meteorological data (rainfall and evaporation) are relevant to better understand the groundwater recharge.
- Information on river and stream flows, in particular in relation to groundwater and surface water interaction, such as flow losses and gains and base flow recordings.
- Up to data land use practices such as which land parcels are irrigated and how the land is used.
- Accurate water quality data from wells throughout the Poverty Bay area screened in different aquifers. This can be used to confirm groundwater flow patterns and help calibrate the model.

Much of the data and information listed above is readily available and can be used to commence development of a groundwater model of the area. The development of a groundwater model typically has the following steps:

1) Data and information inventory and review, including gap analysis
2) Development of the hydrogeological conceptual model
3) Development of a numerical geological layer model as input into the groundwater model
4) Development of a numerical groundwater model
5) Initial modelling runs and sensitivity analysis
6) Model calibration and completion of the model
7) Scenario development and calculations

Targeted monitoring

The monitoring for the 2017 injection trial was aimed at better understanding the extent of the MAR injection influence and also providing assurance to authorities and the community that the trial was undertaken in a controlled manner. The injection trial results show that the groundwater monitoring can be undertaken in a smaller area and can be more targeted, with only a specific set of parameters to be monitored, in order to track the effects of the injection process. Increasing the injection volume could provoke a noticeable change at multiple downgradient monitoring wells, providing a better understanding of aquifer responses to the injection trial. The following adjustments to the monitoring programme are recommended:

- Most of the wells used in 2017 for water level and water quality monitoring can be removed from the monitoring programme, other than one-off testing prior to and after the injection trial. This includes all upgradient wells and all wells beyond 1,500 m from the injection well. This effectively means that only three wells are to remain in the monitoring programme, which is GPE065, GPD096 and GPF105. However, continuation of monitoring may serve purposes other than assessment of effects from the injection trial and this should be taken into consideration.
- Two additional designated monitoring wells (piezometers) could be installed in the Makauri Aquifer within 300 m downgradient from the injection well. These can be used both for groundwater level and water quality monitoring. Core sampling of the Makauri Aquifer formation material could be undertaken and these can be submitted for laboratory quantitative chemical and mineralogical composition analysis (e.g., X-Ray

Fluorescence [XRF] and X-Ray Diffraction [XRD] testing) to confirm mineral composition and potential for adverse water quality effects.

- Water levels can be recorded by automatic water level loggers in up to 5 wells. Manual water level logging is then only required on a quarterly basis for quality assurance purposes.
- Water quality monitoring should include the same field and lab testing parameters undertaken in the 2017 monitoring programme, with the amendment that dissolved fractions are only tested for iron, manganese and arsenic, and that DOC is added to the list of parameters to test. Field parameters (pH, conductivity, DO and temperature) should be recorded with calibrated equipment by suitably qualified field staff.
- Tracer testing with a conservative tracer (i.e., a substance such as bromide that does not react with aquifer material or water) can be considered to better follow injection water plume migration pathways.

Inventory of clogging issues in existing abstraction wells

As stated above, some abstraction wells screened in the Makauri Aquifer in the Poverty Bay area may have had well clogging issues in the past, considering the chemical signature of the aquifer. An inventory of these issues (type of clogging, effects on well yield, frequency, etc.) and how these are commonly mitigated could help understand the likelihood of clogging issues arising at the injection well and what mitigation strategies (i.e., redevelopment strategies) have worked on nearby wells.

Review of similar injection studies and inventory of lessons learned

MAR solutions including ASTR are technologies that have been successfully implemented throughout the world to secure supply of water for industries and communities. It is a mature technique and lessons can be learned from many case studies throughout the world. A targeted case study review for future development of the Poverty Bay MAR scheme as well as for insight into risks and on-going maintenance issues can be beneficial.

5.3 Future of Poverty Bay MAR – from Pilot to Scheme

5.3.1 Scale of a future MAR scheme

Golder (2014b) provides an overview of consented groundwater abstraction volumes and groundwater use on the Poverty Bay flats (Table 3). Approximately 1.5 Mm^3/year is currently abstracted from the Makauri Aquifer and this is expected to further increase in the next decades. Indicative Goldsim water balance modelling suggest that the volume of winter injection would have to increase to some 600,000 m^3/year in the next decades to ensure a sustainable aquifer yield and allow for some future growth in abstraction.

If injection through wells at a rate of 10 L/s per well (the 2017 injection trial reached 14 L/s on average) would be undertaken between 1 May and 30 September (152 days) each year as per the current injection consent, than the total required replenishment volume could be injected by approximately 5 injection wells.

5.3.2 Design Improvements and alternative options

The current Poverty Bay MAR injection setup requires significant capital investment costs and operation and maintenance efforts to keep the system operational. The main point of attention are the suspended fines in the Waipaoa River water used as source water, which need to be filtered before injection in order to minimise clogging of the injection well.

Several options for improvement of the system design can be considered:

- Shallow settling pond: these can be designed to be very effective in removing fines. If kept shallow the sunlight can effectively remove pathogens. A shallow settling pond thus provides for better source water quality control. The settling pond can be made more effective by drawing the water from vertical subsurface drains beneath the pond. A pond can also provide for storage and buffering so injection can

continue even during unfavourable river flow conditions (either too low flows or too high flows). In addition, a pond provides a means of containment in case of a sudden high contaminant load in the river and can be used to optimise a water distribution system for supply to multiple injection sites.

- A slow sand filtration treatment step in combination with storage could be included to improve the source water quality prior to injection.
- Source water could potentially be drawn from shallower aquifers that are hydraulically connected to the Waipaoa River. This would provide for fines filtering and treatment of pathogens. In addition, the shallower aquifers may have a water quality signature similar to that of the Makauri Aquifer reducing the potential risks of clogging outlined above.
- There is evidence that the Makauri Aquifer is shallower up catchment and there may be opportunities to replenish the Makauri Aquifer through infiltration ponds or canals there.

5.3.3 Waipaoa Augmentation Plant

One tangible option to further explore is using the Waipaoa Augmentation Plant 2 km south of the current MAR injection well site. The Waipaoa Augmentation Plant was commissioned in 1991 as an alternative/backup supply to augment the Waingake water supply, and could be used as a source of direct injection water for MAR. The plant has the ability to produce water volumes up to 720m³/hr or 17,000m³/day (GDC 2008). GDC holds resource consent to take up to 13,392 m³/day from the Waipaoa River at the plant. GDC established a minimum Waipaoa River flow of 600 L/s at the Matawhero Bridge and 1,300 L/s at the Kanakanaia Bridge, below which restrictions may be applied.

The site includes ponds and treatment facilities that could potentially be used for injection source water treatment. The Waipaoa Augmentation Plant has been considered for the Poverty Bay MAR pilot in the past. Golder understands that the operational costs of the Waipaoa Augmentation Plant are restrictively high because the intake pumps and treatment plant are powered by local diesel generators (Golder staff field tour, 23 July 2014), although the power supply may have been upgraded recently. It may be worth re-evaluating the options to use the Waipaoa Augmentation Plant.

5.3.4 Business case development

For the future development of a Poverty Bay MAR scheme it is crucial that the project is economically feasible. The long-term benefits need to outweigh the costs. It is important that the parties involved realise that long-term investments are to be made and benefits may not be clear in the first few years. More specifically, the MAR scheme needs to be operational when a period of long-term drought hits the region, which may be years away.

Therefore, the development of a proper business case is warranted in which capital investment and operation and maintenance costs as well as the return on investment of a MAR scheme is compared to other water management solutions, such the construction of storage dams up catchment or on-site storage.

In the business case the possible links to public water supply and formation of a regional water supply company or solely an irrigation MAR company could be further explored.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Makauri Aquifer Characteristics

- The Makauri Aquifer is a ~70 m deep semi-confined aquifer of 4 to 20 m thickness, which is mainly recharged in the upper Waipaoa River catchment and through some leakage from overlying and possibly underlying aquifers. The transmissivity of the aquifer is relatively high and aquifer yield is good with some 1.5 Mm^3/year abstracted from this aquifer mainly for irrigation use in the Poverty Bay area.
- Analysis of various aquifer testing and groundwater level response reviews indicate the following range of aquifer parameter values for the MAR injection well site:
  - Transmissivity: 500 to 800 m^2/day
  - Storativity: 2×10^{-5} to 2×10^{-3}
  - Leakage (K'/B') : 2.5×10^{-5} to 1.6×10^{-4} day^{-1}
- A trend of increasing summer groundwater abstraction from the Makauri Aquifer has caused the long-term declining trend in overall groundwater levels as well as in seasonal low levels. There is an overall increase in groundwater abstraction, not just higher abstraction during dry years. Although the overall trend in groundwater levels is declining, winter recharge appears to be sufficient to recover groundwater levels the following winter in most years. Based on rainfall and Makauri Aquifer groundwater level fluctuations, it would appear that the Makauri Aquifer responses reasonably fast to recharge events.
- The aquifer water is naturally highly mineralised and is presumed anoxic due to the presence of organic matter in the formation material that comprises the groundwater system. The water quality in the aquifer in the area surrounding the MAR injection well site is rather homogenous although two wells south of the site show a gradual change in the past 25 years.

6.2 Conclusions – Injection Trial 2017

- The 2017 injection trial for the Poverty Bay MAR pilot project shows that augmentation of the Makauri Aquifer is technically viable, with about 73,000 m^3 being injected in a single well in a relatively short period of time of 59 days. An increase in Makauri Aquifer groundwater levels during injection is clearly visible, with mounding effects recorded up to 1,500 m away from injection well. This confirms water injection into the Makauri Aquifer can contribute to the natural rise in groundwater levels during winter recharge of the aquifer.
- During the pumping tests a significant volume of gas was released from the discharged aquifer water within the stilling basin adjacent to the injection well. Based on general knowledge of the aquifer chemistry, it was initially assumed that the primary components of the discharged gas would be methane and carbon dioxide.
- Air bubbles in the injection water (i.e., Waipaoa River water) caused temporary blockage of the well screen. The issue has been resolved through the installation of a drop tube in the well head and adjustments of operational procedures. Further enhancement may be possible to achieve greater performance.
- The Waipaoa River carries significant loads of fine sediments which could potentially clog the abstraction and injection infrastructure. To keep abreast of clogging issues, a pre-emptive automated backwashing programme was initiated every 12 hours. Injection well backwashing was undertaken manually twice per week during the main injection trial.
- Iron oxide minerals naturally present in the Makauri Aquifer water have the potential to precipitate during geochemical interactions between the oxygenated injection water and the reduced and anoxic groundwater,

particularly at the outer extent of the injected water plume where mixing with groundwater occurs. However, no such precipitate products were observed during the MAR injection trial, nor was a substantial increase in turbidity detected at GPE065. Extensive chemical clogging, to the extent that it modifies aquifer properties and reduces injection flow rates, was also not observed.

- Other potential clogging issues related to the natural presence of methane and carbon dioxide in the aquifer that can cause biofouling when mixed with oxygen in the injection water, or could accumulate in gas form around the injection well screen. Both can cause clogging of the injection well. These issues have not been encountered during the 2017 injection trial.
- The break-through of the oxic injection water could only be confirmed in the MAR monitoring well GPE065 (21 m distance from the injection well). Some changes in water quality were recorded in GPE010 (190 m from the injection well) post-injection, however these are inconsistent with a break-through of oxic injection water (from the Waipaoa River). The water quality signature in all other wells used for monitoring during the 2017 injection trial remained unchanged. This is consistent with indicative calculations that show the injection water plume will have migrated in the aquifer to a distance of some 230 m in southeastern direction.
- Chlorine dosing was undertaken at the tail-end of the main injection trial. A side-effect of chlorination is the formation of disinfection by-products (DBPs), which were tested in samples taken from several wells during and after the injection triall. No DBP's have been encountered in any of the monitoring wells tested prior to, during and after the injection trial.
- The injection trial was generally undertaken in compliance with the resource consent conditions. A major non-compliance was the injection of water with E.*coli* levels above 100 cfu/100ml on one occasion, being on 8 September 2017. Whilst elevated E.*coli* levels have been encountered in two nearby monitoring wells, this apparent break-through was temporary and no persistent raise in E.*coli* levels were recorded. The maximum E.*coli* level detected in the injection water was 160 cfu/100ml. At this E.*coli* level Golder anticipates rapid die-off in the Makauri Aquifer and E.*coli* from this event is unlikely to be ever encountered in any of the monitoring wells surrounding the injection well.

6.3 Recommendations

- **Explore further expansion of the MAR scheme:** A full MAR scheme could potentially have both a stabilising effect on Makauri Aquifer groundwater levels enhancing aquifer yield, as well as beneficial effects on water quality. Golder recommends further exploring the options to expand the Poverty Bay MAR scheme. There are opportunities to combine MAR solutions with increasing reliability of drinking water supply and pursue environmental ambitions such as stream flow enhancement, which are also worth further exploring.
- **Acknowledge potential issues:** The 2017 injection trial involved injection of oxic river water into the anoxic Makauri Aquifer with an injection well and this process has specific risks. It is important that potential risks are acknowledged and proper management and mitigation strategies are put in place. Details about risks and mitigation are described in more detail in this report.
- **Develop and implement an injection well maintenance programme:** Considering the potential for clogging issues, it is important that an injection well maintenance programme is developed, which includes regular testing of well performance and redevelopment of the well to remove clogging materials.
- **Develop a 3D numerical groundwater model:** To better understand the effects of MAR on groundwater levels, flow and water quality for the current MAR injection operation, and for possible expansion in the future, it is important that a three dimensional numerical groundwater model is developed. A three

dimensional groundwater model can be used to identify optimal locations of monitoring wells and assess monitoring timing and frequency (i.e., it can be used to calculate the injection water plume break-through timing in various wells). In addition, it can be used to better understand long-term regional groundwater processes and associated water quality effects, assess long-term groundwater level trends and aquifer yield, and investigate the benefit of MAR to ensure a long-term sustainable yield and good groundwater quality outcome.

- **Detailed hydrogeochemical evaluation:** investigation of the processes affecting native groundwater composition and processes related clogging risk assessment for MAR injection and abstraction wells. Evaluation of the gas composition and pressures of methane and carbon dioxide, the occurrence of salinization and redox processes that lead to water quality changes in the native groundwater and during the injection trial.
- **Investigate historic well clogging issues in existing abstraction wells:** Several of the issues highlighted in this report below are not solely related to the injection process, but are likely to occur with existing irrigation abstraction wells even without an MAR injection scheme. It is recommended to further investigate on-going clogging issues of abstraction wells in the Poverty Bay area. This would help better understanding the risks for the MAR injection processes, but can also be used to identify if clogging issues relate to the MAR project or are in fact caused by on-going pre-exiting issues.
- **Undertake targeted monitoring:** The injection trial results show that the groundwater monitoring can be undertaken in a smaller area and can be more targeted, with only a specific set of parameters to be monitored, in order to track the effects of the injection process. Field filtration of samples for dissolved metals analysis is recommended during all monitoring activities since it is recognized that iron may have precipitated in some samples that were previously filtered by the laboratory.
- **Review MAR case studies:** MAR solutions including ASTR are technologies that have been successfully implemented throughout the world to secure supply of water for industries and communities. A targeted case study review for future development of the Poverty Bay MAR scheme as well as for insight into risks and on-going maintenance issues can be beneficial.
- **Review injection infrastructure and filtering design:** The current Poverty Bay MAR injection setup requires significant capital investment costs and operation and maintenance efforts to keep the system operational. In addition, chemical and biological clogging issues in the aquifer may arise in due course. There are several options worth further exploring that may be more cost-effective:
  - Pre-treatment of injection water in settling ponds
  - Slow sand filtration treatment with storage
  - Alternative source water, more akin to ambient Makauri Aquifer water
  - Makauri Aquifer replenishment up catchment

  In addition, continued chlorination could cause DBPs to accumulate in the aquifer and is not recommended. It is worth investigating the relationship between river water turbidity and E.*coli* concentrations and using this relationship to provide an early indication of issues with injection water quality.
- **Re-assess the use of the Waipaoa Augmentation Plant**: one tangible option to further explore is using the Waipaoa Augmentation Plant located 2 km south of the current MAR injection well site. This plant has various infrastructure for pre-treatment that can be used to control the source water quality, such as E.*coli* levels and fine sediment loads.

- **Resource consent variation**: consider changing the Poverty Bay MAR resource consent to allow the expansion of the pilot project to include additional injection wells, increase injection volumes and alternative injection water source or pre-treatment options.
- **Develop the business case:** For the future development of a Poverty Bay MAR scheme it is crucial that the project is economically feasible. Therefore, the development of a proper business case is warranted in which capital investment and operation and maintenance costs as well as the return on investment of a MAR scheme is compared to other water management solutions, such the construction of storage dams up catchment or on-site storage.

7.0 REPORT LIMITATIONS

Your attention is drawn to the document, “Report Limitations”, as attached in Appendix H. The statements presented in that document are intended to advise you of what your realistic expectations of this report should be, and to present you with recommendations on how to minimise the risks to which this report relates which are associated with this project. The document is not intended to exclude or otherwise limit the obligations necessarily imposed by law on Golder, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing.

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APPENDIX A

Resource Consent Documents - Poverty Bay MAR pilot project

IN THE MATTER OF	the Resource Management Act 1991
AND	
IN THE MATTER OF	the application for Resource Consent to drill up to three Bores, Take Surface Water from the Waipaoa River, and Discharge Water to Land, and Water to Water via injection (Application Numbers LB-2016-107112-00, WS-2016-107114-00, DW-2016-107113-00 Gisborne District Council.

DECISION OF

GISBORNE DISTRICT COUNCIL

14 November 2016

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1 Appointments

1.1 Pursuant to section 34A of the Resource Management Act 1991 (RMA), Independent Commissioners; Mark St Clair (Chair), Peter Callander and Antoine Coffin were appointed as Commissioners by the Gisborne District Council (GDC) as the consent authority to hear and determine the applications lodged by the "Applicant" Gisborne District Council for Resource Consents (to drill up to three Bores (LB-2016-107112-00), Take Surface Water from the Waipaoa River (WS-2016-107114-00), and Discharge Water to Land, and Water to Water via injection (DW-2016-107113-00) at 555 Matawai Road, Gisborne.

2 Procedural Matters

2.1 Scope

2.1.1 In evidence from the Applicant, amendments to the conditions of consent proposed by the section 42A officer sought that the proposed maximum abstraction rate from the Waipaoa River be increased from 15L/s to 22L/s[1]. We note that this maximum rate would also apply to the rate of injection. Similarly, the Applicant sought that the conditions relating to the injection volume of 100,000m^3 over a 100 day period for the trial, be amended to provide for 100,00m^3 in any one calendar year[2].

2.1.2 We questioned the Applicant and section 42A officers as to whether or not these amendments sought were within the scope of what was sought by the application.

2.1.3 In regard to the maximum abstraction rate, we were advised by the Applicant that the application included the variable speed of the abstraction pump and that the maximum rate that would be used for the trial was 22L/s. In addition, Mr Fraser (Consent Manager for Bay of Plenty Regional Council acting as a section 42A officer) specifically addressed this issue in his response to matters raised in the hearing. Mr Fraser drew our attention to the fact that throughout the application reference is made to the variable speed of the pump and that it is proposed to operate anywhere from 10L/s to a maximum of 22L/s[3]. Mr Fraser set out the three indicative scope tests used by the Environment Court and in summary concluded that 22L/s was within the scope of the application. We heard nothing to the contrary and hence adopt that explanation as our finding.

2.1.4 In regard to the 100,000m^3 injection over 100 days in any one year, the Applicant explained that this amendment was sought to allow for the circumstances where the trial may have to be halted for some technical or operational reason before the 100,000m^3 volume was reached. In such circumstances, the Applicant proposes that the trial would start again the following winter. Mr Fraser also addressed this matter in response to matters raised in the hearing. Mr Fraser's view was that the scope of the application limited the trial to 100,000m^3 plus 10,000m^3 (pre-injection trial) and that it could be carried out over subsequent years, provided that the overall volume limit of 110,000 m^3 was not exceeded[4]. Mr Fraser went to record that his view was a technical planning conclusion rather than a pragmatic consideration. We agree with his finding, but also find that from a pragmatic perspective if the total volume for the trial is limited to 110,000 m^3 that should still be sufficient to achieve the objectives of

[1] Houlbrooke Evidence, Page 2 Paras 8-12
[2] Ibid. Page 3, Paras 13 - 15
[3] E.g. Application – Volume 1- Page 3, Para 2
[4] R Fraser, 18 Oct 2016, Responses to matters raised in Hearing, Page 2

the trial even if it takes more than a year to complete the injection of that water volume.

2.2 Submissions

2.2.1 The applications were notified on the 25th June 2016, with the submission period closing on the 22nd July 2016. Ten submissions were received during the notification period, with all of those submitters requesting to be heard.

2.2.2 There was one submission in opposition, that being from Rongowhakaata Iwi Trust.

2.2.3 In addition a submission from Mr B Thorpe on behalf of NZ Fruits Ltd was received on 23 July 2016. Mr Thorpe did not wish to be heard. At the hearing we sought the views from the parties as to whether or not they were opposed to this late submission being accepted and therefore being considered as part of the hearing process. No party raised any objection and we record that we accept the submission of NZ Fruits Ltd.

2.2.4 We record that we read the submissions in full (including those where the submitters did not wish to be heard) and we have had regard to them as part of our evaluation of the applications.

2.3 Directions

2.3.1 We issued initial Directions on 2 September 2016 regarding the pre-circulation of the section 42A Report and evidence as required by section 103B of the Resource Management Act 1991 (RMA). We note that, those Directions were complied with.

2.3.2 At the adjournment of the hearing on the 18th October 2016, we issued a Minute seeking additional information from the Applicant and for the Applicant to provide their reply in writing. That information and the reply was received by GDC on 21 October 2016 and disseminated to the parties.

2.4 Prehearing meeting

2.4.1. A pre-hearing meeting was held on 8 September 2008. The submitter in attendance was the Rongowhakaata Iwi Trust, represented by Te Rina Whaanga, Moera Brown, Jody Wylie, Murray Palmer and Roy Paro. We were provided with and read a copy of the pre-hearing report, prepared by Mr R Fraser – Consents Manager, Bay of Plenty Regional Council.

2.5 Site Visit

2.5.1. We undertook a site visit on the afternoon of Monday 17th of October 2016.

2.6 Decision format

2.6.1. We have had regard to the requirements of section 113 of the RMA when preparing this decision. In particular we note and have acted in accordance with section 113(3) which states:

"A decision prepared under subsection (1) may, -
(a) instead of repeating material, cross-refer to all or a part of -
(i) the assessment of environmental effects provided by the applicant concerned:
(ii) any report prepared under section 41 C, 42A, or 92; or
(b) adopt all or a part of the assessment or report, and cross-refer to the material accordingly."

2.6.2. During the course of the hearing it became apparent that there were particular issues in regard to the operation and potential groundwater effects of the proposed recharge and cultural effects. We therefore focused our questions on these matters. We have consequently focused our decision on those same matters.

3 Description of the Proposal and Location

3.1. The proposal was described in the application documents[5] and the BoPRC officer's report[6] prepared by Ms Jo Cranswick. Clarification of aspects of the location and details of the surface water take and injection to the aquifer were provided during the hearing. We note that by way of overview we have included a brief description of the proposal which includes:

- Take of surface water from existing infiltration chamber owned by Kaiaponi Farms Ltd;
- Conveyance of water from surface take to injection site by existing pipe;
- Drill up to three bores on the Kaiaponi Farms Ltd property involving a pilot which if successful will be followed by the drilling of a final injection bore and if the first pilot is not successful to drill another pilot bore and final injection bore elsewhere within the Kaiaponi Farms Ltd property;
- Initial 10,000m^3 of water to be injected to Makauri Aquifer followed by monitoring programme before injecting 100,000m^3 over a 100 day trial period at a maximum rate of 22L/s;
- Installation and use of the Arkal filters at a point prior to injection[7]; and
- Monitoring and reporting programme.

3.2. We have already identified in section 2.1 above that an extension of the 110,000 m^3 100 day trial is beyond the scope of the application, although the 100 days of discharge can occur at any time during the term of the consent when the conditions of consent allow.

3.3. Finally in regard to the proposal's location we record that, the location of proposed intake, bore holes and injection point are legally described as follows:

- *The water intake: GS 5D/182 Part sec 2 SO 8571 (GDC owned Land) with the screen and most of the filtration chamber installation being within the Crown Owned River (Waipaoa River)*
- *The proposed site of the first injection bore and pilot: GS 5B/1241 Lot 28 DP 1154 and*

5 Managed Aquifer Recharge Application Volume 1 – Consent Application, Section 1.1 Pages 2-3.
6 J Cranswick, Section 42A Report, Section 4.2 Pages 4-5
7 Confirmed by Applicant at Hearing, 18 Oct 2016

- *The proposed alternate (second injection bore and pilot): GS 106/211 Lot24 DP 1154*[8]

4 Consents Required

4.1 The consents required from the GDC were summarised in section 5.1 of Ms Cranswick's officer's report as follows:

a) Under section 9(2)(a) of the Resource Management Act 1991 and Rule 5.2.4 of the Proposed Gisborne Regional Freshwater Plan to undertake a restricted discretionary activity being to Install up to three Bores, take water for the purposes of pump testing and the associated discharge of drilling fluids and water to land; and

b) Under section 14(2)(a) of the Resource Management Act 1991 and Rule 4.1.7 of the Proposed Gisborne Regional Freshwater Plan to undertake a restricted discretionary activity being to Take and Use Water from the Waipaoa River as a 'B' block allocation; and

c) Under section 15(1)(a) and (b) of the Resource Management Act 1991 and Rule 5.2.8 of the Proposed Gisborne Regional Freshwater Plan to undertake a discretionary activity being to Discharge Water to Water via Injection.

4.2 Ms Cranswick concluded that the activities should be bundled and therefore had an overall activity status of discretionary. In reply, the Applicant addressed those parts of the proposed activities that were permitted9. We heard no contrary view and so we have adopted Ms. Cranswick's advice.

5 The Hearing and Attendances

5.1 The hearing was held on the 17th – 18th October 2016, at the Waikanae Surf Club, in Grey Street, Gisborne. As noted in section 2.3 above, we adjourned the hearing for further information and the Applicant's right of reply on the 18th October 2016. As noted in section 2.3 of this decision, we received that information on the 21st October 2016. Having satisfied ourselves we did not require any further information from the parties, we closed the hearing on the 25th October 2016 by way of a minute.

5.2 The attendances at the hearing were as follows:

5.3 For the reporting officers:

a) Ms Jo Cranswick, Senior Consent's Officer for BoPRC
b) Mr Reuben Fraser, Consents Manager, BoPRC

5.4 At this point we record that as this was an application from GDC seeking authority from itself as the relevant consent authority, GDC appropriately engaged independent consent staff from BoPRC to process the application, conduct the pre-hearing meeting and prepare the relevant s42A report.

5.5 For GDC the Applicant:

a) Mr Denis Crone, Team leader Water and Coastal Services, GDC

[8] Applicant's Reply, 21 Oct 2016, Page 2

[9] Applicant's Reply, Page 3

b) Mrs Lois Easton, Shared Services Science Manager, GDC
c) Ms Clare Houlbrooke, Hydrologist, Golder Associates (NZ)

5.6 For the Submitters:

a) Mr Trevor Lupton – Easter Bay Orchards Ltd and Harpers Gold Ltd
b) Mr Alan Haronga – Mangatu Blocks Inc. and Wi Pere Trust
c) Mr Scott Wilson – Kaiaponi Farms Ltd
d) Mrs Anne Roberts – Roberts Farming Ltd
e) Mr Gordon McPhail and Mr Nick Pollock- Leaderbrand
f) Mrs Moera Brown, Mr Jody Wylie, Ms Te Rina Whaanga and Mr Murray Palmer – Rongowhakaata Iwi Trust
g) Mr Chris Keenan – Horticulture New Zealand

5.7 A comprehensive section 42A officer's report was prepared by Ms Jo Cranswick (for GDC as the consent authority), along with supporting technical reviews from Ms Janine Barber and Mr Alistair Suren (both for BoPRC). We were assisted in an administrative capacity by Ms Laurie Smith, Consents Administrator, GDC.

5.8 The parties provided us with additional material in response to our directions and questions.

5.9 All of the material presented by the above parties is held on file at the GDC. We took our own notes of the verbal presentations and any answers to our questions. For the sake of brevity we do not repeat that material in this decision. However, we do refer to relevant matters raised in the material in subsequent parts of this decision.

6 Principal Issues of Contention

6.1. Section 113

6.1.1 Section 113 of the RMA directs us, in the case of decisions on resource consent applications, to state the principal issues that were in contention and to state our main findings of fact in relation to those issues. Based on the application documents, the submissions, the evidence presented to the hearing, and the contents of the officer's reports, we consider the principal issues of contention to be limited to:

- Operation and potential groundwater effects
- Cultural Effects

6.2. Section 104(1)(a)

6.2.1 Under section 104(1)(a) of the RMA we are required to consider;

"Any actual and potential effects on the environment of allowing the activity; and..."

6.2.2 The main adverse effects of the activity most frequently cited in regard to this application are water resources effects (both at the surface and underground) and cultural effects.

6.3 Water Resources Effects

6.3.1 The information provided in the consent application describes the Poverty Bay flats as an important agricultural productive area for the Gisborne District, with a climate suited to arable farming, market gardening, horticulture and viticulture. Those productive activities require a reliable irrigation water source. The Waipaoa River is the main surface water source although it has limitations due to a high sediment load, physical access and restrictions during summer months due to low flows.

6.3.2 Therefore groundwater is an important source of water supply across the Poverty Bay flats. The information supporting the application indicates that five main aquifers are recognised comprising relatively permeable sand and gravel deposits, separated from each other by lower permeability finer grained silty sediment. This intervening strata is not permeable enough to support productive wells, but does permit leakage of water between the aquifers. The three shallow aquifers are of limited extent and are hydraulically linked to surface waterways. The deepest aquifer is of uncertain extent and has a very slow recharge rate based on a significant long term water level decline that occurred from the pumping of a Gisborne City emergency water supply bore during 1987 and 1988.

6.3.3 We were advised that the fourth aquifer (in terms of depth), the Makauri Aquifer, is the most important groundwater source across the Poverty Bay flats. It occurs as a series of gravel layers, around 5-20m thick, and in the vicinity of this proposed recharge trial is expected to occur at around 70m deep, although there is some uncertainty about this which is why the application allows for the drilling of an initial pilot bore to a depth of 87m. We also recognise that the Makauri Aquifer can vary laterally, which is why the application seeks the ability of drill a second pilot bore at a different location if the first pilot bore does not encounter a suitable thickness of permeable productive gravels.

6.3.4 We were advised that the current consented abstractive allocation from the Makauri Aquifer is around 8.0 million m^3 although actual abstractive use in recent years is around 1.1 – 1.5 million m^3 [10]. Despite the actual use being so much lower than the consented use, the Makauri Aquifer has experienced long term declines in groundwater pressure indicating that the current level of abstraction is unsustainable relative to the natural aquifer water balance of recharge and discharge.

6.3.5 To address this recharge: abstraction imbalance the Proposed Gisborne Regional Freshwater Plan specifies that total allocation from the Makauri Aquifer must be reduced to 1.9 million m^3 by 2020, which is the estimate of current maximum actual use. However Ms Easton advised us that actual use may need to reduce to around 0.6 million m^3 to be in equilibrium with natural rates of aquifer recharge. That would represent a significant restriction on existing groundwater users and have major adverse implications for many productive land use activities. So we recognise the consideration of Managed Aquifer Recharge (MAR) as a pro-active alternative to lessen the impact of possible future restrictions. We were pleased to hear that MAR is not the only option that GDC are pursuing and Mr Crone advised us that surface water storage options and use of natural infiltration basins are also being evaluated as future water management strategies.

6.3.6 Based on the information in the application, the evidence from GDC and the statements from many of the submitter's we clearly recognise the importance of the Makauri Aquifer to support agricultural production across the Poverty Bay flats and the benefits that could be achieved through an effective MAR scheme.

[10] Paul Murphy: Technical Report – Makauri Gravel Aquifer; 1 October 2015

6.3.7 We also recognise that due to the depth of the Makauri Aquifer and the low permeability strata that overlies the productive gravels, that any effective MAR scheme will require an injection bore to direct the recharge water into the aquifer.

6.3.8 We agree with the Applicant that there are uncertainties as to how effective a proposed MAR scheme might be for the Makauri Aquifer. These uncertainties relate to the location and extent of the recharge effect that can be created and the potential water quality effects that might arise. Consequently the current applications are only for a trial of a MAR injection system. Our current decision making process for this application does not include any consideration of the suitability of MAR as a long term water management option for Poverty Bay flats groundwater. We are only considering the effects of a trial period to aid in the community consideration of the MAR option.

6.3.9 In general terms, our view is that undertaking a trial appears to be an appropriate next step to follow-on from the technical evaluations and consultation that have occurred to date. However it is important to ensure that the trial is appropriately monitored and constrained so as to avoid adverse effects that could be detrimental to existing groundwater users and/or to the groundwater and surface water environment that the trial will impact upon. The key areas of potential concern regarding physical effects that need to be considered are:

- effects on the Waipaoa River, which is the source of the water for the trial;
- localised effects in the vicinity of the injection bore, both at the ground surface and in the underlying strata;
- more widespread groundwater effects on neighbouring bore owners and land owners.

6.3.10 We now consider each of these effects.

Effects on the Waipaoa River

6.3.11 The trial will abstract water from an existing intake gallery on the Waipaoa River operated by Kaiaponi Farms Ltd. The intake is currently used for irrigation of horticultural crops, as authorised by consent number WS-2014-106417-00. This consent allows the intake gallery to abstract water from the Waipaoa River at a maximum rate of 50L/s and 4000 m^3/day (which corresponds to an average daily rate of 46.3L/s), when the flow in the river is above 1300L/s as measured at Kanakanaia Bridge. Any abstraction when the river is below that flow can only occur with the authorisation of the Environmental Services Manager of the Gisborne District Council.

6.3.12 For the purposes of the trial, the Applicant proposes the following restriction on their abstraction of water from the gallery:

- a maximum abstraction rate of 22L/s (1901 m^3/day);
- abstraction will only occur during the period from 1 May – 30 September, which is outside of the irrigation season, as advised by GDC's further information ecological report;
- abstraction will only occur when the flow in the Waipaoa River at Kanakanaia and Matawhero is greater than 4000L/s.

6.3.13 In our view, these are conservative restrictions compared to the consented abstraction for Kaiaponi Farms Ltd. The proposed abstraction will occur from an existing intake gallery, and as such should not cause any adverse effects on the Waipaoa River.

Localised Effects in the Vicinity of the Injection Bore

6.3.14 The Applicant proposes to drill an initial pilot bore, to determine the thickness and permeability of the Makauri Aquifer. If suitable conditions are found then a larger diameter injection bore will be drilled. If suitable conditions are not found by the initial pilot bore then a second pilot bore will be drilled at a different location and, if suitable conditions are found, the injection bore will be drilled at that second location. All bores will be located within the Kaiaponi Farms Ltd property.

6.3.15 The drilling of the bores will cause some localised disruption as part of the drilling process and there will be requirements for additional pipework, filters, water treatment and monitoring equipment to conduct the trial.

6.3.16 There are also risks that arise during the trial itself in relation to:

- Failure of the injection bore, which could become clogged with sediment or chemical precipitate (discussed below) or experience seepage of injection water up the outside of the bore casing;
- localised clogging of the aquifer immediately adjacent to the injection bore due to sediment build up or chemical precipitate.

6.3.17 All these effects would primarily impact on the Kaiaponi Farms Ltd property. Kaiaponi Farms Ltd have lodged a submission in support of this application which was presented by their General Manager, Mr Scott Wilson. We questioned Mr Wilson about the potential for these localised adverse effects to occur. He acknowledged that there were risks but has no problem with that and he expects the trial will be well managed so as to minimise those risks. He is happy to make his property available for the trial and his greater concern is about the future uncertainty for water supplies if measures such as MAR are not properly considered.

6.3.18 On the basis of Mr Wilson's statement we have not considered Kaiaponi Farms Ltd to be an adversely affected party and therefore the potential for localised adverse effects at the injection site becomes a smaller consideration for us.

More Widespread Groundwater Effects that Could Impact on Neighbouring Groundwater Users

6.3.19 We recognise the intended benefits of the trial to put extra recharge water into the Makauri Aquifer and raise groundwater levels. But the trial could also cause potential adverse effects for some groundwater users. The main effects that have been described to us are:

- If the trial causes groundwater pressures to rise too much in some neighbouring bores they could cause localised flooding problems if groundwater spilled out the top of unsealed bore casings;
- Changes in the groundwater chemistry within the Makauri Aquifer due to the injection of the Waipaoa River water.

6.3.20 The groundwater in the Makauri Aquifer tends to have a low oxygen content whereas the recharge water for the trial is well oxygenated. This mixing of water

with different oxidation states can cause chemicals dissolved in the groundwater (most notably iron) to from a gelatinous precipitate that would clog the aquifer and reduce the productiveness of bores. Some of the submitter's who spoke to us described the orange staining of tanks or build up of chemical precipitates on irrigation nozzles which is a surface expression of this effect when the groundwater is exposed to oxygen in the atmosphere. Clearly if that process happens underground, due to the introduction of the oxygenated Waipaoa River water, it could adversely affect the aquifer and reduce its productivity for existing and future users.

6.3.21 The Applicant has undertaken geochemical modelling which identifies that iron precipitation can be expected to occur but the amount of chemical clogging will be very low such that no adverse effects should occur. Whilst that theoretical modelling is helpful, we recognise that the natural aquifer conditions can be highly variable and the effect may not be as simple and straightforward as the model predicts.

6.3.22 The Applicant also suggests that if a precipitation problem arose they would endeavour to recover the affected water by pumping it out from the injection bore. Whilst that is one remedial option we question how effective it would be as the groundwater affected by iron precipitate would not move easily through the aquifer.

6.3.23 The Waipaoa River water also has an elevated bacteria content which could migrate through the aquifer. Whilst the aquifer is not used for drinking water, due to the availability of the GDC reticulated supply throughout the area, irrigation of some sensitive crops for human consumption could cause an adverse effect for those groundwater users. For that reason the trial proposes to chlorinate the reinjection water for part of the trial period to determine whether that might be a long term requirement for any MAR scheme that might eventuate.

6.3.24 So whilst there are uncertainties we recognise that the purpose, and value, of the trial is to investigate these situations before considering whether to commit to a larger scale MAR activity.

6.3.25 The limited nature of the trial approach lessens the significance of these potential adverse effects and in our view can be controlled by appropriate conditions, including:

- Limiting the trial to an initial discharge of 10,000m^3, followed by a pause to review the results, before commencing a longer term trial which itself would be limited to a discharge volume of 100,000m^3;
- Monitoring of groundwater quality throughout the trial;
- Stopping the trial if early warning signs of adverse water quality or water pressure effects occur.

6.3.26 With these measures in place we expect that the trial can proceed without causing an unacceptable level of risk to or adverse effects on, the groundwater resource.

6.4 Cultural Effects

6.4.1 The Applicant identified three iwi with a close relationship with the Waipaoa River and the application site(s). These iwi are (in no particular order); Rongowhakaata, Te Aitanga a Mahaki and Ngai Tamanuhiri.

6.4.2 Rongowhakaata and Ngai Tamanuhiri have statutory acknowledgements for the Waipaoa River. These Statutory Acknowledgements affirm the close associations of the Iwi with the Waipaoa River.

6.4.3 The Gisborne District Council contracted Te Runanga o Turanganui a Kiwa to prepare a cultural impact assessment. Te Runanganui o Turanganui a Kiwa represents the interests of Rongowhakaata, Ngai Tamanuhiri and Te Aitanga a Mahaki. It is understood that the iwi represented were involved in the preparation of the cultural impact assessment. The assessment was completed in September 2015. Representatives of Ngai Tamamanuhiri and Te Aitanga a Mahaki did not make submissions to the application and did not attend the hearings.

6.4.4 The assessment provided conditional support to the trial. The conditions of support included;

a) a mauri compass tool being utilised in the assessment and monitoring of the mauri of waterways affected by the trial; and
b) that other options for aquifer replenishment and management be investigated.

6.4.5 The cultural impact assessment provided a stocktake of iwi views on freshwater, copies of the statutory acknowledgements, the consultation process and details of a mauri compass monitoring framework.

6.4.6 We did not cite any traditions relating to the aquifer or surface expressions of the aquifer (waipuna) and it was unclear as to the scale of cultural effects and whether any measures other than those identified in the conditions above, would be appropriate to avoid, mitigate and remedy these effects.

6.4.7 The Rongowhakaata Iwi Trust advised us at the hearing that they did not support the findings of the cultural impact assessment. Rongowhakaata believed that the final cultural impact assessment did not reflect their views and the monitoring recommended was not appropriate. Rongowhakaata Iwi Trust have recommended that a peer review be conducted of the cultural impact assessment and that the review identify an appropriate methodology for cultural impact assessments in the future. We concur with this approach as a means to address their concern.

6.4.8 Rongowhakaata Iwi Trust identified previous monitoring work that had been conducted by them and believe that work would be a basis for investigating and identifying appropriate indicators and monitoring methodologies for the trial.

6.4.9 We record that the peer review was not available before we closed the hearing, but we were made aware at the hearing, that the process of appointing a peer reviewer was underway.

6.4.10 In general terms, we find that undertaking a trial appears to be an appropriate next step to follow-on from the technical evaluations and consultation that has occurred. We say this in the context of a working relationship between the Council and Rongowhakaata and other Iwi. It is our understanding that this mutual relationship will facilitate the identification of appropriate indicators and a monitoring/reporting programme that will acknowledge and respect Rongowhakaata and other Iwi kaitiaki responsibilities and inform the trial assessments. We reiterate that our considerations do not indicate any views as to whether or not MAR is an

appropriate water management tool for this area. That issue is outside our scope of reference and we are only considering the effects of this limited trial.

6.4.11 The cultural effects identified by Rongowhakaata Iwi Trust were:

- The recharge was not a natural process both in nature and time
- Effects on mana, whakapapa, tapu and mauri

6.4.12 We look at each of these effects.

Natural processes

6.4.13 It was suggested to the panel by Rongowhakaata Iwi Trust that the trial is man-made and the injection will be immediate and this is at odds with the natural percolation of water over many years from upstream sources through the ground and into reservoirs deep below the surface. This natural order of things is a tikanga, a proper way of things from a Maori perspective. To breach a tikanga may cause a 'hara' or calamity. As such the Iwi take a precautionary approach.

6.4.14 We agree that the trial is man-made, and that injection will be immediate. We also find that this is a trial and the effects of the trial locally will be able to be assessed at various stages.

Effects on mana, whakapapa, tapu and mauri

6.4.15 As mentioned above it was unclear to us from the cultural impact assessment what the scale of the effects on matters such as mana, whakapapa, tapu and mauri would be in the trial. Certainly, Rongowhakaata Iwi Trust in their submission confirmed that they were unsure of the scale of effects, thus they were taking a precautionary approach.

6.4.16 We understand the mana or prestige of the Iwi is inter-connected with the water quality of the Waipaoa and its resources.

6.4.17 We also understand and acknowledge Rongowhakaata's and other iwi ancestral connections to the Waipaoa River, its surrounds through events, activities and particular ancestors.

6.4.18 We acknowledge that there will be mixing of waters from the Waipaoa and water in the aquifer. As mentioned earlier, there will be potential effects or changes in the water such as clogging. These effects are understood to be localised during the duration of the trial.

6.4.19 We do not discount the potential effects on mana, whakapapa, tapu and mauri, however, the limited nature of the trial in scale, extent and timing lessens the significance of these potential adverse effects. It is our view that the potential for adverse effects can be controlled by appropriate conditions. Furthermore, the willingness of the parties to use the trial to identify appropriate indicator(s) for mauri, tapu, mana or other values is a helpful component of the trial process that assists in addressing iwi concerns. To ensure this opportunity is realised we support the inclusion of the following condition agreed by parties at the hearing:

> *Within four weeks of granting the consent, the consent holder shall commence a collaborative process with mana whenua that will ensure mana*

whenua input into decisions regarding the design, implementation and evaluation of the monitoring programme for the trial. The monitoring and evaluation programme shall include the development and implementation of a process for monitoring and assessing the cultural health of the Makauri Aquifer and Waipaoa River.

6.5 Section 104

6.5.1 This application is considered as a discretionary activity under Part 2 and sections 104 and 104B, of the RMA.

6.6 Section 104B of the RMA

6.6.1 As a discretionary activity, the application must be considered against the requirements of Section 104B, which states that:

> *After considering an application for a discretionary activity or non-complying activity, a consent authority –*
>
> - *May grant or refuse the application; and*
> - *If it grants the application, may impose conditions under section 108."*

6.7 Section 104(1)(b)

6.7.1 Under section 104(1)(b) of the RMA we must have regard to any relevant provisions of:

> *(i) a national environmental standard:*
> *(ii) other regulations:*
> *(iii) a national policy statement:*
> *(iv) a New Zealand coastal policy statement:*
> *(v) a regional policy statement or proposed regional policy statement:*
> *(vi) a plan or proposed plan, and*
>
> *(c) any other matter the consent authority considers relevant and reasonably necessary to determine the application.*

6.7.2 We record that the relevant RMA instruments requiring our consideration in this case are the:

(a) National Policy Statement Freshwater Management 2014 (NPS-FM);

(b) Gisborne District Regional Policy Statement (RPS) as part of the Proposed Gisborne Regional Freshwater Plan

(c) Operative Gisborne District Regional Policy Statement (2002);

(d) Transitional Regional Plan for the Gisborne District

(e) Proposed Gisborne Regional Freshwater Plan

(f) Proposed Regional Plan for Discharges to Land and Water, Waste Management and Hazardous Substances

(g) Resource Management (Measuring and Reporting of Water Takes) Regulations 2010. I also consider the Resource Management (Measuring and Reporting of Water Takes) Regulations 2010 (Other Regulations)

(h) Australian Guidelines for Water Recycling – Managed Aquifer Recharge Document No. 24 (July 2009) (Other Matters)

(i) the Hapu/Iwi Management Plan of Nga Ariki Kaiputahi

6.7.3 These instruments and the relevant objectives and policies are identified in the application[11], with the exception of the Operative Gisborne District Regional Policy Statement, the Resource Management (Measuring and Reporting of Water Takes) Regulations 2010, Australian Guidelines for Water Recycling – Managed Aquifer Recharge Document No. 24 (July 2009) (Other Matters) and the Hapu/Iwi Management Plan of Nga Ariki Kaiputahi, which were identified by the section 42A Officer. We concur with the section 42A officer, in the identification of those additional instruments.

6.7.4 We record that the section 42A officer adopted the information and conclusions of the assessment of the relevant instruments identified in the application[12] and also provided an independent assessment of the additional instruments identified. In summary, Ms Cranswick's view was that the proposal is consistent with objectives and policies in the relevant instruments. We heard no evidence to the contrary and hence adopt that assessment.

7 Statutory Considerations

7.1 Section 105 RMA

7.1.1 Section 105 states **that:**

(1) If an application is for a discharge permit or coastal permit to do something that would contravene section 15 or section 15B, the consent authority must, in addition to the matters in section 104 (1), have regard to –

(a) the nature of the discharge and the sensitivity of the receiving environment to adverse effects; and

(b) the applicant's reasons for the proposed choice; and

(c) any possible alternative methods of discharge, including discharge into any other receiving environment.

7.1.2 With regard to S105(a), for this application the nature of the discharge is a trial discharge of high flow water from the Waipaoa River into the Makauri Aquifer, which is experiencing low groundwater levels due to the effect of numerous abstractions. The sensitivity of the receiving groundwater relates to its use for abstractive purposes for productive land use, including a number of high value, sensitive crops. The aquifer is also sensitive to a potential change in groundwater quality caused by the chemistry of the discharge water, which may oxygenate the groundwater and lead to the precipitation of iron which may decrease the permeability of the aquifer and which may also lead to the introduction of microbiological contaminants. The Applicant recognises these issues and proposes to put in place monitoring and review measures to avoid adverse effects that will impact on other users, whilst still providing sufficient experience from the MAR trial to determine the future capability of it as a water resource management tool for the Makauri Aquifer.

[11] Application, Section 4.1.1 – 4.1.5, Pages 11 - 14
[12] Section 42A Report, Section 8, Page 22

7.1.3 With regard to S105(b), the Applicant has undertaken considerable technical evaluations and consultation with water users to determine the trial process. They have chosen a trial design that utilises an existing river infiltration gallery at times when the river is not widely used by other abstractors and is well above a low flow situation. The location of the trial injection site is efficient in terms of the delivery of water and the location of bores to monitor the effects arising from the trial.

7.1.4 With regard to S105(c) the application recognises that the target aquifer is the Makauri Aquifer which is widely used and currently experiencing declining groundwater levels. Consequently there is no alternative to the aquifer into which the discharge can occur. Due to the depth of the aquifer and low permeability overlying strata the use of surface infiltration systems will not provide an effective alternative recharge mechanism into the aquifer. Based on the evidence before us we are satisfied that the establishment of this trial has considered a range of possible options and has designed an effective trial methodology based on those considerations.

7.1.5 We also acknowledge that GDC are considering alternative water management options to address the trend of declining groundwater levels in the Makauri Aquifer. This includes significant restrictions on current abstractive use (although that would severely impact on a number of productive operations) and alternative sources of water supply via surface water storage and shallow infiltration basins. Our view is that the proposed MAR trial should make a useful contribution to that wider consideration of alternative water management options.

7.1.6 Consequently, we are satisfied that having considered the matters required by S105 that consent can be granted, subject to the conditions that we have adopted.

7.2 Section 107 RMA

7.2.1 Section 107 states that:

> (1) *Except as provided in subsection (2), a consent authority shall not grant a discharge permit or a coastal permit to do something that would otherwise contravene section 15 or section 15A allowing –*
>
> *(a) the discharge of a contaminant or water into water; or*
>
> *(b) a discharge of a contaminant onto or into land in circumstances which may result in that contaminant (or any other contaminant emanating as a result of natural processes from that contaminant) entering water; ….*
>
> *if, after reasonable mixing, the contaminant or water discharged (either by itself or in combination with the same, similar, or other contaminants or water), is likely to give rise to all or any of the following effects in the receiving waters:*
>
> *(c) the production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials:*
> *(d) any conspicuous change in the colour or visual clarity:*
> *(e) any emission of objectionable odour:*
> *(f) the rendering of fresh water unsuitable for consumption by farm animals:*
> *(g) any significant adverse effects on aquatic life.*

7.2.2 We note there is potential for the injection water to cause the formation of a reddy-brown or orange iron precipitate in the Makauri Aquifer, however because it occurs several tens of metres underground it will not be conspicuous. We assume that s107(1)(d) is referring to discharges into surface waterways due to its use of the word “conspicuous”.

7.2.3 With regard to s107(1)(f) the Applicant has advised us that the quality of water in the Makauri Aquifer is of dubious value for stock drinking water and they are not aware of any abstraction bores that use water for that purpose.

7.2.4 With those observations in mind, we are satisfied that, subject to compliance with the recommended conditions of consent, the discharge of contaminants from the treatment plant will not give rise to any of the RMA section 107(1)(c) to (g) effects in the relevant Makauri Aquifer receiving waters.

8 Part 2

8.1 Positive effects

8.1.1 In sections 6.3 and 6.4 of this decision report we discussed some of the potential adverse effects of the proposal. However, the proposal will also yield a number of positive effects which are relevant to our Part 2 assessment. We note the positive effects of the proposed activity, particularly with regard to the recharge of the aquifer, which were outlined in the submissions and evidence of a number of parties including LeaderBrand Produce Ltd, Kaiaponi Farms Ltd, Roberts Farming Ltd, Eastern Bay Orchards and Harpers Gold Ltd and Horticulture NZ.

8.1.2 We find that the positive effects of the proposal provide some weight in favour of the applications being granted, particularly as the actual and potential effects of the activities are either less than minor, or can be avoided, remedied or mitigated by way of imposed consent conditions.

8.2 Part 2

8.2.1 This application is to be considered under section 104 of the RMA, which sets out the matters that consent authorities shall have regard to when considering resource consent applications, subject to Part II of the RMA, as discussed above.

8.2.2 In coming to an overall broad judgement as to whether the proposal is likely to promote the sustainable management of natural and physical resources, as defined in section 5 of the RMA, we have carefully considered the evidence presented.

8.2.3 With respect to the seven Section 6 RMA matters of national importance which must be recognised and provided for in decisions, we accept the advice of Ms. Cranswick, namely, "… that proposed activities are an appropriate use of the resource…"[13] and that *"… [P]public access will not be affected by the proposed activities".*[14]

8.2.4 In terms of section 6(e), we find that the cultural concerns of Rongowhakaata have been recognised and provided for as set out in our consideration of cultural effects in section 6.4 above.

8.2.5 With respect to the eleven Section 7 RMA Other matters to which decision makers must have particular regard, the application identifies that, *"… sub-clauses (b), (c), (d), (f), (g) and (i) are relevant."*[15] As set out in section 6.4 of this decision it is our view that section 6 (a) Kaitiakitanga is also a relevant consideration. We find that

[13] Section 42A Report, Page 22, Para 9
[14] Section 42A Report, Page 22, Para 9 and Page 23 Para 1
[15] Application Volume 1, Page 31, Section 4.3.3

these matters have been appropriately considered and where relevant incorporated into the conditions of consent.

8.2.6 With respect to Section 8 Principles of the Treaty of Waitangi, we find that Rongowhakaata have a special interest in the Makauri Aquifer that should be recognised and again that this has been set out in our consideration of cultural effects in section 6.4 above.

8.2.7 The final task for decision makers is to make an overall broad judgement of the application in light of the purpose of the RMA, as stated in section 5.

8.2.8 Section 5 Purpose states:

> *(1) The purpose of this Act is to promote the sustainable management of natural and physical resources.*
> *(2) In this Act, ``sustainable management'' means managing the use, development and protection of natural and physical resources in way, or at a rate, which enables people and communities to provide for their social, economic and cultural wellbeing and for their health and safety while –*
> *(a) Sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and*
> *(b) Safeguarding the life – supporting capacity of air, water, soil, and ecosystems; and*
> *(c) Avoiding, remedying, or mitigating any adverse effects of activities on the environment."*

8.2.9 The RMA requires applicants to demonstrate that their activities promote the sustainable management of natural and physical resources, and that provided the adverse effects generated by such activities fall within "acceptable" bounds – either through being avoided, remedied or mitigated – their activities are enabled.

8.2.10 As discussed within the body of this Decision and based on the evidence heard and the submissions received, we are satisfied that the proposed activity will not result in such significant adverse effects that these are unable to be dealt with by way of appropriate mitigation and conditions.

8.2.11 We record that additional reasons relevant to particular potential adverse effects are set out in sections 6.3 and 6.4 of this decision.

8.2.12 We are also satisfied that the application for the activity either gives effect to or is consistent with the relevant national and regional planning documents when read as a whole. Furthermore, and having considered all relevant requirements, we find that the purpose of the RMA is likely to be better served by granting this application with appropriate conditions than by declining it.

9 Conditions

9.1 The Applicant proposes to prepare a management plan to address drilling, water injection and monitoring.

9.2 The preparation of a management plan/s as part of a consenting process is not unusual. However, we note that consent conditions relating to management plans

must meet certain standards and we found the conditions initially recommended to us to be inconsistent with that standard.

9.3 The management plan conditions should specify the purpose or objective of the plan, the minimum contents of the plan, how and by whom it is to be prepared, and who should be involved in that process. The conditions also specify that the management plan is to be submitted to GDC and thereafter certified. In addition there should be a process set out for reviewing or amending the plans. We asked the reporting officer to address these matters in any conditions recommended to us. This was duly provided to us in the reporting officer response to matters raised in the hearing.

9.4 In general we found that these amended conditions, which were also endorsed by the Applicant in reply; addressed the majority of our concerns. However, we have included some additional conditions to clarify who prepares the Management Plan, who certifies the Management Plan and the process by which it can be amended.

9.5 We have already addressed conditions regarding a collaborative process with mana whenua in regard to monitoring in Section 6.4 above.

10 Term

10.1 The section 42A Report records that the Applicant verbally requested a term of 5 years[16] and we understood that this position was confirmed by the Applicant at the hearing. Ms Cranswick considered a 5 year term appropriate. We heard no views to contrary and agree to that term.

Mark St.Clair (Chair)

Peter Callander

Antoine Coffin

[16] Section 42A Report – Page 26 Section 10

Appendix 1 - Consents granted by GDC to Gisborne District Council

To drill up to three Bores (LB-2016-107112-00)
Take Surface Water from the Waipaoa River (WS-2016-107114-00), and
Discharge Water to Land, and Water to Water via injection (DW-2016-107113-00))

Conditions for Resource Consent

GISBORNE DISTRICT COUNCIL

A resource consent:

a) Under section 9(2)(a) of the Resource Management Act 1991 and Rule 5.2.4 of the Proposed Gisborne Regional Freshwater Plan to undertake a restricted discretionary activity being to Install up to three Bores, take water for the purposes of pump testing and the associated discharge of drilling fluids and water to land (LB-2016-107112-00); and

b) Under section 14(2)(a) of the Resource Management Act 1991 and Rule 4.1.7 of the Proposed Gisborne Regional Freshwater Plan to undertake a restricted discretionary activity being to Take and Use Water from the Waipaoa River as a 'B' block allocation WS-2016-107114-00); and

c) Under section 15(1)(a) and (b) of the Resource Management Act 1991 and Rule 5.2.8 of the Proposed Gisborne Regional Freshwater Plan to undertake a discretionary activity being to Discharge Water to Water via Injection (DW-2016-107113-00).

subject to the following conditions:

Purpose

1. For the purpose of drilling up to 3 bores, taking water from the Waipaoa River under a B Block allocation and discharging water to water (via injection) and to land associated with the Poverty Bay Flats managed aquifer recharge pilot trial of the Makauri Aquifer.

Location

2. The activities authorised under this consent shall be located at 555 Matawai Road, Gisborne as shown on the plan entitled *Golder Associates – Injection Bore Location* dated August 2016.

Map Reference

3. At or about map references NZTM 2028441, 5714961 and NZTM 2027989, 5715196.

Legal Description

4. Injection Bore and Pilot Bores: Lot 28 DP 1154 and Lot 24 DP1154

Water Intake and Infiltration Gallery: Part sec 2 SO 8571 and Crown Owned River (Waipaoa River)

Drilling Works

5. Any works carried out in conjunction with this consent shall be in general accordance with the depth and location information supplied in support of the application.

6. During the construction of the bore, the consent holder shall ensure that recoverable drilling fluids shall be discharged to land in a manner where it shall not enter water.

7. The consent holder shall complete any maintenance works required for the bore(s) and associated equipment within 14 days as specified by notice in writing from the District Council's Consents Manager hereafter referred to as the GDC Manager.

8. All bores installed under this resource consent shall meet the requirements of schedule 12 of the Proposed Gisborne Regional Freshwater Plan.

9. A pilot bore shall be installed within 30 metres of the main injection bore. The pilot bore shall be fitted with a piezometer and monitoring equipment to inform the monitoring reports required by consent condition 35.

10. The consent holder shall collect drill cuttings from the pilot bore required by condition 9 and analyse for minerals in accordance with the recommendations contained within the resource consent application document and accompanying reports submitted 17 May 2016.

11. No injection bore authorised by this consent shall be installed within 100 metres of any other existing consented abstraction bore in the Makauri Aquifer.

Notification of Drilling Works

12. The consent holder shall email water.info@gdc.govt.nz at least 24 hours before commencing any drilling activity that is authorised by this resource consent.

Bore Detail

13. Within one month of completion of the bore installations, the consent holder shall forward to the Gisborne District Council, a detailed bore log for each bore installed and an as-built construction diagram.

14. The bore log, required under condition 13, shall, as a minimum, describe:

    (a) Location of the bore or well (including property address and NZTM Grid Reference or Global Positioning System (GPS) co-ordinates);

    (b) Bore head pressure or Depth to water level (whichever is applicable);

    (c) The purpose of the bore or well;

    (d) Records of pump test(s), detailing flow rates, drawdown at specific times, and any information analysis;

    (e) Actual bore depth and diameter;

(f) Full construction details (including final casing and screen details);

(g) A bore log showing the depths of geological strata intercepted by the bore;

(h) The temperature of the bore water; and

(i) The method of drilling.

15. The as built construction diagram, required under condition 13 shall show the final cross-sectional construction of the bore (including bore depth, casing and screen details).

Surface Water Take and Use

16. The daily quantity of water taken from Waipaoa River for the purposes of the pilot trial shall not exceed 1901 cubic metres.

17. The instantaneous rate of take from the Waipaoa River shall not exceed 22 litres per second at any time.

18. Abstraction from the Waipaoa River shall only occur when the flow at Kanakanaia and Matawhero, as measured by Gisborne District Council is greater than 4000 litres per second.

19. Abstraction from the Waipaoa River shall only occur during the period 1 May to 30 September each year for the duration of this resource consent.

20. Water shall only be used for the purpose of completing a pilot trial of injecting water into the Makauri Aquifer, or in the case of discharging water to land in accordance with the resource consent application document.

21. The total volume of water abstracted from the Waipaoa River under this consent shall not exceed 110,000 cubic metres, being 10,000 cubic metres for a pre-trial injection and 100,000 cubic metres for the injection trial.

22. Surface water abstraction shall only occur from the infiltration gallery as detailed in the application for this consent.

23. Should adverse effects in the Waipaoa River or Makauri Aquifer be identified, then the injection or taking of water by this permit shall only occur as specifically authorised by the GDC Manager.

Water Use Monitoring

24. The consent holder shall install a water meter on each pump head/intake prior to the exercise of this consent. The water meter/s shall:

(a) meet the Resource Management (Measuring and Reporting of Water Takes) Regulations 2010;

(b) be installed and maintained in accordance with manufacturer's specifications, and to the satisfaction of the Gisborne District Council;

(c) be installed at a location that will ensure the entire water take is measured;

(d) be sealed and as tamper-proof as practicable;

(e) be suited to the qualities of the water it is measuring (such as temperature, algae content and sediment content);

(f) be able to be fitted with a recording device; and

(g) be able to measure both cumulative water abstraction and the instantaneous rate of take to an accuracy of ± 5%.

25. The water meter shall be verified by a suitably qualified operator within two months of the exercise of this resource consent. Within one month of verification being undertaken, the consent holder shall provide appropriate evidence of verification to the Gisborne District Council.

26. All practicable measures shall be taken to ensure that the water meter and recording device are fully functional at all times. All malfunctions of the water meter shall be reported to the Gisborne District Council within 24 hours of observation and appropriate repairs undertaken as soon as practicable following observation of malfunction.

27. The consent holder shall keep a daily record of the following information:

(a) Hours pumped;

(b) Abstraction rate (litres per second);

(c) Quantity of water taken from the Waipaoa River (cubic metres per day); and

(d) If no water is taken, the volume shall show zero (0) cubic metres.

Such records shall be available for inspection by Gisborne District Council staff.

28. The consent holder shall ensure that no later than 31 July of every year for the duration of the consent that the Gisborne District Council has been sent a complete record of all criteria required by condition 27 for the period between 1 July and 30 June of the preceding year.

Discharge of Water to Makauri Aquifer

29. The rate of water injected into the Makauri Aquifer shall not exceed 22 litres per second and the total volume of water injected under this consent shall not exceed 110,000 cubic metres, being 10,000 cubic metres for a pre-trial injection and 100,000 cubic metres for the injection trial.

30. The injection of water into the Makauri Aquifer and associated controls and monitoring shall be undertaken in general accordance with the Australian Guidelines for Water Recycling – Managed Aquifer Recharge document number 24 (July 2009).

31. Water shall only be injected into the Makauri Aquifer via the injection bore authorised under this consent.

32. The consent holder shall install a suitable filter/s inline before injection water enters the Makauri aquifer to treat water prior to injection.

33. No water shall be discharged into the Makauri Aquifer if the following discharge limits have been exceeded:

(a) A concentration of E.coli of 100 cfu/100ml; and

(b) Turbidity of 100 NTU; or

(c) Any amended limit(s) adjusted with the approval of an independent and suitably qualified and experienced professional and certified by the GDC Manager.

34. Prior to seeking certification of any amended limits, the consent holder shall seek input from mana whenua. The consent holder shall advise, in writing, the Council of any advice received from mana whenua and how that advice has been incorporated into decision making.

Pilot Trial Monitoring and Reporting

35. The consent holder must undertake the activity in general accordance with the application and accompanying reports submitted 17th May 2016 to the Bay of Plenty Regional Council except to the extent that these are required to be modified to comply with the conditions of this permit.

36. The consent holder shall, 20 working days prior to any drilling occurring under this consent, lodge a Management Plan with the GDC Manager. The Consent Holder shall not commence works authorised by this consent until the Management Plan has been certified in writing by the GDC Manager acting in a technical certification capacity. The Management Plan shall be peer reviewed by an independent and suitably qualified professional that is experienced in reviewing such a management plan. The objectives of the Management Plan for Poverty Bay MAR Trial are to provide guidance for the construction, operation, monitoring and mitigation of the injection bore and flow system. This management plan shall incorporate methods and monitoring as per the resource consent application and shall include, but not be limited to:

(a) Drilling plan: including as built design, location, water volume metering, Method of drilling, Grouting and sealing, pump testing, observation bore design, rock sampling and aquifer testing. The drilling plan shall comply with schedule 12 of the Proposed Gisborne District Council's Regional Freshwater Plan. The Drilling and Aquifer Testing Plan will guide the injection construction bore requirements and aquifer testing;

(b) Water injection plan: including methods used, rates, volumes of water to be injected and levels of treatment, monitoring and recording of rates and volumes and water quality on a regular basis (continuous where possible) including suspended sediment, bacterial contaminants and clogging, go/no go decisions and trial closure. The Water Injection Plan will outline the site operational plan, management of source water quality parameters, specifically suspended sediment, bacterial contaminants and management of clogging and any borehead overflow issues;

(c) Pilot trial monitoring plan: including a wider district wide monitoring plan that shall report on water quality and hydraulic water level responses for a period not less than three months following the completion of injection. The Monitoring and Mitigation Plan will outline the position of groundwater level and quality monitoring sites, disinfection by-product management and objectives of each monitoring site and schedule of automated and manual monitoring at each site and detail parameters to be measured. The plan will contain alert and trigger levels in terms of water quality and water level responses, so as to ensure early

intervention occurs to avoid the occurrence of effects that adversely impact on the land use activities of any neighbouring land owners.

At all times the consent holder must comply with the certified Management Plan.

37. Post bore installation, and prior to any discharge/injection of surface water into the Makauri Aquifer, the Management Plan referred to in condition 35 shall be updated and re-certified in writing by the GDC Manager.

38. Following the pre-injection trial of 10,000 m^3 the consent holder shall provide a report to the GDC Manager on the performance of this preliminary trial, with particular reference to the water quality and water quantity effects that arose. Any updates to the Management Plan referred to in condition 35 that are required based on the results of the preliminary trial shall be made and re-certified in writing by the GDC Manager. The commencement of the main trial shall not commence until this reporting and potential re-certification (if required) has been completed.

39. By 31 December of each year when the injection trial has been undertaken the consent holder shall prepare a report describing the trial activities that have taken place, the monitoring data obtained and any trial activities planned for the upcoming year. This report shall be provided to the GDC Manager and the Community Liaison Group.

40. Within four weeks of granting the consent, the consent holder shall commence a collaborative process with mana whenua that will ensure mana whenua input into decisions regarding the design, implementation and evaluation of the monitoring programme for the trial. The monitoring and evaluation programme shall include the development and implementation of a process for monitoring and assessing the cultural health of the Makauri Aquifer and Waipaoa River.

41. A minimum of three (3) sets of water quality monitoring samples shall be taken from bores that are identified in the resource consent application document as pre-injection sample bores. The timing shall be determined in the Management Plan required by condition 35.

42. A copy of these consent conditions and the certified Management Plan shall be held on site and accessible for all staff and contractors.

43. Within three months of completing the post-trial monitoring, the consent holder shall convene a workshop to consider methods for assessing changes in cultural health of waterbodies potentially affected by the Managed Aquifer Recharge injection trial. Following the workshop, and within one month, the consent holder shall provide a report to the Community Liaison Group, providing recommendations for monitoring the cultural health of waterbodies should a more comprehensive Managed Aquifer Replenishment programme be promoted or instigated by the consent holder.

44. The consent holder shall be responsible for all person(s) and contracted operations related to the exercise of this consent/permit and ensure that all persons on site are aware of the conditions of consent and ensure compliance with the permit/consent conditions.

Liaison Groups

45. The consent holder shall establish a Community Liaison Group (CLG) to provide an ongoing point of contact between the consent holder and the community in relation to the

operation and monitoring of the injection trial. The consent holder shall send invitations for the first meeting of the CLG within four weeks of the commencement of this consent.

46. The consent holder shall invite members of the stakeholder reference group established during the consultation period of developing the proposal and application for the injection trial. At the time of this invitation the consent holder shall ask such persons whether they wish to receive further invitations to CLG meetings.

47. If a positive response is received (whether by mail, email, telephone message or in person), that person shall be invited to CLG meetings until the consent holder is advised that such invitations are no longer desired. The consent holder may also invite any other representative(s) of local tangata whenua, the Consent Authority, and/or any other person who may be able to provide assistance, to attend CLG meetings.

Review of Consent Conditions

48. The Gisborne District Council may serve notice on the permit holder of its intention to review the conditions of this resource consent in accordance with section 128 of the Resource Management Act 1991. Such a review will be within one month after the first anniversary of the commencement of this resource consent, or at monthly intervals during the works and thereafter within one month after each subsequent anniversary, for the following reasons:

    (a) to require the consent holder to adopt the best practicable option to remove or reduce any adverse effects on the environment; or

    (b) to deal with any other adverse effects on the environment on which the exercise of this permit may have an influence; or

    (c) to review the appropriateness of consent conditions if there are changes to relevant national standards, regulations or guidelines, or the Council's relevant regional and district level plans. Should any adverse effects be identified in the exercising of this consent, further activity shall only occur as specifically authorised by the GDC Manager.

Resource Management Charges

49. The consent holder shall pay to the Gisborne District Council any administration, inspection or monitoring charges payable in respect of this resource consent. Any such charges shall be either fixed or additional charges set in accordance with section 36 of the Resource Management Act 1991 and section 150 of the Local Government Act 2002.

Term of Consent

50. This consent shall expire on 14 November 2021.

The Resource Consent hereby authorised is granted under the Resource Management Act 1991 by the consent authority subject to its servants and agents being permitted access to the relevant parts of the site at all times for the purpose of carrying out inspections, surveys, investigations, tests, measurements or taking samples and does not constitute an authority under any other Act, Regulation or Bylaw.

Advice Notes:

1. *This consent does not authorise the holder to modify or disturb any archaeological or listed historic sites within the area affected by this consent. Should any artefacts, bones or any other sites of archaeological significance be discovered within the area affected by this operation, written authorisation should be obtained from Heritage New Zealand before any damage, modification or destruction is undertaken.*

2. *The consent holder is advised that non-compliance with consent conditions may result in enforcement action against the consent holder and/or their contractor(s).*

APPENDIX B

Aquifer parameter analysis for MAR site based on winter 2017 trial data

Introduction

Groundwater levels near the MAR injection well (GPE066) will respond as a result of the injection of water into the Makauri Aquifer. The response is determined by the injection flow rate and by the transmissivity and storativity of the Makauri Aquifer as well as the leakage from overlying and underlying aquifers.

The groundwater level data of the main injection trial has been reviewed and analysed to estimate these aquifer parameters and confirm previous assumptions and aquifer characteristics.

Groundwater Level and Injection Rate Monitoring

Groundwater levels have been monitored in 13 Makauri Aquifer screened wells in the general area near the MAR injection well (GPE066) as listed in Table 1. The location of the wells is shown in (Figure 1). Injection flows have been recorded every 15 minutes with a calibrated automatic flow meter that is installed in the well headworks (Figure 2). Automatic water level loggers, which also record temperature, are installed in the MAR injection wells and the 4 nearest Makauri Aquifer wells (Table 1) and record every 15 minutes.

Table 1: Makauri Aquifer groundwater level monitoring wells.

Makauri Aquifer (distance from injection well)	NZTMX	NZTMY	Depth (m)	Water level monitoring - type and frequency
GPE066 (injection well)2)	2028438	5714964	72.0	Manual: fortnightly Automatic: every 15 min
GPE065 (21 m)	2028454	5714952	72.6	Manual: fortnightly Automatic: every 15 min
GPE010 (190 m)	2028282	5714854	73.8	Manual: fortnightly Automatic: every 15 min
GPE030 (364 m)	2028501	5715323	68.0	Manual: fortnightly Automatic: every 15 min
GPF159 (864 m)	2029259	5715232	83.0	Manual: fortnightly
GPF105 (1205 m)	2029570	5714552	71.0	Manual: fortnightly Automatic: every 15 min
GPD096 (1422 m)	2029123	5713718	81.4	Manual: fortnightly
GPD115 (1576 m)	2028056	5713435	75.1	Manual: fortnightly
GPF074 (1630 m)	2029571	5716137	79.2	Manual: fortnightly
GPD147 (2099 m)	2029020	5712947	114.0	Manual: fortnightly
GPD116 (2225 m)	2029842	5713237	76.2	Manual: fortnightly
GPJ040 (2745 m)	2027527	5712374	80.0	Manual: fortnightly

The groundwater level response to the MAR injection trialling is clearly visible in Makauri aquifer monitoring wells GPE065 (the MAR monitoring well), GPE010 and GPE030 as shown in Figure 3. Groundwater levels rise by approximately 1.3 m in GPE065 (at 21 m distance), by 1.2 m in GPE010 (at 190 m distance) and by 0.9 m in GPE030 (at 364 m distance). After injection ceases, groundwater levels decline again by a similar amount as the mounding caused by injection.

Figure 1: Overview map Makauri Aquifer monitoring wells.

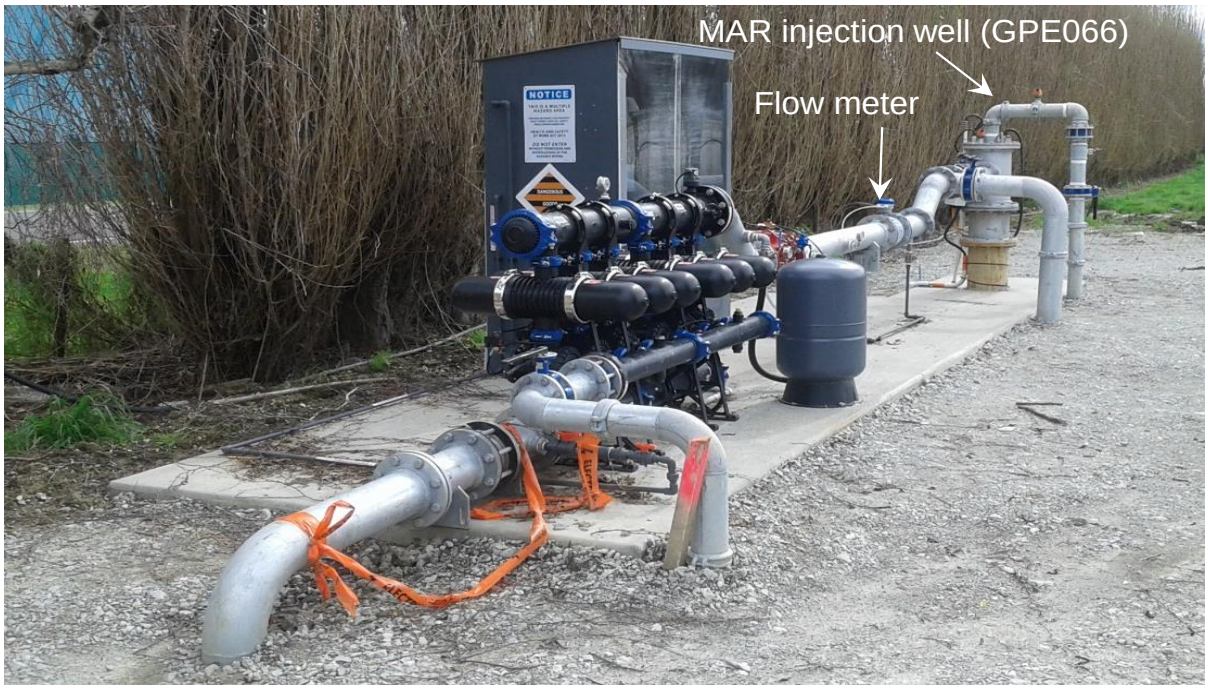


Figure 2: MAR injection well (GPE066) and headworks.

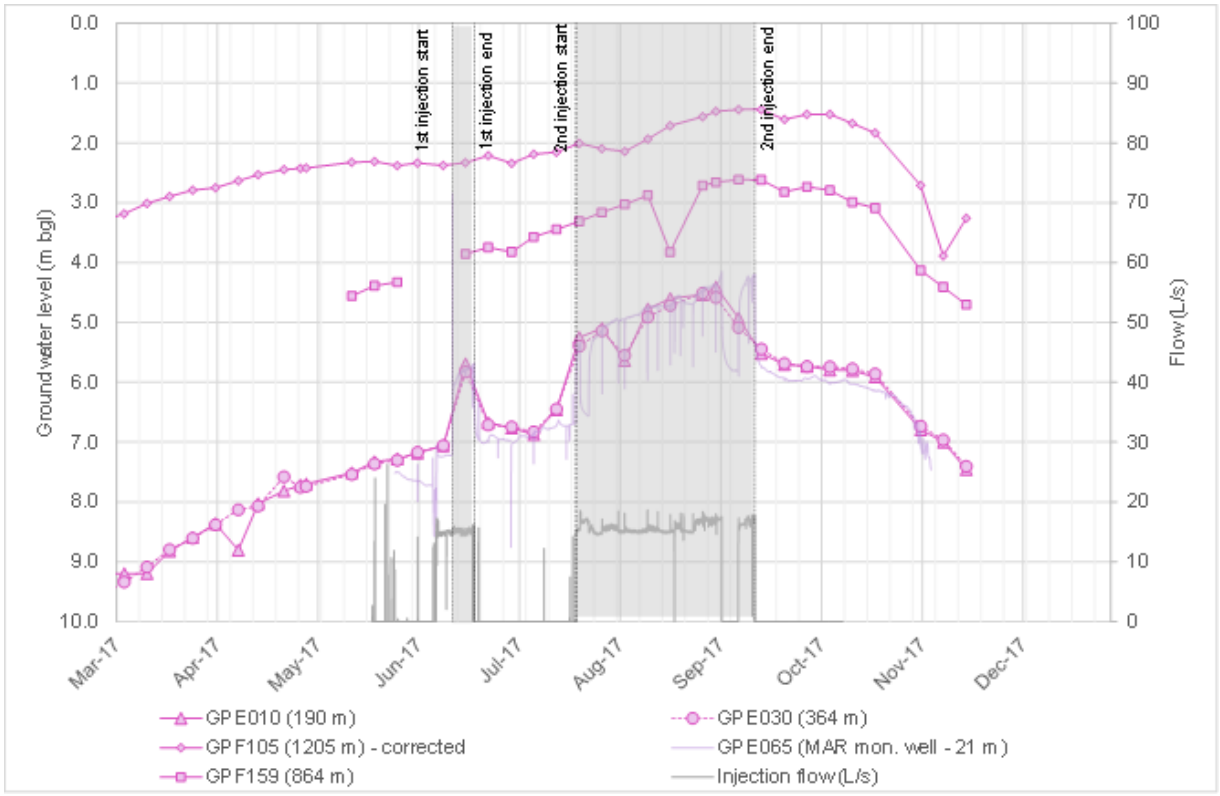


Figure 3: Groundwater level fluctuations in Makauri (injection) aquifer in 2017 injection trial period near injection well.

At greater distance from the injection well, there appears to be a groundwater level rise response of less than 0.2 m in GPF105 and GPE096 (Figure 3 and Figure 4). However, the ongoing background trend associated with the winter recharge obscures the response to the injection trialling.

There does not appear to be any response in nearby monitoring wells screened in the Shallow Fluvial Aquifer (Figure 5).

The winter recharge of the Makauri Aquifer causes a steady increase in Makauri Aquifer water levels during the injection trial and this has obscured the response from the injection. This background trend has been analysed for several of the monitoring wells surrounding the MAR injection well (GPE066), in which the influence of the injection trialling was not observed (Figure 6). The recharge induced background trend appears to be approximately 0.013 m per day during the injection trial period.

In wells or piezometers tapping confined and leaky aquifers, the water levels are continuously changing as the atmospheric pressure changes. When the atmospheric pressure decreases, the water levels rise in compensation, and vice versa (Kruseman and De Ridder 2000). This is referred to as the Barometric Efficiency (BE) effect, which has also been investigated for the groundwater level responses of the injection trialling. No significant changes in atmospheric pressure occurred that have had a notable impact on the recorded groundwater responses to the injection trialling. Furthermore, analysis of the BE effect for the groundwater level fluctuations recorded in GPE065 may have only been 10 % and not significant enough to warrant data correction.

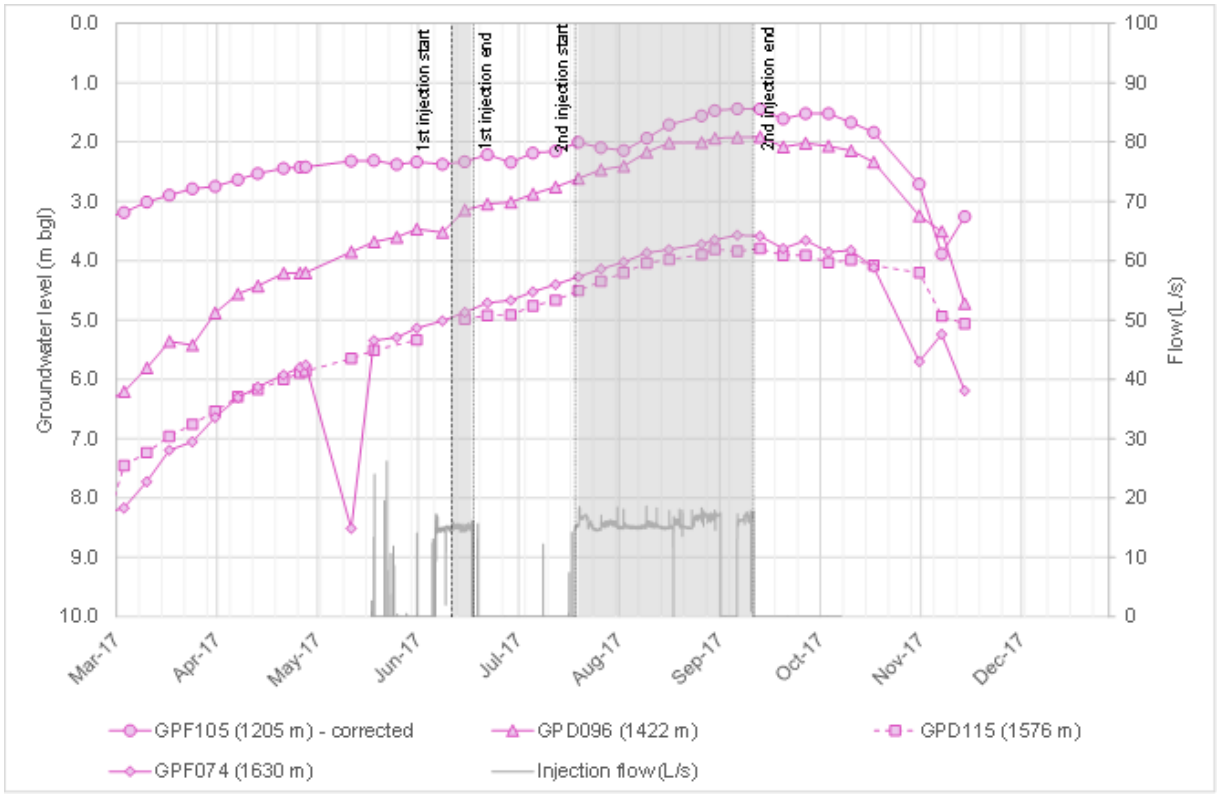


Figure 4: Groundwater level fluctuations in Makauri (injection) aquifer in 2017 trial at 1200 - 1600 m distance from injection well.

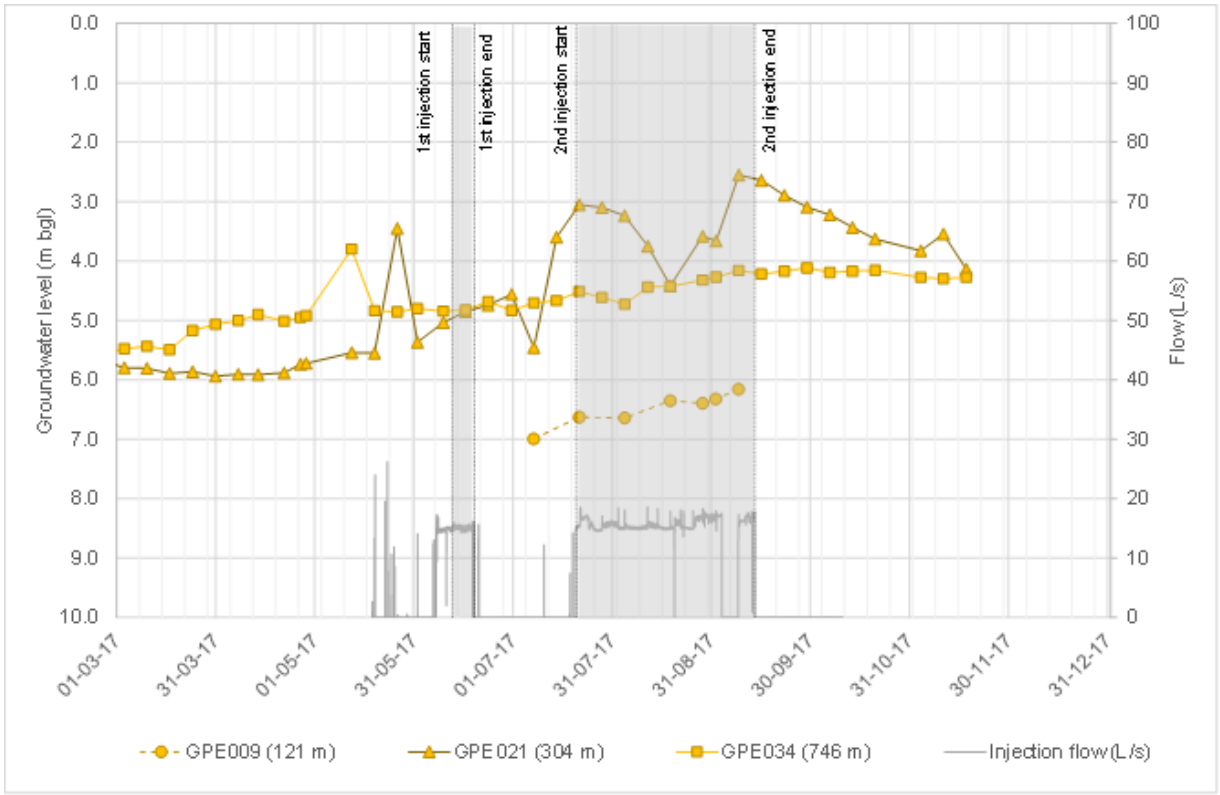


Figure 5: Groundwater level fluctuations in Shallow Fluvial Aquifer in 2017 injection trial period.

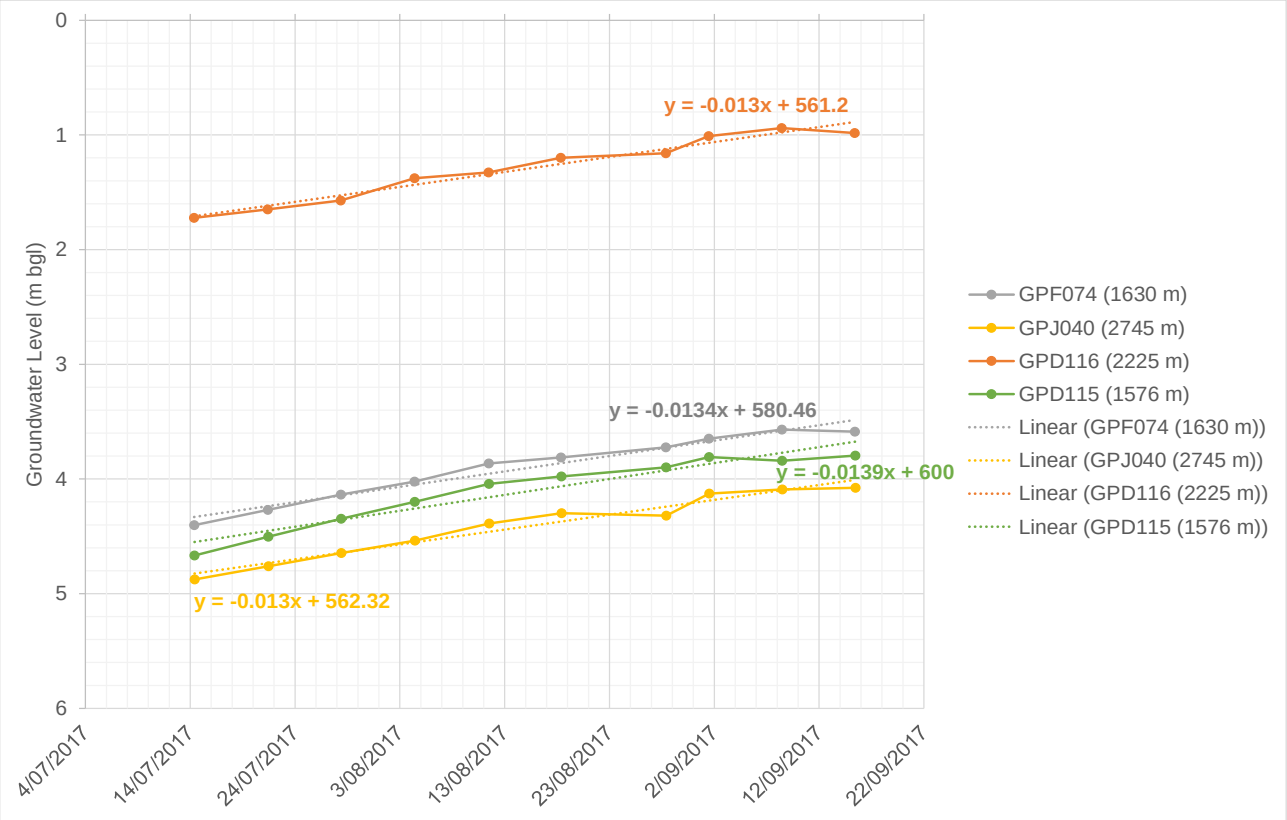


Figure 6: Recharge induced groundwater level background tend analysis.

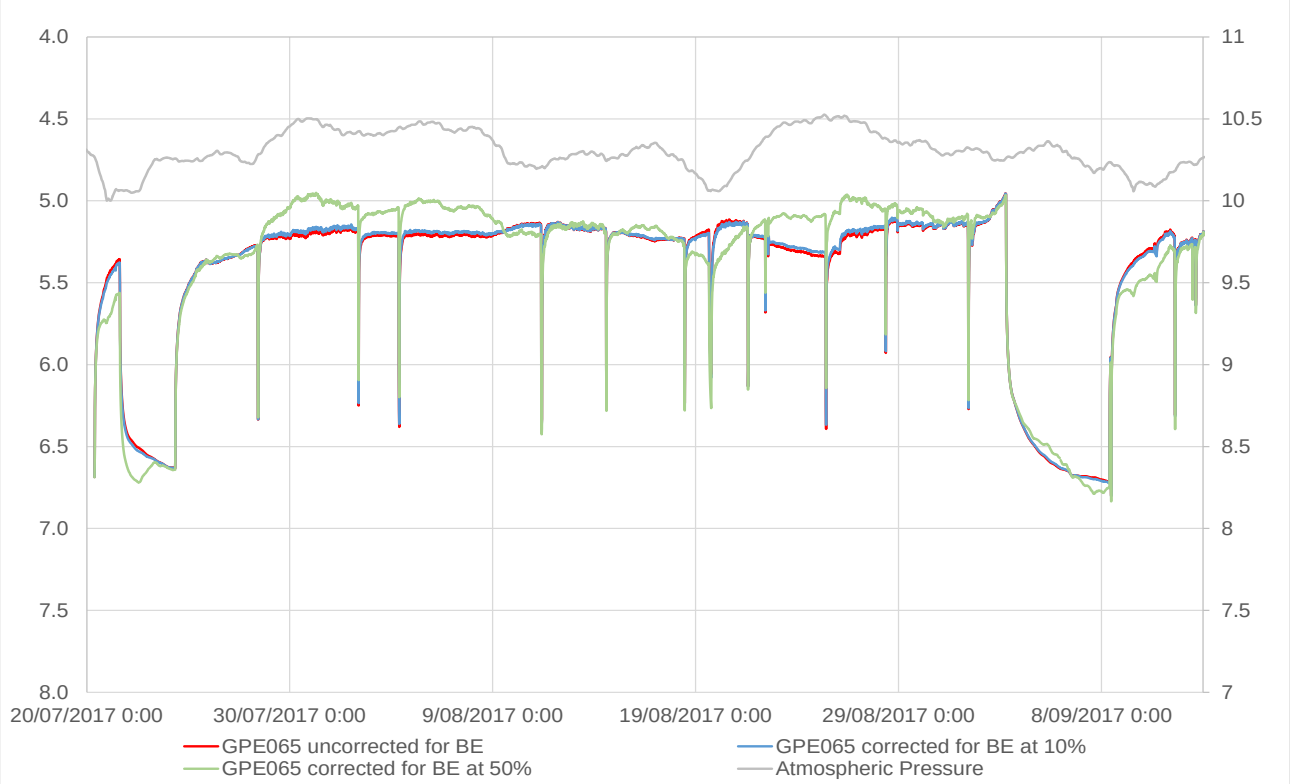


Figure 7: Barometric efficiency (BE) effect analysis for GPE065 – 10 % BE effect is shown.

Data Corrections

Two type of data corrections have been applied to the data set before further analysis of aquifer parameters was undertaken:

- An unexplained offset in the groundwater level recordings for well GPF105 was removed.
- The effect of the background trend was separated from the effects of the injection trialling.

An unexplained offset was observed in GPF105 on 10 August 2017 (Figure 8). No explanation has been provided to Golder. However, the offset appears to be consistent with a well headworks adjustments in which the top of the casing is lowered. The logger would then have been installed at greater depth causing an apparent rise in groundwater level. Depth of water level below top of casing will also decrease if the casing was lowered and this is reflected in the sudden offset in manual recordings. Because of the uncertainty regarding this apparent offset, Golder has only used the GPF105 groundwater level recordings for general indication of responses, but not to estimate aquifer parameter values. Instead, the response of GPD096 has been used in further analysis.

The background trend was corrected for GPE065, GPE010, GPE030 and GPD096 water levels as shown in Figure 9. The best fit was obtained by applying a correction of 0.013 m/day to the GPF105 water level records and 0.018 m/day to GPE065, GPE010 and GPE030 water level records.

No correction for BE effects were required and therefore not applied.

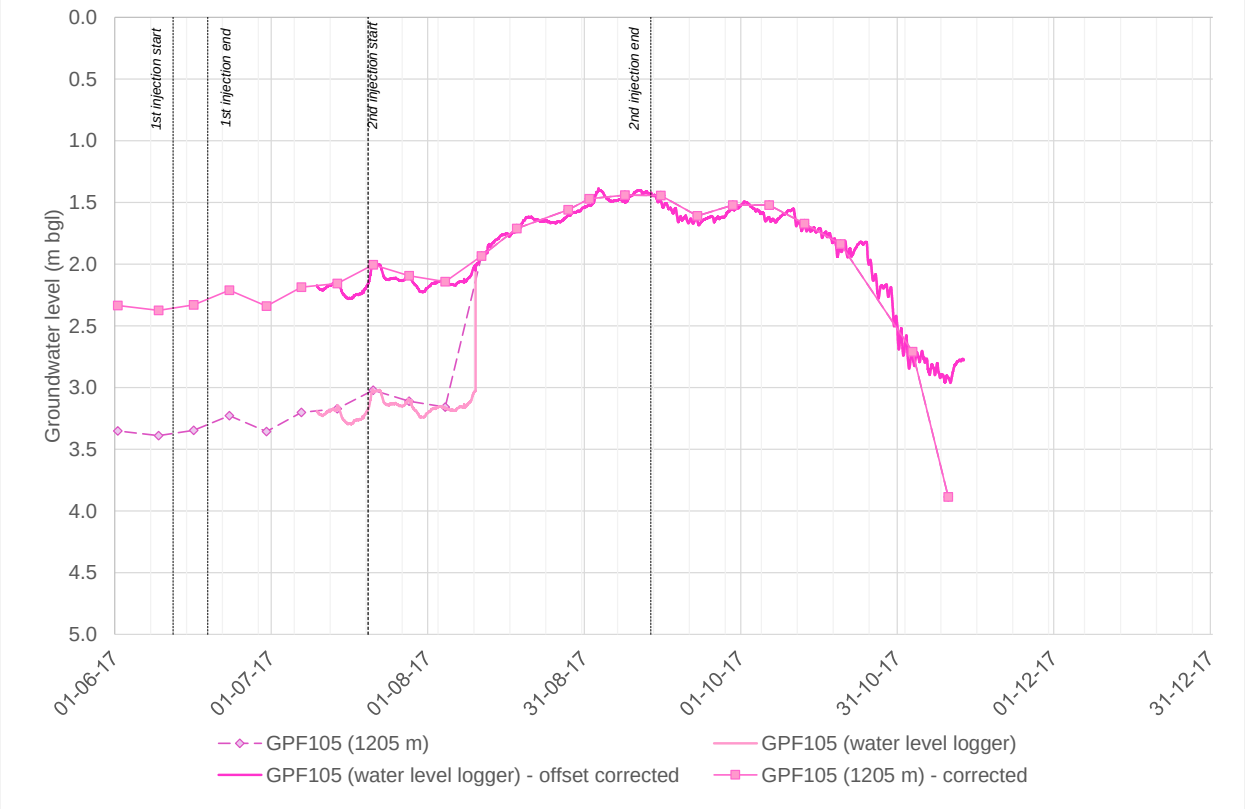


Figure 8: Offset corrections for GPF105 water level recordings.

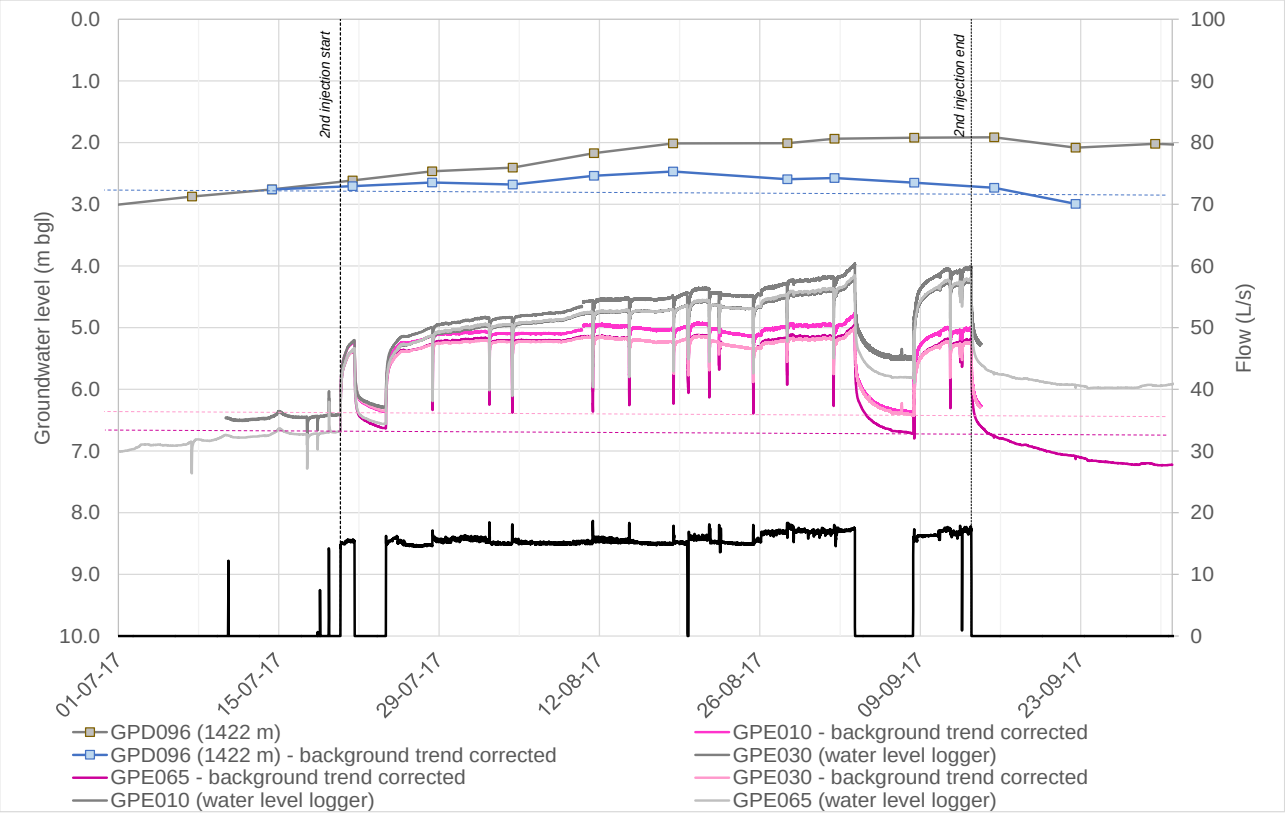


Figure 9: Background trend correction of groundwater levels.

Aquifer Parameter Estimations

The corrected data sets were used in further analysis and estimations of aquifer parameters. Analysis were undertaken with AQTESOLV aquifer parameter estimation software. To assess possible leakage from overlying or underlying aquifers, the Hantush Jacob solution was used. The results are shown in Figure 10.

A reasonable fit can be obtained when the combined responses of the following monitoring well combinations are analysed:

- GPE010 and GPE030 as indicated in the top pane in Figure 10
- GPE065 and GPD096 as indicated in the bottom pane in Figure 10

A lower transmissivity and leakage is derived from analysis of GPE010 and GPE030 than for GPE065 and GPD096. The likely reason is that the aquifer is thinner and overlying confining layer thicker to the north and west of the MAR injection well (GPE066).

The vertical hydraulic conductivity can be calculated from the leakage parameter (1/B) reported by AQTESOLV with the following formula, with leakage factor (B), transmissivity (T), thickness overlying confining layer (b') and vertical hydraulic conductivity (Kv):

$$B = \sqrt{\frac{Tb'}{Kv}}$$

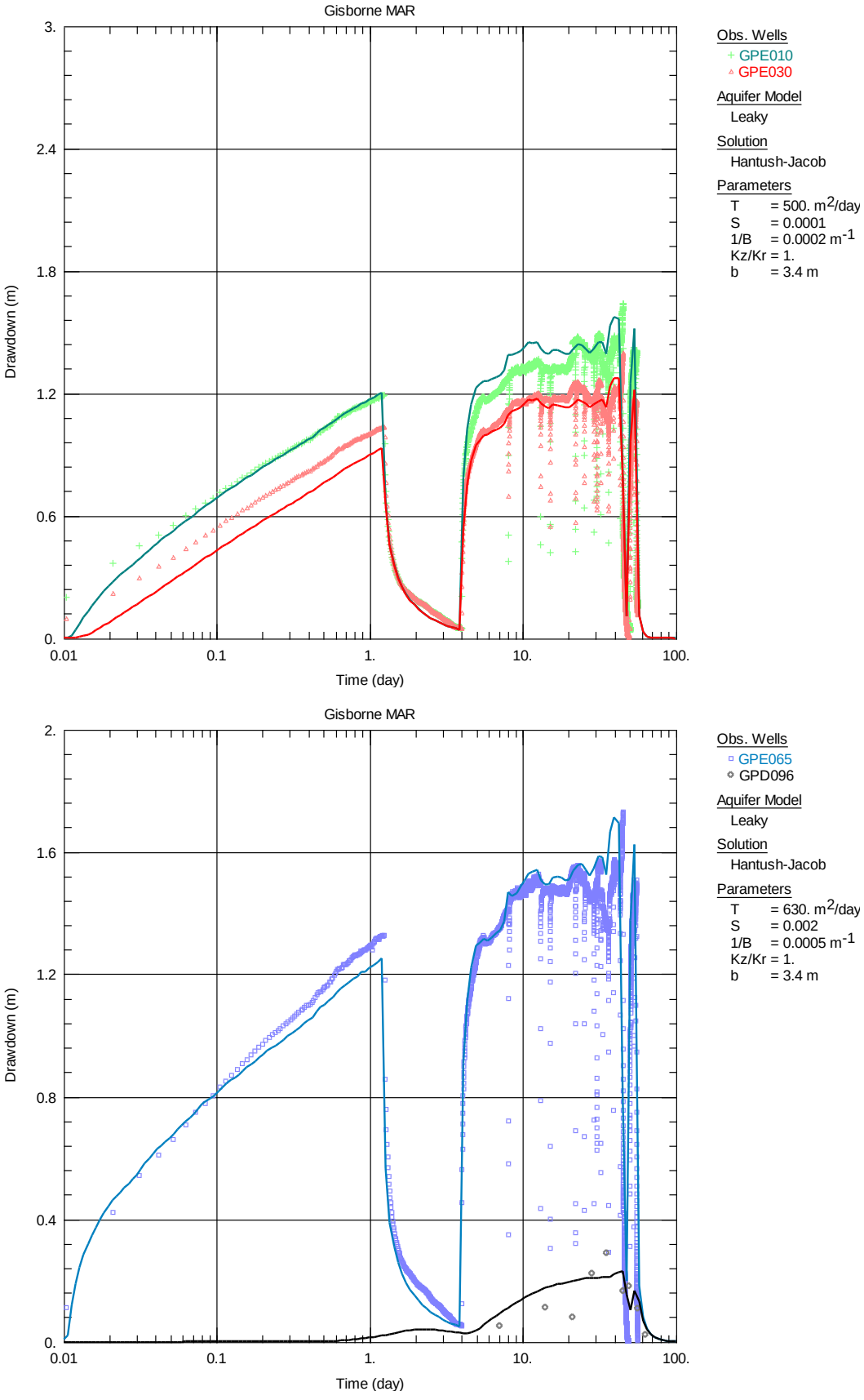


Figure 10: Results from aquifer parameter estimations.

Golder assumed a thickness of the overlying confining layer to be 38 m and that leakage only occurs from the overlying aquifer. It is acknowledged that this is not confirmed and some leakage from a lower aquifer could occur.

The resulting range of aquifer parameter values is listed in Table 2.

Table 2: Aquifer parameter estimations.

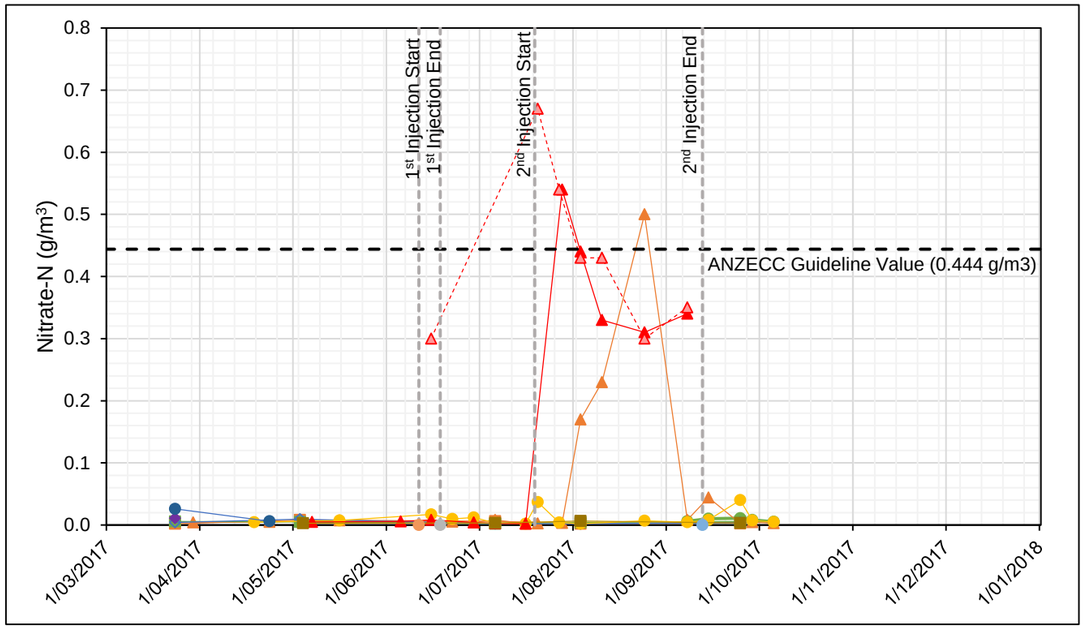
Aquifer Parameter	Estimated Range
Transmissivity (T)	500 to 630 m^2/day
Storage (S)	0.0001 to 0.002
Leakage factor (B)	2,075 to 5,083 m
Leakage factor (K'/B')	2.5×10^{-5} to 1.6×10^{-4} day^{-1}
Vertical hydraulic conductivity (Kv)	0.001 to 0.006 m/day

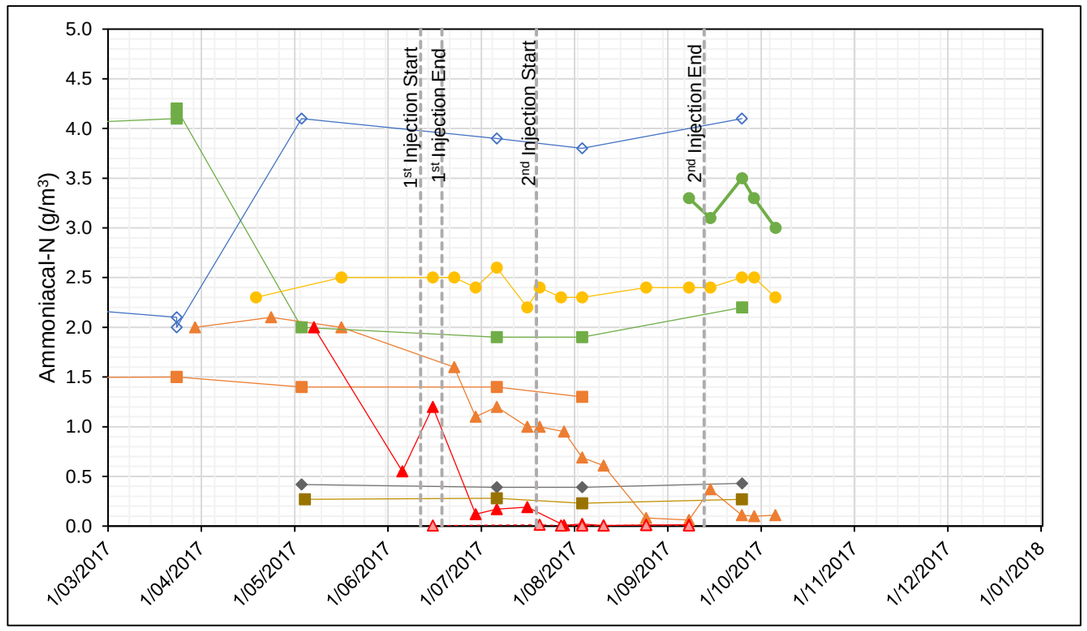
References

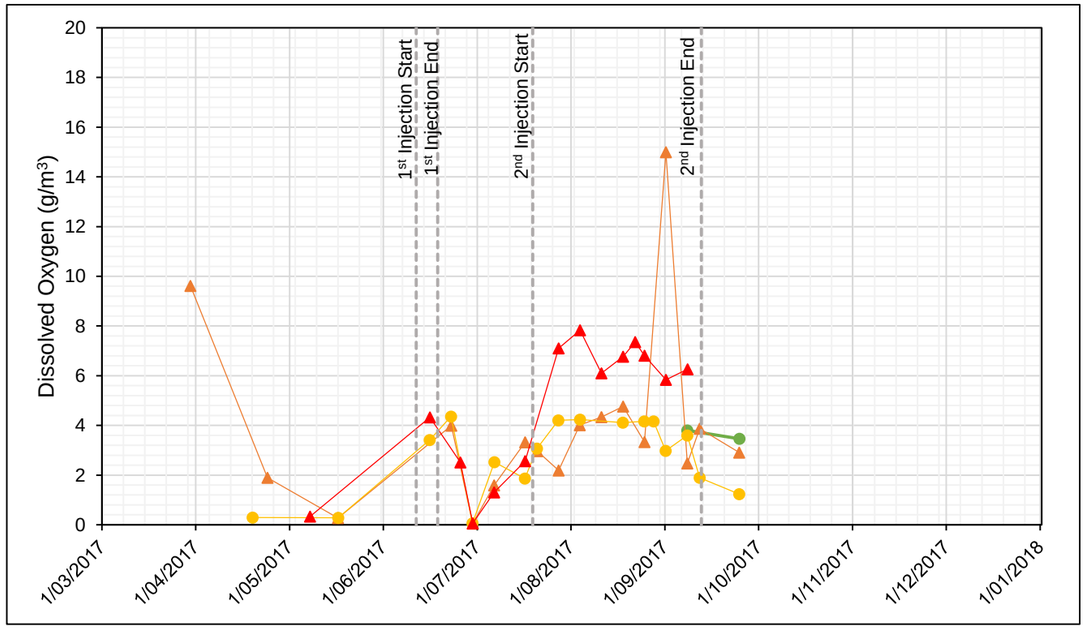
Kruseman, G.P., De Ridder, N.A. 2000, Analysis and Evaluation of Pumping Test Data, Second Edition (completely revised), ILRI publication 47, ISBN 90 70754 207

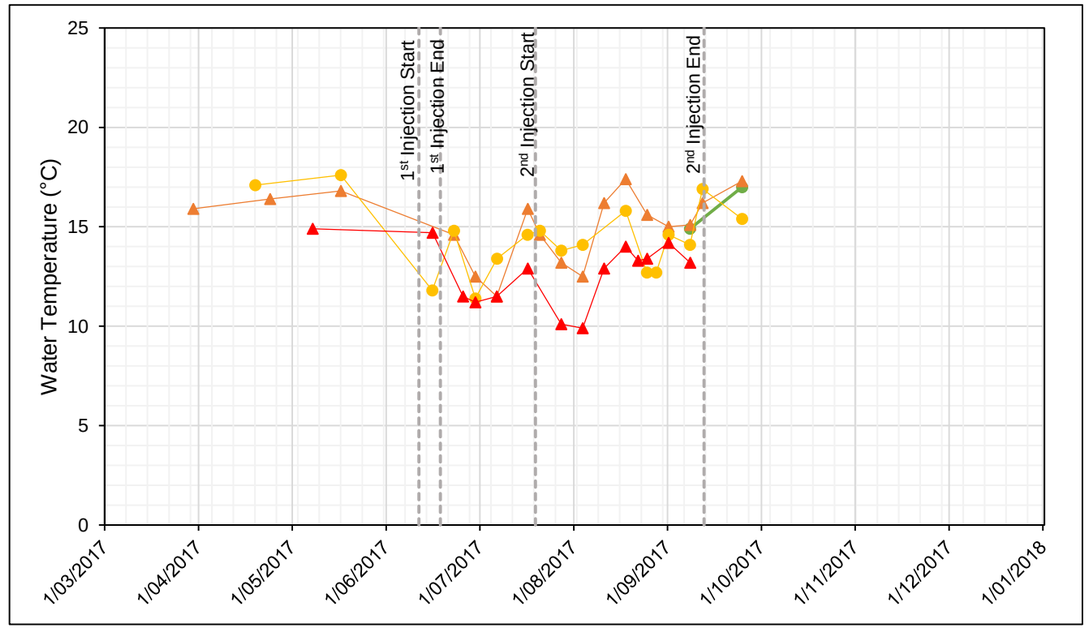
APPENDIX C

Groundwater Quality Graphs









- GPD116
- GPE030
- GPD147
- GPE010
- GPF162
- Whiteshed Bore
- GPF159
- GPE065 (MAR Monitoring Well)
- GPD115
- GPE066 (injection well)
- GPE012
- MAR Headworks outlet

CLIENT
Gisborne District Council

PROJECT
Poverty Bay Managed Aquifer Recharge Trial - Results 2017 Injection Trial

TITLE
Makauri Aquifer Groundwater Nitrate, Ammonia Nitrogen, Dissolved Oxygen, and Temperature

CONSULTANT
Golder Associates

YYY/MM/DD	26-Nov-2017
PREPARED	DB
DESIGN	HD
REVIEW	EV
APPROVED	EV

PROJECT No. 1415771_7403-025-R-Rev0
Rev. 0
FIGURE 1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI A

https://goldenassociates.sharepoint.com/sites/20734g/Technical Work/Data/Major Cat&An_DB.xlsx

APPENDIX D

Laboratory Analytical Reports

Watercare Laboratory Services

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(03) 214 4041

Queenstown
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(03) 409 0559

www.watercarelabs.co.nz
clientsupport@water.co.nz

Certificate of Analysis
Laboratory Reference:151216-157

Attention:	General Results	*Final Report:*	**164056-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**21-Dec-2015**
Address:	**PO Box 747, GISBORNE, 4040**	*Received Date:*	**16-Dec-2015**
Client Reference:	**Reticulated Potable Drinking Water**		
Purchase Order:	**Not Available**	*Quote Reference :*	**5880**

Sample Details	WATERS
Lab Sample ID:	**151216-157-1**
Client Sample ID:	20150137
Sample Date/Time:	15/12/2015 07:10
Description:	Campion College Venturi
Sample Parameters and Field Testing	
External Provided by Client	
Temperature °C	17.2 *
Time	07:10:00 AM *
Organics	
Total Organic Carbon by Non-dispersive infrared detection	
Total Organic Carbon mg/L	1.3

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Sample Parameters and Field Testing				
External Provided by Client				
Temperature			All	Auckland
Time			All	Auckland
Organics				
Total Organic Carbon by Non-dispersive infrared detection				
Total Organic Carbon	APHA (online edition) 5310 B	0.1 mg/L	All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

Watercare Laboratory Services is a division of Watercare Services Limited.

ACCREDITED LABORATORY

Report Signatory 21/12/2015

Peter Boniface
KTP Signatory

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Certificate of Analysis
Laboratory Reference:151223-109

Attention:	Hilltop Sampler	*Final Report:*	**165361-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**04-Jan-2016**
Address:	**PO Box 747, GISBORNE, 4040**	*Received Date:*	**23-Dec-2015**
Client Reference:	**Campion College Venturi**		
Purchase Order:	**Not Available**	*Quote Reference :*	**6370**

Sample Details	WATERS
Lab Sample ID:	**151223-109-1**
Client Sample ID:	20150138
Sample Date/Time:	22/12/2015
Description:	Campion College Venturi

Organics

Total Organic Carbon by Non-dispersive infrared detection

Total Organic Carbon	mg/L	1.2

*Results marked with * are not accredited to International Accreditation New Zealand*

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Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Organics				
Total Organic Carbon by Non-dispersive infrared detection				
Total Organic Carbon	APHA (online edition) 5310 B	0.1 mg/L	All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

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Report Signatory 04/01/2016

Rachel Hwang
KTP Signatory

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Certificate of Analysis
Laboratory Reference:151230-130

Attention:	Hilltop Sampler	*Final Report:*	**165838-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**07-Jan-2016**
Address:	**PO Box 747, GISBORNE, 4040**	*Received Date:*	**30-Dec-2015**
Client Reference:		*Sampled By:*	**Lee McKay**
Purchase Order:	**Not Available**	*Quote Reference :*	**6370**

Sample Details	WATERS
Lab Sample ID:	**151230-130-1**
Client Sample ID:	20150139
Sample Date/Time:	29/12/2015
Description:	Venturi Shed - Campion College

Organics

Total Organic Carbon by Non-dispersive infrared detection

Total Organic Carbon	mg/L	1.2

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Organics				
Total Organic Carbon by Non-dispersive infrared detection				
Total Organic Carbon	APHA (online edition) 5310 B	0.1 mg/L	All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

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Report Signatory 07/01/2016

Peter Boniface
KTP Signatory

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Certificate of Analysis
Laboratory Reference:170221-094

Attention:	Hilltop Sampler	*Final Report:*	**217544-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**03-Mar-2017**
Address:	**PO Box 747, GISBORNE, 4040**	*Received Date:*	**21-Feb-2017**
Client Reference:	**MAR**	*Sampled By:*	**Alice Trevalyan**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

Sample Details		WATERS	WATERS
Lab Sample ID:		**170221-094-1**	**170221-094-2**
Client Sample ID:		20170809	20170810
Sample Date/Time:		20/02/2017 08:40	20/02/2017 08:25
Description:		Waipaoa River at Infultration Chamber	598 Bushmere Rd at Cyclone Filter
General Testing			
COD (as O2)	mg/L	65	<30
Conductivity (at 25 °C)	mS/m	46.8	56.8
Dissolved Oxygen (Percent Saturation)	%	103 *	99.9 *
Dissolved Oxygen	mg/L	9.0 *	8.6 *
pH (at room temp c. 20 °C)	pH unit	8.2	8.1
Salinity	ppt	0.2 *	0.3 *
TBOD5	mg/L	0.91	0.63
Total Suspended Solids	mg/L	120	1.6
Turbidity	NTU	95	1.0
Organics			
Dissolved Organic Carbon (DOC) by Non-dispersive infrared detection			
Dissolved Organic Carbon	mg/L	4.3	2.1
Total Organic Carbon by Non-dispersive infrared detection			
Total Organic Carbon	mg/L	4.7	2.5
Microbiology			
Escherichia coli by Membrane Filtration			
Escherichia coli	cfu/100 mL	1000	15
Total coliforms by Membrane Filtration			
Total coliforms	cfu/100 mL	2700	150

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
General Testing				
Chemical Oxygen Demand (as O2) by Dichromate/Sulphuric Acid Digestion and Spectrophotometry, Screen level	APHA (online edition) 5220 D	30 mg/L	All	Auckland
Conductivity (at 25 °C) by Electrode	APHA (online edition) 2510 B	0.5 mS/m	All	Auckland
Dissolved Oxygen (Percent Saturation) by Titration	APHA (online edition) 4500-O C		All	Auckland
Dissolved Oxygen by Titration	APHA (online edition) 4500-O C	0.05 mg/L	All	Auckland
pH (at room temp c. 20 °C) by Electrode	APHA (online edition) 4500-H B	0.1 pH unit	All	Auckland
Salinity by Electrode	APHA (online edition) 2520 D	0.1 ppt	All	Auckland
Total Biochemical Oxygen Demand, TBOD5 by Electrode	APHA (online edition) 5210 B (modified)	0.5 mg/L	All	Auckland
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	0.2 mg/L	All	Auckland
Turbidity by Nephelometry	APHA (online edition) 2130 B (modified)	0.05 NTU	All	Auckland
Organics				
Dissolved Organic Carbon (DOC) by Non-dispersive infrared detection				

Organics				
Dissolved Organic Carbon (DOC) by Non-dispersive infrared detection				
Dissolved Organic Carbon	APHA (online edition) 5310 B	0.1 mg/L	All	Auckland
Total Organic Carbon by Non-dispersive infrared detection				
Total Organic Carbon	APHA (online edition) 5310 B	0.1 mg/L	All	Auckland
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603	2 cfu/100 mL	All	Auckland
Total coliforms by Membrane Filtration				
Total coliforms	APHA (online edition) 9222 B	2 cfu/100 mL	All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher.

For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

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Report Signatory 03/03/2017

Chandra Sharma
KTP Signatory

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Certificate of Analysis
Laboratory Reference:170324-089

Attention:	Hilltop Sampler	*Final Report:*	**222914-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**18-Apr-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**25-Mar-2017**
Client Reference:	**MAR**	*Sampled By:*	**Matt McGill-Brown**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

Sample Details		WATERS	WATERS	WATERS	WATERS
Lab Sample ID:		**170324-089-1**	**170324-089-13**	**170324-089-14**	**170324-089-15**
Client Sample ID:		20171396	20171400	20171401	20171402
Sample Date/Time:		24/03/2017 12:15	24/03/2017 08:58	24/03/2017 13:05	24/03/2017 14:30
Description:		511 Matawai Road GPE012	Mc Intyre 409 Matawai Rd (SH2) GPD116	Patterson 54 Bolitho Rd GPD115	Stuart 370 Bushmere Rd GPD147
Chemistry Detailed					
Anions by Ion Chromatography (0.45 µm Filtered)					
Chloride	mg/L	2300	65	300	130
Nitrate (as N)	mg/L	0.011	<0.002	<0.004	0.0057
Nitrite (as N)	mg/L	<0.01	<0.002	<0.004	<0.002
Sulphate	mg/L	<0.1	<0.02	<0.04	<0.02
Total Oxidised Nitrogen (as N) by Calculation	mg/L	0.011 *	<0.002 *	<0.004 *	0.0057 *
Ion Balance (Anions/Cations) by Calculation					
Anion Total	meq/L	110 *	16 *	22 *	15 *
Cation Total	meq/L	120 *	15 *	21 *	14 *
meq/L Difference	meq/L	6.5 *	0.99 *	1.2 *	0.86 *
Percent Difference	%	2.7 *	3.1 *	2.8 *	3.0 *
Sum of Anions + Cations	meq/L	240 *	32 *	43 *	28 *
Sample Parameters and Field Testing					
External Provided by Client					
Conductivity	mS/cm	10270 *	1275 *	-	-
Dissolved Oxygen	mg/L	0.40 *	4.00 *	-	-
Dissolved Oxygen %	%	4.3 *	39.6 *	-	-
pH	pH unit	6.78 *	7.31 *	-	-
Salinity	ppt	5.83 *	0.64 *	-	-
Temperature	°C	17.1 *	14.7 *	-	-
Time		01:15:00 PM *	08:58:00 AM *	01:05:00 PM *	02:30:00 PM *
General Testing					
Ammoniacal Nitrogen (as N)	mg/L	28	1.5	2.1	4.1
Ammoniacal Nitrogen (as NH4)	mg/L	37 *	1.9 *	2.7 *	5.5 *
Bicarbonate Alkalinity (as HCO3) by Calc	mg/L	3100 *	890 *	830 *	660 *
Carbonate Alkalinity (as CO3)	mg/L	1.3 *	<0.6 *	<0.6 *	<0.6 *
Carbonate Alkalinity (as CO3)	mg/L	<20	<20	<20	<20
Dissolved Ammoniacal Nitrogen (as N)	mg/L	28	1.5	2.0	4.2
Hydroxide Alkalinity (as CaCO3)	mg/L	<20	<20	<20	<20
pH (at room temp c. 20 °C)	pH unit	7.0	7.1	7.1	7.2
Sulfide	mg/L	<0.1 *	<0.1 *	<0.1 *	<0.1 *
Total Alkalinity (as CaCO3)	mg/L	2500	730	680	540
Total Chlorine (as Cl2)	mg/L	0.06	0.04	0.09	0.05
Total Dissolved Solids	mg/L	7000	890	1300	760
Total Nitrogen (as N)	mg/L	27	1.5	2.1	3.7
Total Phosphorus (as P)	mg/L	6.4	0.75	0.67	0.35
Total Suspended Solids	mg/L	11000	100	450	20
Turbidity	NTU	6100	110	200	70
Metals					

Sample Details (continued)		WATERS	WATERS	WATERS	WATERS
Lab Sample ID:		**170324-089-1**	**170324-089-13**	**170324-089-14**	**170324-089-15**
Client Sample ID:		20171396	20171400	20171401	20171402
Sample Date/Time:		24/03/2017 12:15	24/03/2017 08:58	24/03/2017 13:05	24/03/2017 14:30
Description:		511 Matawai Road GPE012	Mc Intyre 409 Matawai Rd (SH2) GPD116	Patterson 54 Bolitho Rd GPD115	Stuart 370 Bushmere Rd GPD147
Metals					
Dissolved Metals by ICP-MS—Trace					
Arsenic (Dissolved)	mg/L	0.0058	0.0020	0.0031	0.0028
Calcium (Dissolved)	mg/L	260	180	210	160
Iron (Dissolved)	mg/L	0.067	0.0057	0.0060	<0.004
Magnesium (Dissolved)	mg/L	210	24	32	18
Manganese (Dissolved)	mg/L	0.17	1.3	1.2	0.60
Potassium (Dissolved)	mg/L	79	6.8	7.6	13
Sodium (Dissolved)	mg/L	2000	92	170	88
Total Metals by ICP-MS—Trace (Default Digest)					
Arsenic (Total)	mg/L	0.081	0.0046	0.0078	0.0062
Calcium (Total)	mg/L	530	190	230	160
Iron (Total)	mg/L	320	8.7	11	5.3
Magnesium (Total)	mg/L	290	25	37	19
Manganese (Total)	mg/L	4.2	1.4	1.5	0.64
Potassium (Total)	mg/L	98	6.9	8.3	6.5
Sodium (Total)	mg/L	2100	100	180	89
Total Hardness (as CaCO3)	mg/L	2500	570	720	470
Organics					
Total Organic Carbon by Non-dispersive infrared detection					
Total Organic Carbon	mg/L	41	4.2	4.7	2.8
Microbiology					
Escherichia coli by Membrane Filtration					
Escherichia coli	cfu/100 mL	<1.6	<1.6	<1.6	<1.6

Sample Details		WATERS
Lab Sample ID:		**170324-089-17**
Client Sample ID:		20171404
Sample Date/Time:		24/03/2017 13:20
Description:		598 Bushmere Road Whiteshed Bore
Chemistry Detailed		
Anions by Ion Chromatography (0.45 µm Filtered)		
Chloride	mg/L	180
Nitrate (as N)	mg/L	0.026
Nitrite (as N)	mg/L	<0.002
Sulphate	mg/L	<0.02
Total Oxidised Nitrogen (as N) by Calculation	mg/L	0.026 *
Ion Balance (Anions/Cations) by Calculation		
Anion Total	meq/L	26 *
Cation Total	meq/L	25 *
meq/L Difference	meq/L	1.7 *
Percent Difference	%	3.3 *
Sum of Anions + Cations	meq/L	51 *
Sample Parameters and Field Testing		
External Provided by Client		
Conductivity	mS/cm	2046 *
Dissolved Oxygen	mg/L	0.57 *
Dissolved Oxygen %	%	5.8 *
pH	pH unit	6.90 *
Salinity	ppt	0.57 *
Temperature	°C	15.8 *
Time		01:20:00 PM *
General Testing		
Ammoniacal Nitrogen (as N)	mg/L	7.7
Ammoniacal Nitrogen (as NH4)	mg/L	9.9 *
Bicarbonate Alkalinity (as HCO3) by Calc	mg/L	1300 *
Carbonate Alkalinity (as CO3)	mg/L	<0.6 *

Sample Details (continued)	WATERS
Lab Sample ID:	**170324-089-17**
Client Sample ID:	20171404
Sample Date/Time:	24/03/2017 13:20
Description:	598 Bushmere Road Whiteshed Bore

General Testing		
Carbonate Alkalinity (as CO3)	mg/L	<20
Dissolved Ammoniacal Nitrogen (as N)	mg/L	7.2
Hydroxide Alkalinity (as CaCO3)	mg/L	<20
pH (at room temp c. 20 °C)	pH unit	6.9
Sulfide	mg/L	<0.1 *
Total Alkalinity (as CaCO3)	mg/L	1100
Total Chlorine (as Cl2)	mg/L	0.05
Total Dissolved Solids	mg/L	1400
Total Nitrogen (as N)	mg/L	8.2
Total Phosphorus (as P)	mg/L	1.9
Total Suspended Solids	mg/L	140
Turbidity	NTU	180
Metals		
Dissolved Metals by ICP-MS—Trace		
Arsenic (Dissolved)	mg/L	0.0011
Calcium (Dissolved)	mg/L	120
Iron (Dissolved)	mg/L	0.039
Magnesium (Dissolved)	mg/L	80
Manganese (Dissolved)	mg/L	0.36
Potassium (Dissolved)	mg/L	47
Sodium (Dissolved)	mg/L	240
Total Metals by ICP-MS—Trace (Default Digest)		
Arsenic (Total)	mg/L	0.0059
Calcium (Total)	mg/L	120
Iron (Total)	mg/L	22
Magnesium (Total)	mg/L	83
Manganese (Total)	mg/L	0.43
Potassium (Total)	mg/L	44
Sodium (Total)	mg/L	250
Total Hardness (as CaCO3)	mg/L	640
Organics		
Total Organic Carbon by Non-dispersive infrared detection		
Total Organic Carbon	mg/L	18
Microbiology		
Escherichia coli by Membrane Filtration		
Escherichia coli	cfu/100 mL	<1.6

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods

The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Chemistry Detailed				
Anions by Ion Chromatography (0.45 µm Filtered)				
Chloride	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Nitrate (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Nitrite (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Sulphate	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Total Oxidised Nitrogen (as N) by Calculation	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Ion Balance (Anions/Cations) by Calculation				
Anion Total	APHA (online edition) 1030 E	meq/L	All	Auckland
Cation Total	APHA (online edition) 1030 E	meq/L	All	Auckland
meq/L Difference	APHA (online edition) 1030 E	meq/L	All	Auckland
Percent Difference	APHA (online edition) 1030 E		All	Auckland
Sum of Anions + Cations	APHA (online edition) 1030 E		All	Auckland

Sample Parameters and Field Testing				
External Provided by Client				
Conductivity		mS/cm	1, 13, 17	Auckland
Dissolved Oxygen %		%	1, 13, 17	Auckland
Dissolved Oxygen		mg/L	1, 13, 17	Auckland
pH		pH unit	1, 13, 17	Auckland
Salinity		ppt	1, 13, 17	Auckland
Temperature			1, 13, 17	Auckland
Time			All	Auckland
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	HMSO (1981) ISBN 0117516139	0.005 mg/L	13, 14, 15	Auckland
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	HMSO (1981) ISBN 0117516139	0.4 mg/L	1, 17	Auckland
Ammoniacal Nitrogen (as NH4) by Calculation	Calculation from Ammonia (as N)	0.006 mg/L	All	Auckland
Bicarbonate Alkalinity (as HCO3) by Calculation	APHA (online edition) 4500-CO2 D	1 mg/L	All	Auckland
Carbonate Alkalinity (as CO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Carbonate Alkalinity (as CO3) by Calculation	APHA (online edition) 4500-CO2 D	1 mg/L	All	Auckland
Dissolved Ammoniacal Nitrogen (as N) by Colorimetry/ Discrete Analyser	HMSO (1981) ISBN 0117516139	0.005 mg/L	13, 14, 15	Auckland
Dissolved Ammoniacal Nitrogen (as N) by Colorimetry/ Discrete Analyser	HMSO (1981) ISBN 0117516139	0.4 mg/L	1, 17	Auckland
Hydroxide Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
pH (at room temp c. 20 °C) by Electrode	APHA (online edition) 4500-H B	0.1 pH unit	All	Auckland
Sulfide by Colour Comparison (Methylene Blue Method)	APHA (online edition) 4500-S2 D	0.1 mg/L	All	Auckland
Total Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Total Chlorine (as Cl2) by Spectrophotometry according to APHA (2005) 4500-Cl G	APHA (online edition) 4500-Cl G	0.02 mg/L	All	Auckland
Total Dissolved Solids by Gravimetry	APHA (online edition) 2540 C (Modified: Dried at 103 - 105 ºC)	15 mg/L	All	Auckland
Total Nitrogen (as N) by Persulphate Digestion and Flow Analysis	APHA (online edition) 4500-P J (modified), 4500-NO3 I	0.010 mg/L	All	Auckland
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J (modified)	0.004 mg/L	All	Auckland
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	0.2 mg/L	All	Auckland
Turbidity by Nephelometry	APHA (online edition) 2130 B (modified)	0.05 NTU	All	Auckland
Metals				
Dissolved Metals by ICP-MS—Trace				
Arsenic (Dissolved)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Dissolved)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Dissolved)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.05 mg/L	All	Auckland
Sodium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Metals by ICP-MS—Trace (Default Digest)				
Arsenic (Total)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Total)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Total)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Total)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Total)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Total)	In House based on EPA 200.8 by ICPMS	0.05 mg/L	All	Auckland
Sodium (Total)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Hardness (as CaCO3)	In House based on EPA 200.8 by ICPMS	0.03 mg/L	All	Auckland
Organics				
Total Organic Carbon by Non-dispersive infrared detection				
Total Organic Carbon	APHA (online edition) 5310 B	0.1 mg/L	All	Auckland
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603	2 cfu/100 mL	All	Auckland
Preparations				
0.45 µm Filtration for Dissolved Metals	APHA (online edition) 3010B (modified)		All	Auckland
Digest for Total Metals in Liquids	APHA (online edition) 3030 E (modified, 4:1 Nitric:Hydrochloric Acid)		All	Auckland
Glass Fibre Filtration (1.2 µm)	APHA (online edition) 2540 C (Filtration)		All	Auckland
Membrane Filtration (0.45 µm)	APHA (online edition) 4500-P B (preliminary filtration)		All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher. For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

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Report Signatory 18/04/2017

Carol Taylor
KTP Signatory

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Certificate of Analysis
Laboratory Reference:170325-061

Attention:	Hilltop Sampler	*Final Report:*	**221385-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**03-Apr-2017**
Address:	**PO Box 747, GISBORNE, 4040**	*Received Date:*	**25-Mar-2017**
Client Reference:	**MAR**	*Sampled By:*	**Matt McGill-Brown**
Purchase Order:	**37 00 01 2104**	*Quote Reference :*	**5880**

Sample Details		WATERS	WATERS	WATERS	WATERS
Lab Sample ID:		**170325-061-1**	**170325-061-3**	**170325-061-4**	**170325-061-5**
Client Sample ID:		20171405	20171409	20171410	20171411
Sample Date/Time:		24/03/2017 12:15	24/03/2017 08:58	24/03/2017 13:05	24/03/2017 14:30
Description:		511 Matawai Road GPE012	Mc Intyre 409 Matawai Rd (SH2) GPD116	Patterson 54 Bolitho Rd GPD115	Stuart 370 Bushmere Rd GPD147
Metals					
Dissolved Metals by ICP-MS—Trace					
Arsenic (Dissolved)	mg/L	0.0039	0.0021	0.0036	0.0030
Iron (Dissolved)	mg/L	0.17	0.0053	0.024	<0.004
Manganese (Dissolved)	mg/L	0.16	1.3	1.2	0.59

Sample Details		WATERS
Lab Sample ID:		**170325-061-6**
Client Sample ID:		20171413
Sample Date/Time:		24/03/2017 13:20
Description:		598 Bushmere Road Whiteshed Bore
Metals		
Dissolved Metals by ICP-MS—Trace		
Arsenic (Dissolved)	mg/L	0.0010
Iron (Dissolved)	mg/L	0.037
Manganese (Dissolved)	mg/L	0.33

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Metals				
Dissolved Metals by ICP-MS—Trace				
Arsenic (Dissolved)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Iron (Dissolved)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Manganese (Dissolved)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Preparations				
0.45 µm Filtration for Dissolved Metals	APHA (online edition) 3010B (modified)		All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher.

For more information please contact the Operations Manager

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

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Report Signatory 03/04/2017

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Certificate of Analysis
Laboratory Reference:170331-083

Attention:	Hilltop Sampler	*Final Report:*	**224116-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**26-Apr-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**31-Mar-2017**
Client Reference:	**MAR**	*Sampled By:*	**Matt McGill-Brown**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

Sample Details	WATERS
Lab Sample ID:	**170331-083-1**
Client Sample ID:	20171598
Sample Date/Time:	30/03/2017 09:52
Description:	MAR Pilot Bore

Chemistry Detailed

Anions by Ion Chromatography (0.45 µm Filtered)

Chloride	mg/L	120
Nitrate (as N)	mg/L	<0.004
Nitrite (as N)	mg/L	<0.004
Sulphate	mg/L	0.11
Total Oxidised Nitrogen (as N) by Calculation	mg/L	<0.004 *

Ion Balance (Anions/Cations) by Calculation

Anion Total	meq/L	15 *
Cation Total	meq/L	15 *
meq/L Difference	meq/L	0.93 *
Percent Difference	%	3.1 *
Sum of Anions + Cations	meq/L	30 *

General Testing

Ammoniacal Nitrogen (as N)	mg/L	2.0
Bicarbonate Alkalinity (as HCO3)	mg/L	690
Carbonate Alkalinity (as CO3)	mg/L	<4.0
Hydroxide Alkalinity (as CaCO3)	mg/L	<4.0
pH (at room temp c. 20 °C)	pH unit	7.8
Sulfide	mg/L	<0.1 *
Total Alkalinity (as CaCO3)	mg/L	560
Total Dissolved Solids	mg/L	770
Total Nitrogen (as N)	mg/L	2.0
Total Phosphorus (as P)	mg/L	0.39
Total Suspended Solids	mg/L	100
Turbidity	NTU	55

Metals

Dissolved Metals by ICP-MS—Trace (Received Filtered)

Arsenic (Dissolved)	mg/L	0.0084
Calcium (Dissolved)	mg/L	180
Iron (Dissolved)	mg/L	3.4
Magnesium (Dissolved)	mg/L	21
Manganese (Dissolved)	mg/L	0.88
Potassium (Dissolved)	mg/L	9.4
Sodium (Dissolved)	mg/L	99

Total Metals by ICP-MS—Trace (Default Digest)

Arsenic (Total)	mg/L	0.0096
Calcium (Total)	mg/L	180
Iron (Total)	mg/L	6.7
Magnesium (Total)	mg/L	19
Manganese (Total)	mg/L	0.86
Potassium (Total)	mg/L	12
Sodium (Total)	mg/L	87

Sample Details (continued)	WATERS
Lab Sample ID:	**170331-083-1**
Client Sample ID:	20171598
Sample Date/Time:	30/03/2017 09:52
Description:	MAR Pilot Bore

Metals		
Total Metals by ICP-MS—Trace (Default Digest)		
Total Hardness (as CaCO3)	mg/L	530
Organics		
Total Organic Carbon by Non-dispersive infrared detection		
Total Organic Carbon	mg/L	5.9
Microbiology		
Escherichia coli by Membrane Filtration		
Escherichia coli	cfu/100 mL	<1.6

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods

The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Chemistry Detailed				
Anions by Ion Chromatography (0.45 µm Filtered)				
Chloride	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Nitrate (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Nitrite (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Sulphate	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Total Oxidised Nitrogen (as N) by Calculation	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Ion Balance (Anions/Cations) by Calculation				
Anion Total	APHA (online edition) 1030 E	meq/L	All	Auckland
Cation Total	APHA (online edition) 1030 E	meq/L	All	Auckland
meq/L Difference	APHA (online edition) 1030 E	meq/L	All	Auckland
Percent Difference	APHA (online edition) 1030 E		All	Auckland
Sum of Anions + Cations	APHA (online edition) 1030 E		All	Auckland
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	HMSO (1981) ISBN 0117516139	0.005 mg/L	All	Auckland
Bicarbonate Alkalinity (as HCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Carbonate Alkalinity (as CO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Hydroxide Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
pH (at room temp c. 20 °C) by Electrode	APHA (online edition) 4500-H B	0.1 pH unit	All	Auckland
Sulfide by Colour Comparison (Methylene Blue Method)	APHA (online edition) 4500-S2 D	0.1 mg/L	All	Auckland
Total Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Total Dissolved Solids by Gravimetry	APHA (online edition) 2540 C (Modified: Dried at 103 - 105 °C)	15 mg/L	All	Auckland
Total Nitrogen (as N) by Persulphate Digestion and Flow Analysis	APHA (online edition) 4500-P J (modified), 4500-NO3 I	0.010 mg/L	All	Auckland
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J (modified)	0.004 mg/L	All	Auckland
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	0.2 mg/L	All	Auckland
Turbidity by Nephelometry	APHA (online edition) 2130 B (modified)	0.05 NTU	All	Auckland
Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Arsenic (Dissolved)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Dissolved)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Dissolved)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.02 mg/L	All	Auckland
Sodium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Metals by ICP-MS—Trace (Default Digest)				
Arsenic (Total)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Total)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland

Metals				
Total Metals by ICP-MS—Trace (Default Digest)				
Iron (Total)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Total)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Total)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Total)	In House based on EPA 200.8 by ICPMS	0.05 mg/L	All	Auckland
Sodium (Total)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Hardness (as CaCO3)	In House based on EPA 200.8 by ICPMS	0.03 mg/L	All	Auckland
Organics				
Total Organic Carbon by Non-dispersive infrared detection				
Total Organic Carbon	APHA (online edition) 5310 B	0.1 mg/L	All	Auckland
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603	2 cfu/100 mL	All	Auckland
Preparations				
Digest for Total Metals in Liquids	APHA (online edition) 3030 E (modified, 4:1 Nitric:Hydrochloric Acid)		All	Auckland
Glass Fibre Filtration (1.2 µm)	APHA (online edition) 2540 C (Filtration)		All	Auckland
Membrane Filtration (0.45 µm)	APHA (online edition) 4500-P B (preliminary filtration)		All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher. For more information please contact the Operations Manager.

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Report Signatory 26/04/2017

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Certificate of Analysis
Laboratory Reference:170420-101

Attention:	Hilltop Sampler	*Final Report:*	**225981-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**09-May-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**20-Apr-2017**
Client Reference:	**MAR**	*Sampled By:*	**Matt McGill-Brown**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

Sample Details	WATERS
Lab Sample ID:	**170420-101-1**
Client Sample ID:	20171750
Sample Date/Time:	19/04/2017 14:57
Description:	599 Bushmere Road GPE010

Chemistry Detailed

Anions by Ion Chromatography (0.45 µm Filtered)

Chloride	mg/L	140
Nitrate (as N)	mg/L	0.0044
Nitrite (as N)	mg/L	<0.004
Sulphate	mg/L	<0.04
Total Oxidised Nitrogen (as N) by Calculation	mg/L	0.0044 *

Ion Balance (Anions/Cations) by Calculation

Anion Total	meq/L	15 *
Cation Total	meq/L	16 *
meq/L Difference	meq/L	0.65 *
Percent Difference	%	2.1 *
Sum of Anions + Cations	meq/L	31 *

General Testing

Ammoniacal Nitrogen (as N)	mg/L	2.3
Ammoniacal Nitrogen (as NH4)	mg/L	2.9 *
Bicarbonate Alkalinity (as HCO3) by Calc	mg/L	700 *
Carbonate Alkalinity (as CO3)	mg/L	1.5 *
Hydroxide Alkalinity (as CaCO3)	mg/L	<4.0
pH (at room temp c. 20 °C)	pH unit	7.7
Sulfide	mg/L	<0.1 *
Total Alkalinity (as CaCO3)	mg/L	580
Total Chlorine (as Cl2)	mg/L	0.05
Total Dissolved Solids	mg/L	840
Total Nitrogen (as N)	mg/L	2.1
Total Phosphorus (as P)	mg/L	0.25
Total Suspended Solids	mg/L	44
Turbidity	NTU	230

Metals

Dissolved Metals by ICP-MS—Trace (Received Filtered)

Arsenic (Dissolved)	mg/L	0.0064
Calcium (Dissolved)	mg/L	190
Iron (Dissolved)	mg/L	17
Magnesium (Dissolved)	mg/L	24
Manganese (Dissolved)	mg/L	1.0
Potassium (Dissolved)	mg/L	9.5
Sodium (Dissolved)	mg/L	81

Total Metals by ICP-MS—Trace (Default Digest)

Arsenic (Total)	mg/L	0.0066
Calcium (Total)	mg/L	190
Calcium Hardness (as CaCO3) (Total)	mg/L	490

Sample Details (continued)

WATERS

Lab Sample ID:	**170420-101-1**
Client Sample ID:	20171750
Sample Date/Time:	19/04/2017 14:57
Description:	599 Bushmere Road GPE010

Metals

Total Metals by ICP-MS—Trace (Default Digest)

Iron (Total)	mg/L	18
Magnesium (Total)	mg/L	24
Magnesium Hardness (as CaCO3) (Total)	mg/L	98
Manganese (Total)	mg/L	1.1
Potassium (Total)	mg/L	8.9
Sodium (Total)	mg/L	81
Total Hardness (as CaCO3)	mg/L	580

Organics

Total Organic Carbon by Non-dispersive infrared detection

Total Organic Carbon	mg/L	4.0

Microbiology

Escherichia coli by Membrane Filtration

Escherichia coli	cfu/100 mL	<1.6

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods

The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Chemistry Detailed				
Anions by Ion Chromatography (0.45 µm Filtered)				
Chloride	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Nitrate (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Nitrite (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Sulphate	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Total Oxidised Nitrogen (as N) by Calculation	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Ion Balance (Anions/Cations) by Calculation				
Anion Total	APHA (online edition) 1030 E	meq/L	All	Auckland
Cation Total	APHA (online edition) 1030 E	meq/L	All	Auckland
meq/L Difference	APHA (online edition) 1030 E	meq/L	All	Auckland
Percent Difference	APHA (online edition) 1030 E		All	Auckland
Sum of Anions + Cations	APHA (online edition) 1030 E		All	Auckland
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	HMSO (1981) ISBN 0117516139	0.005 mg/L	All	Auckland
Ammoniacal Nitrogen (as NH4) by Calculation	Calculation from Ammonia (as N)	0.006 mg/L	All	Auckland
Bicarbonate Alkalinity (as HCO3) by Calculation	APHA (online edition) 4500-CO2 D	1 mg/L	All	Auckland
Carbonate Alkalinity (as CO3) by Calculation	APHA (online edition) 4500-CO2 D	1 mg/L	All	Auckland
Hydroxide Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
pH (at room temp c. 20 °C) by Electrode	APHA (online edition) 4500-H B	0.1 pH unit	All	Auckland
Sulfide by Colour Comparison (Methylene Blue Method)	APHA (online edition) 4500-S2 D	0.1 mg/L	All	Auckland
Total Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Total Chlorine (as Cl2) by Spectrophotometry according to APHA (2005) 4500-Cl G	APHA (online edition) 4500-Cl G	0.02 mg/L	All	Auckland
Total Dissolved Solids by Gravimetry	APHA (online edition) 2540 C (Modified: Dried at 103 - 105 °C)	15 mg/L	All	Auckland
Total Nitrogen (as N) by Persulphate Digestion and Flow Analysis	APHA (online edition) 4500-P J (modified), 4500-NO3 I	0.010 mg/L	All	Auckland
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J (modified)	0.004 mg/L	All	Auckland
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	0.2 mg/L	All	Auckland
Turbidity by Nephelometry	APHA (online edition) 2130 B (modified)	0.05 NTU	All	Auckland
Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				

Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Arsenic (Dissolved)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Dissolved)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Dissolved)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.02 mg/L	All	Auckland
Sodium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Metals by ICP-MS—Trace (Default Digest)				
Arsenic (Total)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Total)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Calcium Hardness (as CaCO3) (Total)	In House based on EPA 200.8 by ICPMS	0.03 mg/L	All	Auckland
Iron (Total)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Total)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Magnesium Hardness (as CaCO3) (Total)	In House based on EPA 200.8 by ICPMS	0.004 mg/L	All	Auckland
Manganese (Total)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Total)	In House based on EPA 200.8 by ICPMS	0.05 mg/L	All	Auckland
Sodium (Total)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Hardness (as CaCO3)	In House based on EPA 200.8 by ICPMS	0.03 mg/L	All	Auckland
Organics				
Total Organic Carbon by Non-dispersive infrared detection				
Total Organic Carbon	APHA (online edition) 5310 B	0.1 mg/L	All	Auckland
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603	2 cfu/100 mL	All	Auckland
Preparations				
Digest for Total Metals in Liquids	APHA (online edition) 3030 E (modified, 4:1 Nitric:Hydrochloric Acid)		All	Auckland
Glass Fibre Filtration (1.2 µm)	APHA (online edition) 2540 C (Filtration)		All	Auckland
Membrane Filtration (0.45 µm)	APHA (online edition) 4500-P B (preliminary filtration)		All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher. For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

Watercare Laboratory Services is a division of Watercare Services Limited .

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Report Signatory 09/05/2017

Zum Nguyen
KTP Signatory

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Certificate of Analysis
Laboratory Reference:170425-086

Attention:	Hilltop Sampler	*Final Report:*	**225982-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**09-May-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**25-Apr-2017**
Client Reference:	**MAR**	*Sampled By:*	**Peter Hancock**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

Sample Details		WATERS	WATERS
Lab Sample ID:		**170425-086-1**	**170425-086-2**
Client Sample ID:		20171939	20171940
Sample Date/Time:		24/04/2017 13:20	24/04/2017 11:49
Description:		598 Bushmere Road Whiteshed Bore	MAR Pilot Bore
Chemistry Detailed			
Anions by Ion Chromatography (0.45 µm Filtered)			
Chloride	mg/L	160	110
Nitrate (as N)	mg/L	0.0061	0.0048
Nitrite (as N)	mg/L	<0.004	<0.004
Sulphate	mg/L	0.065	0.26
Total Oxidised Nitrogen (as N) by Calculation	mg/L	0.0061 *	0.0048 *
Ion Balance (Anions/Cations) by Calculation			
Anion Total	meq/L	25 *	15 *
Cation Total	meq/L	22 *	13 *
meq/L Difference	meq/L	3.2 *	1.5 *
Percent Difference	%	6.9 *	5.4 *
Sum of Anions + Cations	meq/L	47 *	28 *
General Testing			
Ammoniacal Nitrogen (as N)	mg/L	8.2	2.1
Ammoniacal Nitrogen (as NH4)	mg/L	11 *	2.7 *
Bicarbonate Alkalinity (as HCO3) by Calc	mg/L	1200 *	690 *
Carbonate Alkalinity (as CO3)	mg/L	<0.6 *	<0.6 *
Hydroxide Alkalinity (as CaCO3)	mg/L	<5.0	<4.0
pH (at room temp c. 20 °C)	pH unit	7.0	7.2
Sulfide	mg/L	<0.1 *	-
Total Alkalinity (as CaCO3)	mg/L	1000	570
Total Chlorine (as Cl2)	mg/L	0.04	0.04
Total Dissolved Solids	mg/L	1400	860
Total Nitrogen (as N)	mg/L	8.6	2.3
Total Phosphorus (as P)	mg/L	0.62	0.21
Total Suspended Solids	mg/L	90	31
Turbidity	NTU	130	50
Metals			
Dissolved Metals by ICP-MS—Trace			
Arsenic (Dissolved)	mg/L	0.0054	0.0012
Calcium (Dissolved)	mg/L	110	160
Iron (Dissolved)	mg/L	0.030	0.0046
Magnesium (Dissolved)	mg/L	73	18
Manganese (Dissolved)	mg/L	0.35	0.82
Potassium (Dissolved)	mg/L	36	7.2
Sodium (Dissolved)	mg/L	200	76
Total Metals by ICP-MS—Trace (Default Digest)			
Arsenic (Total)	mg/L	0.028	0.0068
Calcium (Total)	mg/L	120	180
Calcium Hardness (as CaCO3) (Total)	mg/L	300	440

Sample Details (continued)		WATERS	WATERS
Lab Sample ID:		**170425-086-1**	**170425-086-2**
Client Sample ID:		20171939	20171940
Sample Date/Time:		24/04/2017 13:20	24/04/2017 11:49
Description:		598 Bushmere Road Whiteshed Bore	MAR Pilot Bore
Metals			
Total Metals by ICP-MS—Trace (Default Digest)			
Iron (Total)	mg/L	17	5.4
Magnesium (Total)	mg/L	81	21
Magnesium Hardness (as CaCO3) (Total)	mg/L	330	84
Manganese (Total)	mg/L	0.42	0.92
Potassium (Total)	mg/L	46	9.1
Sodium (Total)	mg/L	240	89
Total Hardness (as CaCO3)	mg/L	640	520
Organics			
Total Organic Carbon by Non-dispersive infrared detection			
Total Organic Carbon	mg/L	24	8.0
Microbiology			
Escherichia coli by Membrane Filtration			
Escherichia coli	cfu/100 mL	<1.6	<1.6

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods

The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Chemistry Detailed				
Anions by Ion Chromatography (0.45 µm Filtered)				
Chloride	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Nitrate (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Nitrite (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Sulphate	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Total Oxidised Nitrogen (as N) by Calculation	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Ion Balance (Anions/Cations) by Calculation				
Anion Total	APHA (online edition) 1030 E	meq/L	All	Auckland
Cation Total	APHA (online edition) 1030 E	meq/L	All	Auckland
meq/L Difference	APHA (online edition) 1030 E	meq/L	All	Auckland
Percent Difference	APHA (online edition) 1030 E		All	Auckland
Sum of Anions + Cations	APHA (online edition) 1030 E		All	Auckland
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	HMSO (1981) ISBN 0117516139	0.005 mg/L	2	Auckland
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	HMSO (1981) ISBN 0117516139	0.4 mg/L	1	Auckland
Ammoniacal Nitrogen (as NH4) by Calculation	Calculation from Ammonia (as N)	0.006 mg/L	All	Auckland
Bicarbonate Alkalinity (as HCO3) by Calculation	APHA (online edition) 4500-CO2 D	1 mg/L	All	Auckland
Carbonate Alkalinity (as CO3) by Calculation	APHA (online edition) 4500-CO2 D	1 mg/L	All	Auckland
Hydroxide Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
pH (at room temp c. 20 °C) by Electrode	APHA (online edition) 4500-H B	0.1 pH unit	All	Auckland
Sulfide by Colour Comparison (Methylene Blue Method)	APHA (online edition) 4500-S2 D	0.1 mg/L	1	Auckland
Total Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Total Chlorine (as Cl2) by Spectrophotometry according to APHA (2005) 4500-Cl G	APHA (online edition) 4500-Cl G	0.02 mg/L	All	Auckland
Total Dissolved Solids by Gravimetry	APHA (online edition) 2540 C (Modified: Dried at 103 - 105 ºC)	15 mg/L	All	Auckland
Total Nitrogen (as N) by Persulphate Digestion and Flow Analysis	APHA (online edition) 4500-P J (modified), 4500-NO3 I	0.010 mg/L	All	Auckland
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J (modified)	0.004 mg/L	All	Auckland
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	0.2 mg/L	All	Auckland
Turbidity by Nephelometry	APHA (online edition) 2130 B (modified)	0.05 NTU	All	Auckland
Metals				

Metals				
Dissolved Metals by ICP-MS—Trace				
Arsenic (Dissolved)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Dissolved)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Dissolved)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.05 mg/L	All	Auckland
Sodium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Metals by ICP-MS—Trace (Default Digest)				
Arsenic (Total)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Total)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Calcium Hardness (as CaCO3) (Total)	In House based on EPA 200.8 by ICPMS	0.03 mg/L	All	Auckland
Iron (Total)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Total)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Magnesium Hardness (as CaCO3) (Total)	In House based on EPA 200.8 by ICPMS	0.004 mg/L	All	Auckland
Manganese (Total)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Total)	In House based on EPA 200.8 by ICPMS	0.05 mg/L	All	Auckland
Sodium (Total)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Hardness (as CaCO3)	In House based on EPA 200.8 by ICPMS	0.03 mg/L	All	Auckland
Organics				
Total Organic Carbon by Non-dispersive infrared detection				
Total Organic Carbon	APHA (online edition) 5310 B	0.1 mg/L	All	Auckland
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603	2 cfu/100 mL	All	Auckland
Preparations				
0.45 µm Filtration for Dissolved Metals	APHA (online edition) 3010B (modified)		All	Auckland
Digest for Total Metals in Liquids	APHA (online edition) 3030 E (modified, 4:1 Nitric:Hydrochloric Acid)		All	Auckland
Glass Fibre Filtration (1.2 µm)	APHA (online edition) 2540 C (Filtration)		All	Auckland
Membrane Filtration (0.45 µm)	APHA (online edition) 4500-P B (preliminary filtration)		All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher. For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

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Report Signatory 09/05/2017

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Certificate of Analysis
Laboratory Reference:170505-086

Attention:	Hilltop Sampler	*Final Report:*	**228730-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**31-May-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**05-May-2017**
Client Reference:	**MAR**	*Sampled By:*	**Daniel Williams**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

No client filtered sample bottle received for sample ID 20172080 (590 Matawai rd GPF159). Logged as lab filtered dissolved metal test instead and was subsampled from the bulk as requested by the client.

Sample Details		WATERS	WATERS	WATERS	WATERS
Lab Sample ID:		**170505-086-1**	**170505-086-2**	**170505-086-3**	**170505-086-4**
Client Sample ID:		20172070	20172071	20172072	20172080
Sample Date/Time:		04/05/2017 09:20	04/05/2017 10:05	04/05/2017 11:05	04/05/2017 13:00
Description:		Mc Intyre 409 Matawai Rd (SH2) GPD116	Patterson 54 Bolitho Rd GPD115	Stuart 370 Bushmere Rd	590 Matawai Rd
Chemistry Detailed					
Anions by Ion Chromatography (0.45 µm Filtered)					
Chloride	mg/L	65	130	320	27
Nitrate (as N)	mg/L	0.0080	0.0094	0.0050	0.0054
Nitrite (as N)	mg/L	<0.002	<0.002	<0.002	<0.002
Sulphate	mg/L	<0.04	<0.04	<0.04	0.68
Total Oxidised Nitrogen (as N) by Calculation	mg/L	0.0080 *	0.0094 *	0.0050 *	0.0054 *
Ion Balance (Anions/Cations) by Calculation					
Anion Total	meq/L	16 *	14 *	22 *	8.9 *
Cation Total	meq/L	16 *	14 *	22 *	8.5 *
meq/L Difference	meq/L	0.78 *	0.25 *	0.021 *	0.40 *
Percent Difference	%	2.4 *	0.88 *	0.046 *	2.3 *
Sum of Anions + Cations	meq/L	32 *	28 *	45 *	17 *
General Testing					
Ammoniacal Nitrogen (as N)	mg/L	1.4	4.1	2.0	0.42
Ammoniacal Nitrogen (as NH4)	mg/L	2.0 *	5.5 *	2.6 *	0.53 *
Bicarbonate Alkalinity (as HCO3) by Calc	mg/L	840 *	630 *	810 *	490 *
Bicarbonate Alkalinity (as HCO3)	mg/L	840	630	810	500
Carbonate Alkalinity (as CO3)	mg/L	0.6 *	<0.6 *	0.6 *	<0.6 *
Carbonate Alkalinity (as CO3)	mg/L	<3.3	<4.0	<3.3	<2.0
Hydroxide Alkalinity (as CaCO3)	mg/L	<3.3	<4.0	<3.3	<2.0
Nitrate (as NO3)	mg/L	0.035 *	0.042 *	0.022 *	0.024 *
Nitrite (as NO2)	mg/L	<0.007 *	<0.007 *	<0.007 *	<0.007 *
pH (at room temp c. 20 °C)	pH unit	7.2	7.0	7.2	7.2
Sulfide	mg/L	<0.1 *	<0.1 *	<0.1 *	-
Total Alkalinity (as CaCO3)	mg/L	690	520	660	410
Total Chlorine (as Cl2)	mg/L	0.07	0.06	0.09	0.03
Total Dissolved Solids	mg/L	850	780	1200	530
Total Nitrogen (as N)	mg/L	1.2	3.8	1.8	0.42
Total Phosphorus (as P)	mg/L	0.31	0.15	0.33	0.13
Total Suspended Solids	mg/L	200	30	220	2.0
Turbidity	NTU	310	150	110	12
Metals					
Dissolved Metals by ICP-MS—Trace					
Arsenic (Dissolved)	mg/L	-	-	-	0.0020
Calcium (Dissolved)	mg/L	-	-	-	100

Sample Details (continued)		WATERS	WATERS	WATERS	WATERS
Lab Sample ID:		**170505-086-1**	**170505-086-2**	**170505-086-3**	**170505-086-4**
Client Sample ID:		20172070	20172071	20172072	20172080
Sample Date/Time:		04/05/2017 09:20	04/05/2017 10:05	04/05/2017 11:05	04/05/2017 13:00
Description:		Mc Intyre 409 Matawai Rd (SH2) GPD116	Patterson 54 Bolitho Rd GPD115	Stuart 370 Bushmere Rd	590 Matawai Rd
Metals					
Dissolved Metals by ICP-MS—Trace					
Iron (Dissolved)	mg/L	-	-	-	0.0025
Magnesium (Dissolved)	mg/L	-	-	-	11
Manganese (Dissolved)	mg/L	-	-	-	0.31
Potassium (Dissolved)	mg/L	-	-	-	5.2
Sodium (Dissolved)	mg/L	-	-	-	52
Dissolved Metals by ICP-MS—Trace (Received Filtered)					
Arsenic (Dissolved)	mg/L	0.0043	0.0053	0.0076	-
Calcium (Dissolved)	mg/L	190	160	220	-
Iron (Dissolved)	mg/L	10	8.9	4.9	-
Magnesium (Dissolved)	mg/L	24	19	34	-
Manganese (Dissolved)	mg/L	1.5	0.70	1.4	-
Potassium (Dissolved)	mg/L	6.4	9.0	7.6	-
Sodium (Dissolved)	mg/L	100	89	180	-
Total Metals by ICP-MS—Trace (Default Digest)					
Arsenic (Total)	mg/L	0.0051	0.0051	0.0094	0.0022
Calcium (Total)	mg/L	190	160	230	110
Iron (Total)	mg/L	28	10	10	1.0
Magnesium (Total)	mg/L	25	19	37	11
Manganese (Total)	mg/L	1.6	0.68	1.5	0.32
Potassium (Total)	mg/L	7.5	9.0	8.6	5.8
Sodium (Total)	mg/L	98	89	190	54
Total Hardness (as CaCO3)	mg/L	570	480	730	320
Organics					
Total Organic Carbon by Non-dispersive infrared detection					
Total Organic Carbon	mg/L	4.1	3.3	4.7	2.5
Microbiology					
Escherichia coli by Membrane Filtration					
Escherichia coli	cfu/100 mL	<1.6	<1.6	<1.6	<1.6

Sample Details		WATERS
Lab Sample ID:		**170505-086-5**
Client Sample ID:		20172074
Sample Date/Time:		05/05/2017 09:45
Description:		Harper Road
Chemistry Detailed		
Anions by Ion Chromatography (0.45 µm Filtered)		
Chloride	mg/L	29
Nitrate (as N)	mg/L	0.0028
Nitrite (as N)	mg/L	0.0037
Sulphate	mg/L	0.47
Total Oxidised Nitrogen (as N) by Calculation	mg/L	0.0065 *
Ion Balance (Anions/Cations) by Calculation		
Anion Total	meq/L	9.3 *
Cation Total	meq/L	9.5 *
meq/L Difference	meq/L	0.25 *
Percent Difference	%	1.3 *
Sum of Anions + Cations	meq/L	19 *
General Testing		
Ammoniacal Nitrogen (as N)	mg/L	0.27
Ammoniacal Nitrogen (as NH4)	mg/L	0.35 *
Bicarbonate Alkalinity (as HCO3) by Calc	mg/L	510 *
Bicarbonate Alkalinity (as HCO3)	mg/L	520

Sample Details (continued)	WATERS
Lab Sample ID:	**170505-086-5**
Client Sample ID:	20172074
Sample Date/Time:	05/05/2017 09:45
Description:	Harper Road

General Testing		
Carbonate Alkalinity (as CO3)	mg/L	<0.6 *
Carbonate Alkalinity (as CO3)	mg/L	<2.0
Hydroxide Alkalinity (as CaCO3)	mg/L	<2.0
Nitrate (as NO3)	mg/L	0.012 *
Nitrite (as NO2)	mg/L	0.012 *
pH (at room temp c. 20 °C)	pH unit	7.4
Sulfide	mg/L	<0.1 *
Total Alkalinity (as CaCO3)	mg/L	420
Total Chlorine (as Cl2)	mg/L	0.02
Total Dissolved Solids	mg/L	520
Total Nitrogen (as N)	mg/L	0.29
Total Phosphorus (as P)	mg/L	0.12
Total Suspended Solids	mg/L	4.8
Turbidity	NTU	17
Metals		
Dissolved Metals by ICP-MS—Trace (Received Filtered)		
Arsenic (Dissolved)	mg/L	0.0035
Calcium (Dissolved)	mg/L	130
Iron (Dissolved)	mg/L	1.6
Magnesium (Dissolved)	mg/L	13
Manganese (Dissolved)	mg/L	0.20
Potassium (Dissolved)	mg/L	4.2
Sodium (Dissolved)	mg/L	47
Total Metals by ICP-MS—Trace (Default Digest)		
Arsenic (Total)	mg/L	0.0033
Calcium (Total)	mg/L	130
Iron (Total)	mg/L	1.6
Magnesium (Total)	mg/L	13
Manganese (Total)	mg/L	0.20
Potassium (Total)	mg/L	5.2
Sodium (Total)	mg/L	46
Total Hardness (as CaCO3)	mg/L	360
Organics		
Total Organic Carbon by Non-dispersive infrared detection		
Total Organic Carbon	mg/L	5.8
Microbiology		
Escherichia coli by Membrane Filtration		
Escherichia coli	cfu/100 mL	<1.6

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods

The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Chemistry Detailed				
Anions by Ion Chromatography (0.45 µm Filtered)				
Chloride	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Nitrate (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Nitrite (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Sulphate	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Total Oxidised Nitrogen (as N) by Calculation	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Ion Balance (Anions/Cations) by Calculation				
Anion Total	APHA (online edition) 1030 E	meq/L	All	Auckland

Chemistry Detailed

Ion Balance (Anions/Cations) by Calculation

Cation Total	APHA (online edition) 1030 E	meq/L	All	Auckland
meq/L Difference	APHA (online edition) 1030 E	meq/L	All	Auckland
Percent Difference	APHA (online edition) 1030 E		All	Auckland
Sum of Anions + Cations	APHA (online edition) 1030 E		All	Auckland

General Testing

Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	HMSO (1981) ISBN 0117516139	0.005 mg/L	All	Auckland
Ammoniacal Nitrogen (as NH4) by Calculation	Calculation from Ammonia (as N)	0.006 mg/L	All	Auckland
Bicarbonate Alkalinity (as HCO3) by Calculation	APHA (online edition) 4500-CO2 D	1 mg/L	All	Auckland
Bicarbonate Alkalinity (as HCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Carbonate Alkalinity (as CO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Carbonate Alkalinity (as CO3) by Calculation	APHA (online edition) 4500-CO2 D	1 mg/L	All	Auckland
Hydroxide Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Nitrate (as NO3) by Calculation	Calculation	0.009 mg/L	All	Auckland
Nitrite (as NO2) by Calculation	Calculation	0.007 mg/L	All	Auckland
pH (at room temp c. 20 °C) by Electrode	APHA (online edition) 4500-H B	0.1 pH unit	All	Auckland
Sulfide by Colour Comparison (Methylene Blue Method)	APHA (online edition) 4500-S2 D	0.1 mg/L	1, 2, 3, 5	Auckland
Total Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Total Chlorine (as Cl2) by Spectrophotometry according to APHA (2005) 4500-Cl G	APHA (online edition) 4500-Cl G	0.02 mg/L	All	Auckland
Total Dissolved Solids by Gravimetry	APHA (online edition) 2540 C (Modified: Dried at 103 - 105 ºC)	15 mg/L	All	Auckland
Total Nitrogen (as N) by Persulphate Digestion and Flow Analysis	APHA (online edition) 4500-P J (modified), 4500-NO3 I	0.010 mg/L	All	Auckland
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J (modified)	0.004 mg/L	All	Auckland
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	0.2 mg/L	All	Auckland
Turbidity by Nephelometry	APHA (online edition) 2130 B (modified)	0.05 NTU	All	Auckland

Metals

Dissolved Metals by ICP-MS—Trace

Arsenic (Dissolved)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	4	Auckland
Calcium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	4	Auckland
Iron (Dissolved)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	4	Auckland
Magnesium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	4	Auckland
Manganese (Dissolved)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	4	Auckland
Potassium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.05 mg/L	4	Auckland
Sodium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	4	Auckland

Dissolved Metals by ICP-MS—Trace (Received Filtered)

Arsenic (Dissolved)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	1, 2, 3, 5	Auckland
Calcium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	1, 2, 3, 5	Auckland
Iron (Dissolved)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	1, 2, 3, 5	Auckland
Magnesium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	1, 2, 3, 5	Auckland
Manganese (Dissolved)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	1, 2, 3, 5	Auckland
Potassium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.02 mg/L	1, 2, 3, 5	Auckland
Sodium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	1, 2, 3, 5	Auckland

Total Metals by ICP-MS—Trace (Default Digest)

Arsenic (Total)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Total)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Total)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Total)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Total)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Total)	In House based on EPA 200.8 by ICPMS	0.05 mg/L	All	Auckland
Sodium (Total)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Hardness (as CaCO3)	In House based on EPA 200.8 by ICPMS	0.03 mg/L	All	Auckland

Organics

Total Organic Carbon by Non-dispersive infrared detection

Total Organic Carbon	APHA (online edition) 5310 B	0.1 mg/L	All	Auckland

Microbiology

Escherichia coli by Membrane Filtration

Escherichia coli	USEPA Method 1603	2 cfu/100 mL	All	Auckland

Preparations

0.45 µm Filtration for Dissolved Metals	APHA (online edition) 3010B (modified)		4	Auckland

Preparations

Digest for Total Metals in Liquids	APHA (online edition) 3030 E (modified, 4:1 Nitric:Hydrochloric Acid)	All	Auckland
Glass Fibre Filtration (1.2 µm)	APHA (online edition) 2540 C (Filtration)	All	Auckland
Membrane Filtration (0.45 µm)	APHA (online edition) 4500-P B (preliminary filtration)	All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher.

For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

Watercare Laboratory Services is a division of Watercare Services Limited .

Report Signatory 31/05/2017

Anel Du Preez
KTP Signatory

Watercare Laboratory Services

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Certificate of Analysis
Laboratory Reference:170509-082

Attention:	Hilltop Sampler	*Final Report:*	**228731-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**31-May-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**09-May-2017**
Client Reference:	**MAR**	*Sampled By:*	**Peter Hancock**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

Sample Details	WATERS
Lab Sample ID:	**170509-082-1**
Client Sample ID:	20172081
Sample Date/Time:	08/05/2017 08:53
Description:	598 Bushmere Rd - MAR injection bore GPE066

Chemistry Detailed

Anions by Ion Chromatography (0.45 µm Filtered)

Chloride	mg/L	120
Nitrate (as N)	mg/L	0.0048
Nitrite (as N)	mg/L	0.0060
Sulphate	mg/L	<0.04
Total Oxidised Nitrogen (as N) by Calculation	mg/L	0.011 *

Ion Balance (Anions/Cations) by Calculation

Anion Total	meq/L	15 *
Cation Total	meq/L	15 *
meq/L Difference	meq/L	0.25 *
Percent Difference	%	0.85 *
Sum of Anions + Cations	meq/L	29 *

General Testing

Ammoniacal Nitrogen (as N)	mg/L	2.0
Ammoniacal Nitrogen (as NH4)	mg/L	2.6 *
Bicarbonate Alkalinity (as HCO3) by Calc	mg/L	690 *
Bicarbonate Alkalinity (as HCO3)	mg/L	680
Carbonate Alkalinity (as CO3)	mg/L	<0.6 *
Carbonate Alkalinity (as CO3)	mg/L	<3.3
Hydroxide Alkalinity (as CaCO3)	mg/L	<3.3
Nitrate (as NO3)	mg/L	0.021 *
Nitrite (as NO2)	mg/L	0.020 *
pH (at room temp c. 20 °C)	pH unit	7.1
Sulfide	mg/L	<0.1 *
Total Alkalinity (as CaCO3)	mg/L	560
Total Chlorine (as Cl2)	mg/L	0.09
Total Dissolved Solids	mg/L	780
Total Nitrogen (as N)	mg/L	2.0
Total Phosphorus (as P)	mg/L	0.43
Total Suspended Solids	mg/L	13
Turbidity	NTU	37

Metals

Dissolved Metals by ICP-MS—Trace (Received Filtered)

Arsenic (Dissolved)	mg/L	0.011
Calcium (Dissolved)	mg/L	170
Iron (Dissolved)	mg/L	5.1

Sample Details (continued)

WATERS

Lab Sample ID:	**170509-082-1**
Client Sample ID:	20172081
Sample Date/Time:	08/05/2017 08:53
Description:	598 Bushmere Rd - MAR injection bore GPE066

Metals

Dissolved Metals by ICP-MS—Trace (Received Filtered)

Magnesium (Dissolved)	mg/L	20
Manganese (Dissolved)	mg/L	0.96
Potassium (Dissolved)	mg/L	8.4
Sodium (Dissolved)	mg/L	88

Total Metals by ICP-MS—Trace (Default Digest)

Arsenic (Total)	mg/L	0.011
Calcium (Total)	mg/L	170
Iron (Total)	mg/L	5.1
Magnesium (Total)	mg/L	19
Manganese (Total)	mg/L	0.94
Potassium (Total)	mg/L	8.2
Sodium (Total)	mg/L	86
Total Hardness (as CaCO3)	mg/L	520

Organics

Total Organic Carbon by Non-dispersive infrared detection

Total Organic Carbon	mg/L	5.2

Microbiology

Escherichia coli by Membrane Filtration

Escherichia coli	cfu/100 mL	<1.6

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods

The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Chemistry Detailed				
Anions by Ion Chromatography (0.45 µm Filtered)				
Chloride	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Nitrate (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Nitrite (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Sulphate	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Total Oxidised Nitrogen (as N) by Calculation	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Ion Balance (Anions/Cations) by Calculation				
Anion Total	APHA (online edition) 1030 E	meq/L	All	Auckland
Cation Total	APHA (online edition) 1030 E	meq/L	All	Auckland
meq/L Difference	APHA (online edition) 1030 E	meq/L	All	Auckland
Percent Difference	APHA (online edition) 1030 E		All	Auckland
Sum of Anions + Cations	APHA (online edition) 1030 E		All	Auckland
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	HMSO (1981) ISBN 0117516139	0.005 mg/L	All	Auckland
Ammoniacal Nitrogen (as NH4) by Calculation	Calculation from Ammonia (as N)	0.006 mg/L	All	Auckland
Bicarbonate Alkalinity (as HCO3) by Calculation	APHA (online edition) 4500-CO2 D	1 mg/L	All	Auckland
Bicarbonate Alkalinity (as HCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Carbonate Alkalinity (as CO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Carbonate Alkalinity (as CO3) by Calculation	APHA (online edition) 4500-CO2 D	1 mg/L	All	Auckland
Hydroxide Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Nitrate (as NO3) by Calculation	Calculation	0.009 mg/L	All	Auckland
Nitrite (as NO2) by Calculation	Calculation	0.007 mg/L	All	Auckland
pH (at room temp c. 20 °C) by Electrode	APHA (online edition) 4500-H B	0.1 pH unit	All	Auckland

General Testing				
Sulfide by Colour Comparison (Methylene Blue Method)	APHA (online edition) 4500-S2 D	0.1 mg/L	All	Auckland
Total Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Total Chlorine (as Cl2) by Spectrophotometry according to APHA (2005) 4500-Cl G	APHA (online edition) 4500-Cl G	0.02 mg/L	All	Auckland
Total Dissolved Solids by Gravimetry	APHA (online edition) 2540 C (Modified: Dried at 103 - 105 °C)	15 mg/L	All	Auckland
Total Nitrogen (as N) by Persulphate Digestion and Flow Analysis	APHA (online edition) 4500-P J (modified), 4500-NO3 I	0.010 mg/L	All	Auckland
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J (modified)	0.004 mg/L	All	Auckland
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	0.2 mg/L	All	Auckland
Turbidity by Nephelometry	APHA (online edition) 2130 B (modified)	0.05 NTU	All	Auckland
Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Arsenic (Dissolved)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Dissolved)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Dissolved)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.02 mg/L	All	Auckland
Sodium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Metals by ICP-MS—Trace (Default Digest)				
Arsenic (Total)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Total)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Total)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Total)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Total)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Total)	In House based on EPA 200.8 by ICPMS	0.05 mg/L	All	Auckland
Sodium (Total)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Hardness (as CaCO3)	In House based on EPA 200.8 by ICPMS	0.03 mg/L	All	Auckland
Organics				
Total Organic Carbon by Non-dispersive infrared detection				
Total Organic Carbon	APHA (online edition) 5310 B	0.1 mg/L	All	Auckland
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603	2 cfu/100 mL	All	Auckland
Preparations				
Digest for Total Metals in Liquids	APHA (online edition) 3030 E (modified, 4:1 Nitric:Hydrochloric Acid)		All	Auckland
Glass Fibre Filtration (1.2 µm)	APHA (online edition) 2540 C (Filtration)		All	Auckland
Membrane Filtration (0.45 µm)	APHA (online edition) 4500-P B (preliminary filtration)		All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher.

For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

Watercare Laboratory Services is a division of Watercare Services Limited .

ilac-MRA IANZ ACCREDITED LABORATORY

Report Signatory 31/05/2017

Anel Du Preez
KTP Signatory

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Certificate of Analysis
Laboratory Reference:170518-076

Attention:	Hilltop Sampler	*Final Report:*	**229077-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**04-Jun-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**18-May-2017**
Client Reference:	**MAR**	*Sampled By:*	**Peter Hancock**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

Sample Details		WATERS	WATERS
Lab Sample ID:		**170518-076-1**	**170518-076-2**
Client Sample ID:		20172234	20172235
Sample Date/Time:		17/05/2017 12:14	17/05/2017 14:02
Description:		598 Bushmere Rd MAR Pilot Bore GPE 065	599 Bushmere Rd GPE010
Chemistry Detailed			
Anions by Ion Chromatography (0.45 µm Filtered)			
Chloride	mg/L	120	140
Nitrate (as N)	mg/L	0.0071	0.0072
Nitrite (as N)	mg/L	0.013	0.011
Sulphate	mg/L	0.11	<0.02
Total Oxidised Nitrogen (as N) by Calculation	mg/L	0.020 *	0.018 *
Ion Balance (Anions/Cations) by Calculation			
Anion Total	meq/L	15 *	16 *
Cation Total	meq/L	15 *	16 *
meq/L Difference	meq/L	0.063 *	0.38 *
Percent Difference	%	0.21 *	1.2 *
Sum of Anions + Cations	meq/L	30 *	32 *
General Testing			
Ammoniacal Nitrogen (as N)	mg/L	2.0	2.5
Ammoniacal Nitrogen (as NH4)	mg/L	2.5 *	3.2 *
Bicarbonate Alkalinity (as HCO3)	mg/L	700	710
Carbonate Alkalinity (as CO3)	mg/L	<4.0	<4.0
Hydroxide Alkalinity (as CaCO3)	mg/L	<4.0	<4.0
Nitrate (as NO3)	mg/L	0.031 *	0.032 *
Nitrite (as NO2)	mg/L	0.043 *	0.036 *
pH (at room temp c. 20 °C)	pH unit	7.1	7.2
Total Alkalinity (as CaCO3)	mg/L	580	580
Total Chlorine (as Cl2)	mg/L	0.07	0.04
Total Dissolved Solids	mg/L	850	860
Total Nitrogen (as N)	mg/L	1.9	2.3
Total Phosphorus (as P)	mg/L	0.39	0.33
Total Suspended Solids	mg/L	69	42
Turbidity	NTU	65	160
Metals			
Dissolved Metals by ICP-MS—Trace (Received Filtered)			
Arsenic (Dissolved)	mg/L	0.0080	0.0068
Calcium (Dissolved)	mg/L	180	200
Iron (Dissolved)	mg/L	5.5	15
Magnesium (Dissolved)	mg/L	20	22
Manganese (Dissolved)	mg/L	0.92	1.0
Potassium (Dissolved)	mg/L	10	9.6
Sodium (Dissolved)	mg/L	87	79

Sample Details (continued)		WATERS	WATERS
Lab Sample ID:		**170518-076-1**	**170518-076-2**
Client Sample ID:		20172234	20172235
Sample Date/Time:		17/05/2017 12:14	17/05/2017 14:02
Description:		598 Bushmere Rd MAR Pilot Bore GPE 065	599 Bushmere Rd GPE010
Metals			
Total Metals by ICP-MS—Trace (Default Digest)			
Arsenic (Total)	mg/L	0.0095	0.0072
Calcium (Total)	mg/L	180	180
Iron (Total)	mg/L	8.3	16
Magnesium (Total)	mg/L	22	24
Manganese (Total)	mg/L	0.95	1.0
Potassium (Total)	mg/L	9.0	8.9
Sodium (Total)	mg/L	90	82
Total Hardness (as CaCO3)	mg/L	550	560
Organics			
Total Organic Carbon by Non-dispersive infrared detection			
Total Organic Carbon	mg/L	5.4	3.7
Microbiology			
Escherichia coli by Membrane Filtration			
Escherichia coli	cfu/100 mL	<1.6	<1.6

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods

The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Chemistry Detailed				
Anions by Ion Chromatography (0.45 µm Filtered)				
Chloride	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Nitrate (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Nitrite (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Sulphate	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Total Oxidised Nitrogen (as N) by Calculation	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Ion Balance (Anions/Cations) by Calculation				
Anion Total	APHA (online edition) 1030 E	meq/L	All	Auckland
Cation Total	APHA (online edition) 1030 E	meq/L	All	Auckland
meq/L Difference	APHA (online edition) 1030 E	meq/L	All	Auckland
Percent Difference	APHA (online edition) 1030 E		All	Auckland
Sum of Anions + Cations	APHA (online edition) 1030 E		All	Auckland
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	HMSO (1981) ISBN 0117516139	0.005 mg/L	All	Auckland
Ammoniacal Nitrogen (as NH4) by Calculation	Calculation from Ammonia (as N)	0.006 mg/L	All	Auckland
Bicarbonate Alkalinity (as HCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Carbonate Alkalinity (as CO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Hydroxide Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Nitrate (as NO3) by Calculation	Calculation	0.009 mg/L	All	Auckland
Nitrite (as NO2) by Calculation	Calculation	0.007 mg/L	All	Auckland
pH (at room temp c. 20 °C) by Electrode	APHA (online edition) 4500-H B	0.1 pH unit	All	Auckland
Total Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Total Chlorine (as Cl2) by Spectrophotometry according to APHA (2005) 4500-Cl G	APHA (online edition) 4500-Cl G	0.02 mg/L	All	Auckland
Total Dissolved Solids by Gravimetry	APHA (online edition) 2540 C (Modified: Dried at 103 - 105 °C)	15 mg/L	All	Auckland
Total Nitrogen (as N) by Persulphate Digestion and Flow Analysis	APHA (online edition) 4500-P J (modified), 4500-NO3 I	0.010 mg/L	All	Auckland

General Testing				
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J (modified)	0.004 mg/L	All	Auckland
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	0.2 mg/L	All	Auckland
Turbidity by Nephelometry	APHA (online edition) 2130 B (modified)	0.05 NTU	All	Auckland
Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Arsenic (Dissolved)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Dissolved)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Dissolved)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.02 mg/L	All	Auckland
Sodium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Metals by ICP-MS—Trace (Default Digest)				
Arsenic (Total)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Total)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Total)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Total)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Total)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Total)	In House based on EPA 200.8 by ICPMS	0.05 mg/L	All	Auckland
Sodium (Total)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Hardness (as CaCO3)	In House based on EPA 200.8 by ICPMS	0.03 mg/L	All	Auckland
Organics				
Total Organic Carbon by Non-dispersive infrared detection				
Total Organic Carbon	APHA (online edition) 5310 B	0.1 mg/L	All	Auckland
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603	2 cfu/100 mL	All	Auckland
Preparations				
Digest for Total Metals in Liquids	APHA (online edition) 3030 E (modified, 4:1 Nitric:Hydrochloric Acid)		All	Auckland
Glass Fibre Filtration (1.2 µm)	APHA (online edition) 2540 C (Filtration)		All	Auckland
Membrane Filtration (0.45 µm)	APHA (online edition) 4500-P B (preliminary filtration)		All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher.

For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

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Report Signatory 04/06/2017

Carol Taylor
KTP Signatory

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Certificate of Analysis
Laboratory Reference:170607-106

Attention:	Hilltop Sampler	*Final Report:*	**231671-0**	*Replaces Report*	**230948-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**22-Jun-2017**		
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**07-Jun-2017**		
Client Reference:	**598 Bushmere Road MAR Injection Bore GPE066**	*Sampled By:*	**Mark Joblin**		
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**		

Sample Details	WATERS
Lab Sample ID:	**170607-106-1**
Client Sample ID:	20172586
Sample Date/Time:	06/06/2017 11:30
Description:	598 Bushmere Road MAR Injection Bore GPE066

Chemistry Detailed

Anions by Ion Chromatography (0.45 µm Filtered)

Chloride	mg/L	15
Nitrate (as N)	mg/L	0.0055
Nitrite (as N)	mg/L	<0.002
Sulphate	mg/L	76
Total Oxidised Nitrogen (as N) by Calculation	mg/L	0.0055 *

Ion Balance (Anions/Cations) by Calculation

Anion Total	meq/L	6.4 *
Cation Total	meq/L	6.5 *
meq/L Difference	meq/L	0.54e-1 *
Percent Difference	%	0.42 *
Sum of Anions + Cations	meq/L	13 *

General Testing

Ammoniacal Nitrogen (as N)	mg/L	0.55
Ammoniacal Nitrogen (as NH4)	mg/L	0.71 *
Bicarbonate Alkalinity (as HCO3)	mg/L	270
Carbonate Alkalinity (as CO3)	mg/L	<2.0
Conductivity (at 25 °C)	mS/m	60.6
Hydroxide Alkalinity (as CaCO3)	mg/L	<2.0
pH (at room temp c. 20 °C)	pH unit	7.6
Total Alkalinity (as CaCO3)	mg/L	220
Total Chlorine (as Cl2)	mg/L	0.04
Total Dissolved Solids	mg/L	460
Total Nitrogen (as N)	mg/L	1.1
Total Phosphorus (as P)	mg/L	0.018
Total Suspended Solids	mg/L	3.0
Turbidity	NTU	0.65

Metals

Dissolved Metals by ICP-MS—Trace (Received Filtered)

Arsenic (Dissolved)	mg/L	0.0027
Calcium (Dissolved)	mg/L	78
Iron (Dissolved)	mg/L	0.035
Magnesium (Dissolved)	mg/L	8.5
Manganese (Dissolved)	mg/L	0.21
Potassium (Dissolved)	mg/L	4.9
Sodium (Dissolved)	mg/L	39

Total Metals by ICP-MS—Trace (Default Digest)

Sample Details (continued)

WATERS

Lab Sample ID:	**170607-106-1**
Client Sample ID:	20172586
Sample Date/Time:	06/06/2017 11:30
Description:	598 Bushmere Road MAR Injection Bore GPE066

Metals

Total Metals by ICP-MS—Trace (Default Digest)

Arsenic (Total)	mg/L	0.0027
Iron (Total)	mg/L	0.063
Manganese (Total)	mg/L	0.20
Potassium (Total)	mg/L	4.9
Sodium (Total)	mg/L	35

Organics

Total Organic Carbon by Non-dispersive infrared detection

Total Organic Carbon	mg/L	3.7

Microbiology

Escherichia coli by Membrane Filtration

Escherichia coli	cfu/100 mL	1.6

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods

The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Chemistry Detailed				
Anions by Ion Chromatography (0.45 µm Filtered)				
Chloride	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Nitrate (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Nitrite (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Sulphate	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Total Oxidised Nitrogen (as N) by Calculation	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Ion Balance (Anions/Cations) by Calculation				
Anion Total	APHA (online edition) 1030 E	meq/L	All	Auckland
Cation Total	APHA (online edition) 1030 E	meq/L	All	Auckland
meq/L Difference	APHA (online edition) 1030 E	meq/L	All	Auckland
Percent Difference	APHA (online edition) 1030 E		All	Auckland
Sum of Anions + Cations	APHA (online edition) 1030 E		All	Auckland
General Testing				
Ammoniacal Nitrogen (as N) by Flow Analysis	APHA (online edition) 4500-NH3 H	0.005 mg/L	All	Auckland
Ammoniacal Nitrogen (as NH4) by Calculation	Calculation from Ammonia (as N)	0.006 mg/L	All	Auckland
Bicarbonate Alkalinity (as HCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Carbonate Alkalinity (as CO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Conductivity (at 25 °C) by Electrode	APHA (online edition) 2510 B	0.5 mS/m	All	Auckland
Hydroxide Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
pH (at room temp c. 20 °C) by Electrode	APHA (online edition) 4500-H B	0.1 pH unit	All	Auckland
Total Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Total Chlorine (as Cl2) by Spectrophotometry according to APHA (2005) 4500-Cl G	APHA (online edition) 4500-Cl G	0.02 mg/L	All	Auckland
Total Dissolved Solids by Gravimetry	APHA (online edition) 2540 C (Modified: Dried at 103 - 105 ºC)	15 mg/L	All	Auckland
Total Nitrogen (as N) by Persulphate Digestion and Flow Analysis	APHA (online edition) 4500-P J (modified), 4500-NO3 I	0.010 mg/L	All	Auckland
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J (modified)	0.004 mg/L	All	Auckland
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	0.2 mg/L	All	Auckland
Turbidity by Nephelometry	APHA (online edition) 2130 B (modified)	0.05 NTU	All	Auckland
Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				

Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Arsenic (Dissolved)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Dissolved)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Dissolved)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.02 mg/L	All	Auckland
Sodium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Metals by ICP-MS—Trace (Default Digest)				
Arsenic (Total)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Iron (Total)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Manganese (Total)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Total)	In House based on EPA 200.8 by ICPMS	0.05 mg/L	All	Auckland
Sodium (Total)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Organics				
Total Organic Carbon by Non-dispersive infrared detection				
Total Organic Carbon	APHA (online edition) 5310 B	0.1 mg/L	All	Auckland
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603	2 cfu/100 mL	All	Auckland
Preparations				
Digest for Total Metals in Liquids	APHA (online edition) 3030 E (modified, 4:1 Nitric:Hydrochloric Acid)		All	Auckland
Glass Fibre Filtration (1.2 µm)	APHA (online edition) 2540 C (Filtration)		All	Auckland
Membrane Filtration (0.45 µm)	APHA (online edition) 4500-P B (preliminary filtration)		All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher.

For more information please contact the Operations Manager.

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Report Signatory 22/06/2017

Carol Taylor
KTP Signatory

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Certificate of Analysis
Laboratory Reference:170616-116

Attention:	Hilltop Sampler	*Final Report:*	**231867-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**29-Jun-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**17-Jun-2017**
Client Reference:	**MAR**	*Sampled By:*	**Matt McGill-Brown**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

Sample Details		WATERS	WATERS	WATERS
Lab Sample ID:		**170616-116-1**	**170616-116-2**	**170616-116-3**
Client Sample ID:		20172805	20172806	20172808
Sample Date/Time:		16/06/2017 09:30	16/06/2017 11:02	16/06/2017 09:57
Description:		599 Bushmere Road GPE010	598 Bushmere Rd - MAR injection bore GPE066	598 Bushmere Road MAR Headworks outlet
Chemistry Detailed				
Anions by Ion Chromatography (0.45 µm Filtered)				
Chloride	mg/L	140	13	11
Nitrate (as N)	mg/L	0.017	0.0080	0.30
Nitrite (as N)	mg/L	0.012	0.011	0.0042
Sulphate	mg/L	<0.04	86	92
Total Oxidised Nitrogen (as N) by Calculation	mg/L	0.028 *	0.019 *	0.31 *
General Testing				
Ammoniacal Nitrogen (as N)	mg/L	2.5	1.2	<0.005
Ammoniacal Nitrogen (as NH4)	mg/L	3.2 *	1.6 *	<0.006 *
Bicarbonate Alkalinity (as HCO3)	mg/L	720	200	200
Carbonate Alkalinity (as CO3)	mg/L	<4.0	<1.0	<1.0
Hydroxide Alkalinity (as CaCO3)	mg/L	<4.0	<1.0	<1.0
pH (at room temp c. 20 °C)	pH unit	7.2	7.6	8.0
Sulfide	mg/L	<0.1 *	<0.1 *	<0.1 *
Total Alkalinity (as CaCO3)	mg/L	590	170	160
Total Chlorine (as Cl2)	mg/L	0.03	0.06	0.08
Total Dissolved Solids	mg/L	1000	390	390
Total Nitrogen (as N)	mg/L	2.4	1.3	0.47
Total Phosphorus (as P)	mg/L	0.017	0.044	0.026
Total Suspended Solids	mg/L	41	1.6	0.75
Turbidity	NTU	80	15	0.60
Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Arsenic (Dissolved)	mg/L	0.0071	<0.001	0.00068
Iron (Dissolved)	mg/L	16	1.4	0.0054
Manganese (Dissolved)	mg/L	1.1	0.34	0.013
Total Metals by ICP-MS—Trace (Default Digest)				
Arsenic (Total)	mg/L	0.0073	0.0011	0.00066
Calcium (Total)	mg/L	200	65	73
Iron (Total)	mg/L	14	1.4	0.024
Magnesium (Total)	mg/L	23	7.4	8.1
Manganese (Total)	mg/L	1.1	0.35	0.013
Potassium (Total)	mg/L	8.4	4.3	2.5
Sodium (Total)	mg/L	82	30	27
Total Hardness (as CaCO3)	mg/L	590	190	220
Organics				
Total Organic Carbon by Non-dispersive infrared detection				
Total Organic Carbon	mg/L	3.2	3.6	3.0
Microbiology				

Sample Details (continued)		WATERS	WATERS	WATERS
Lab Sample ID:		**170616-116-1**	**170616-116-2**	**170616-116-3**
Client Sample ID:		20172805	20172806	20172808
Sample Date/Time:		16/06/2017 09:30	16/06/2017 11:02	16/06/2017 09:57
Description:		599 Bushmere Road GPE010	598 Bushmere Rd - MAR injection bore GPE066	598 Bushmere Road MAR Headworks outlet
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	cfu/100 mL	4.9	1.6	4.9

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods

The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Chemistry Detailed				
Anions by Ion Chromatography (0.45 µm Filtered)				
Chloride	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Nitrate (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Nitrite (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Sulphate	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Total Oxidised Nitrogen (as N) by Calculation	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	HMSO (1981) ISBN 0117516139	0.005 mg/L	All	Auckland
Ammoniacal Nitrogen (as NH4) by Calculation	Calculation from Ammonia (as N)	0.006 mg/L	All	Auckland
Bicarbonate Alkalinity (as HCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Carbonate Alkalinity (as CO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Hydroxide Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
pH (at room temp c. 20 °C) by Electrode	APHA (online edition) 4500-H B	0.1 pH unit	All	Auckland
Sulfide by Colour Comparison (Methylene Blue Method)	APHA (online edition) 4500-S2 D	0.1 mg/L	All	Auckland
Total Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Total Chlorine (as Cl2) by Spectrophotometry according to APHA (2005) 4500-Cl G	APHA (online edition) 4500-Cl G	0.02 mg/L	All	Auckland
Total Dissolved Solids by Gravimetry	APHA (online edition) 2540 C (Modified: Dried at 103 - 105 ºC)	15 mg/L	All	Auckland
Total Nitrogen (as N) by Persulphate Digestion and Flow Analysis	APHA (online edition) 4500-P J (modified), 4500-NO3 I	0.010 mg/L	All	Auckland
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J (modified)	0.004 mg/L	All	Auckland
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	0.2 mg/L	All	Auckland
Turbidity by Nephelometry	APHA (online edition) 2130 B (modified)	0.05 NTU	All	Auckland
Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Arsenic (Dissolved)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Iron (Dissolved)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Manganese (Dissolved)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Total Metals by ICP-MS—Trace (Default Digest)				
Arsenic (Total)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Total)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Total)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Total)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Total)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Total)	In House based on EPA 200.8 by ICPMS	0.05 mg/L	All	Auckland
Sodium (Total)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Hardness (as CaCO3)	In House based on EPA 200.8 by ICPMS	0.03 mg/L	All	Auckland
Organics				
Total Organic Carbon by Non-dispersive infrared detection				
Total Organic Carbon	APHA (online edition) 5310 B	0.1 mg/L	All	Auckland
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603	2 cfu/100 mL	All	Auckland

Preparations			
Digest for Total Metals in Liquids	APHA (online edition) 3030 E (modified, 4:1 Nitric:Hydrochloric Acid)	All	Auckland
Glass Fibre Filtration (1.2 µm)	APHA (online edition) 2540 C (Filtration)	All	Auckland
Membrane Filtration (0.45 µm)	APHA (online edition) 4500-P B (preliminary filtration)	All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher. For more information please contact the Operations Manager.

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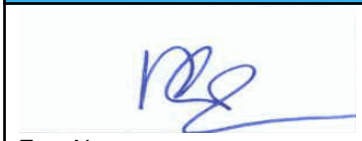
Report Signatory 29/06/2017



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Certificate of Analysis
Laboratory Reference:170623-107

Attention:	Hilltop Sampler	*Final Report:*	**232974-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**30-Jun-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**24-Jun-2017**
Client Reference:	**MAR Project**	*Sampled By:*	**Alice Trevelyan**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

Sample Details		WATERS	WATERS
Lab Sample ID:		**170623-107-1**	**170623-107-2**
Client Sample ID:		20172812	20172813
Sample Date/Time:		23/06/2017 09:42	23/06/2017 10:49
Description:		599 Bushmere Road GPE010	598 Bushmere Road MAR Pilot Bore GPE 065
Chemistry Detailed			
Anions by Ion Chromatography (0.45 µm Filtered)			
Chloride	mg/L	140	47
Nitrate (as N)	mg/L	0.0099	0.0052
Nitrite (as N)	mg/L	0.0066	0.0037
Sulphate	mg/L	<0.04	55
Total Oxidised Nitrogen (as N) by Calculation	mg/L	0.017 *	0.0089 *
Ion Balance (Anions/Cations) by Calculation			
Anion Total	meq/L	16 *	8.8 *
Cation Total	meq/L	16 *	8.7 *
meq/L Difference	meq/L	0.51 *	0.84e-1 *
Percent Difference	%	1.6 *	0.48 *
Sum of Anions + Cations	meq/L	32 *	18 *
General Testing			
Ammoniacal Nitrogen (as N)	mg/L	2.5	1.6
Ammoniacal Nitrogen (as NH4)	mg/L	3.3 *	2.0 *
Bicarbonate Alkalinity (as HCO3)	mg/L	740	390
Carbonate Alkalinity (as CO3)	mg/L	<5.0	<2.0
Hydroxide Alkalinity (as CaCO3)	mg/L	<5.0	<2.0
pH (at room temp c. 20 °C)	pH unit	7.4	7.6
Sulfide	mg/L	<0.1 *	0.6 *
Total Alkalinity (as CaCO3)	mg/L	610	320
Total Chlorine (as Cl2)	mg/L	0.03	0.05
Total Dissolved Solids	mg/L	880	530
Total Nitrogen (as N)	mg/L	2.5	2.0
Total Phosphorus (as P)	mg/L	0.23	0.23
Total Suspended Solids	mg/L	39	12
Turbidity	NTU	180	30
Metals			
Dissolved Metals by ICP-MS—Trace (Received Filtered)			
Arsenic (Dissolved)	mg/L	0.0081	0.0021
Calcium (Dissolved)	mg/L	200	100
Iron (Dissolved)	mg/L	15	2.3
Magnesium (Dissolved)	mg/L	23	12
Manganese (Dissolved)	mg/L	1.2	0.53
Potassium (Dissolved)	mg/L	8.3	5.9
Sodium (Dissolved)	mg/L	83	52
Total Metals by ICP-MS—Trace (Default Digest)			
Arsenic (Total)	mg/L	0.0080	0.0024
Calcium (Total)	mg/L	200	100
Iron (Total)	mg/L	15	2.5

Sample Details (continued)		WATERS	WATERS
Lab Sample ID:		**170623-107-1**	**170623-107-2**
Client Sample ID:		20172812	20172813
Sample Date/Time:		23/06/2017 09:42	23/06/2017 10:49
Description:		599 Bushmere Road GPE010	598 Bushmere Road MAR Pilot Bore GPE 065
Metals			
Total Metals by ICP-MS—Trace (Default Digest)			
Magnesium (Total)	mg/L	24	12
Manganese (Total)	mg/L	1.1	0.56
Potassium (Total)	mg/L	8.7	6.3
Sodium (Total)	mg/L	81	53
Total Hardness (as CaCO3)	mg/L	590	310
Organics			
Total Organic Carbon by Non-dispersive infrared detection			
Total Organic Carbon	mg/L	5.8	8.9

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods

The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Chemistry Detailed				
Anions by Ion Chromatography (0.45 µm Filtered)				
Chloride	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Nitrate (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Nitrite (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Sulphate	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Total Oxidised Nitrogen (as N) by Calculation	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Ion Balance (Anions/Cations) by Calculation				
Anion Total	APHA (online edition) 1030 E	meq/L	All	Auckland
Cation Total	APHA (online edition) 1030 E	meq/L	All	Auckland
meq/L Difference	APHA (online edition) 1030 E	meq/L	All	Auckland
Percent Difference	APHA (online edition) 1030 E		All	Auckland
Sum of Anions + Cations	APHA (online edition) 1030 E		All	Auckland
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	HMSO (1981) ISBN 0117516139	0.005 mg/L	All	Auckland
Ammoniacal Nitrogen (as NH4) by Calculation	Calculation from Ammonia (as N)	0.006 mg/L	All	Auckland
Bicarbonate Alkalinity (as HCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Carbonate Alkalinity (as CO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Hydroxide Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
pH (at room temp c. 20 °C) by Electrode	APHA (online edition) 4500-H B	0.1 pH unit	All	Auckland
Sulfide by Colour Comparison (Methylene Blue Method)	APHA (online edition) 4500-S2 D	0.1 mg/L	All	Auckland
Total Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Total Chlorine (as Cl2) by Spectrophotometry according to APHA (2005) 4500-Cl G	APHA (online edition) 4500-Cl G	0.02 mg/L	All	Auckland
Total Dissolved Solids by Gravimetry	APHA (online edition) 2540 C (Modified: Dried at 103 - 105 ºC)	15 mg/L	All	Auckland
Total Nitrogen (as N) by Persulphate Digestion and Flow Analysis	APHA (online edition) 4500-P J (modified), 4500-NO3 I	0.010 mg/L	All	Auckland
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J (modified)	0.004 mg/L	All	Auckland
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	0.2 mg/L	All	Auckland
Turbidity by Nephelometry	APHA (online edition) 2130 B (modified)	0.05 NTU	All	Auckland
Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Arsenic (Dissolved)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Dissolved)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Dissolved)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland

Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Potassium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.02 mg/L	All	Auckland
Sodium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Metals by ICP-MS—Trace (Default Digest)				
Arsenic (Total)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Total)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Total)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Total)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Total)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Total)	In House based on EPA 200.8 by ICPMS	0.05 mg/L	All	Auckland
Sodium (Total)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Hardness (as CaCO3)	In House based on EPA 200.8 by ICPMS	0.03 mg/L	All	Auckland
Organics				
Total Organic Carbon by Non-dispersive infrared detection				
Total Organic Carbon	APHA (online edition) 5310 B	0.1 mg/L	All	Auckland
Preparations				
Digest for Total Metals in Liquids	APHA (online edition) 3030 E (modified, 4:1 Nitric:Hydrochloric Acid)		All	Auckland
Glass Fibre Filtration (1.2 µm)	APHA (online edition) 2540 C (Filtration)		All	Auckland
Membrane Filtration (0.45 µm)	APHA (online edition) 4500-P B (preliminary filtration)		All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher. For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

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Report Signatory 30/06/2017

Peter Boniface
KTP Signatory

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Certificate of Analysis
Laboratory Reference:170701-047

Attention:	Hilltop Sampler	*Final Report:*	**234815-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**19-Jul-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**01-Jul-2017**
Client Reference:	**MAR**	*Sampled By:*	**Alice Trevelyan**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

Note: For sample 2 (598 Bushmere Road MAR Pilot Bore GPE 065), dissolved calcium, magnesium and sodium higher than total calcium, magnesium and sodium - retested and confirmed, suspect contamination during sampling.

Sample Details		WATERS	WATERS	WATERS
Lab Sample ID:		**170701-047-1**	**170701-047-2**	**170701-047-3**
Client Sample ID:		20172815	20172816	20172883
Sample Date/Time:		30/06/2017 09:26	30/06/2017 10:45	30/06/2017 10:17
Description:		599 Bushmere Road GPE010	598 Bushmere Road MAR Pilot Bore GPE 065	598 Bushmere Rd - MAR injection bore GPE066
Chemistry Detailed				
Anions by Ion Chromatography (0.45 µm Filtered)				
Chloride	mg/L	140	17	11
Nitrate (as N)	mg/L	0.012	0.0039	0.0041
Nitrite (as N)	mg/L	0.013	0.0048	0.0055
Sulphate	mg/L	<0.04	86	95
Total Oxidised Nitrogen (as N) by Calculation	mg/L	0.024 *	0.0087 *	0.0096 *
Ion Balance (Anions/Cations) by Calculation				
Anion Total	meq/L	16 *	6.2 *	6.1 *
Cation Total	meq/L	16 *	8.2 *	6.2 *
meq/L Difference	meq/L	0.80 *	2.1 *	0.14 *
Percent Difference	%	2.5 *	14 *	1.1 *
Sum of Anions + Cations	meq/L	32 *	14 *	12 *
General Testing				
Ammoniacal Nitrogen (as N)	mg/L	2.4	1.1	0.12
Ammoniacal Nitrogen (as NH4)	mg/L	3.1 *	1.5 *	0.15 *
Bicarbonate Alkalinity (as HCO3)	mg/L	720	240	230
Carbonate Alkalinity (as CO3)	mg/L	<4.0	<2.0	<2.0
Hydroxide Alkalinity (as CaCO3)	mg/L	<4.0	<2.0	<2.0
pH (at room temp c. 20 °C)	pH unit	6.9	7.3	7.4
Sulfide	mg/L	<0.1 *	<0.1 *	<0.1 *
Total Alkalinity (as CaCO3)	mg/L	590	200	190
Total Chlorine (as Cl2)	mg/L	0.05	0.06	0.09
Total Dissolved Solids	mg/L	830	350	340
Total Nitrogen (as N)	mg/L	2.3	1.2	0.25
Total Phosphorus (as P)	mg/L	0.26	0.25	0.023
Total Suspended Solids	mg/L	43	4.8	3.0
Turbidity	NTU	200	17	1.5
Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Arsenic (Dissolved)	mg/L	0.0063	0.0029	0.0018
Calcium (Dissolved)	mg/L	200	97	83
Iron (Dissolved)	mg/L	11	1.1	0.0043
Magnesium (Dissolved)	mg/L	23	11	8.8
Manganese (Dissolved)	mg/L	1.2	0.49	0.068
Potassium (Dissolved)	mg/L	8.6	5.5	2.8

Sample Details (continued)		WATERS	WATERS	WATERS
Lab Sample ID:		**170701-047-1**	**170701-047-2**	**170701-047-3**
Client Sample ID:		20172815	20172816	20172883
Sample Date/Time:		30/06/2017 09:26	30/06/2017 10:45	30/06/2017 10:17
Description:		599 Bushmere Road GPE010	598 Bushmere Road MAR Pilot Bore GPE 065	598 Bushmere Rd - MAR injection bore GPE066
Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Sodium (Dissolved)	mg/L	86	51	30
Total Metals by ICP-MS—Trace (Default Digest)				
Arsenic (Total)	mg/L	0.0085	0.0042	0.0019
Calcium (Total)	mg/L	200	79	86
Iron (Total)	mg/L	17	2.0	0.032
Magnesium (Total)	mg/L	23	8.5	8.9
Manganese (Total)	mg/L	1.2	0.40	0.069
Potassium (Total)	mg/L	9.2	5.3	3.2
Sodium (Total)	mg/L	88	39	30
Total Hardness (as CaCO3)	mg/L	600	230	250
Organics				
Total Organic Carbon by Non-dispersive infrared detection				
Total Organic Carbon	mg/L	3.5	3.4	2.9

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods

The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Chemistry Detailed				
Anions by Ion Chromatography (0.45 µm Filtered)				
Chloride	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Nitrate (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Nitrite (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Sulphate	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Total Oxidised Nitrogen (as N) by Calculation	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Ion Balance (Anions/Cations) by Calculation				
Anion Total	APHA (online edition) 1030 E	meq/L	All	Auckland
Cation Total	APHA (online edition) 1030 E	meq/L	All	Auckland
meq/L Difference	APHA (online edition) 1030 E	meq/L	All	Auckland
Percent Difference	APHA (online edition) 1030 E		All	Auckland
Sum of Anions + Cations	APHA (online edition) 1030 E		All	Auckland
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	HMSO (1981) ISBN 0117516139	0.005 mg/L	All	Auckland
Ammoniacal Nitrogen (as NH4) by Calculation	Calculation from Ammonia (as N)	0.006 mg/L	All	Auckland
Bicarbonate Alkalinity (as HCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Carbonate Alkalinity (as CO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Hydroxide Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
pH (at room temp c. 20 °C) by Electrode	APHA (online edition) 4500-H B	0.1 pH unit	All	Auckland
Sulfide by Colour Comparison (Methylene Blue Method)	APHA (online edition) 4500-S2 D	0.1 mg/L	All	Auckland
Total Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Total Chlorine (as Cl2) by Spectrophotometry according to APHA (2005) 4500-Cl G	APHA (online edition) 4500-Cl G	0.02 mg/L	All	Auckland
Total Dissolved Solids by Gravimetry	APHA (online edition) 2540 C (Modified: Dried at 103 - 105 °C)	15 mg/L	All	Auckland
Total Nitrogen (as N) by Persulphate Digestion and Flow Analysis	APHA (online edition) 4500-P J (modified), 4500-NO3 I	0.010 mg/L	All	Auckland
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J (modified)	0.004 mg/L	All	Auckland
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	0.2 mg/L	All	Auckland

General Testing				
Turbidity by Nephelometry	APHA (online edition) 2130 B (modified)	0.05 NTU	All	Auckland
Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Arsenic (Dissolved)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Dissolved)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Dissolved)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.02 mg/L	All	Auckland
Sodium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Metals by ICP-MS—Trace (Default Digest)				
Arsenic (Total)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Total)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Total)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Total)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Total)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Total)	In House based on EPA 200.8 by ICPMS	0.05 mg/L	All	Auckland
Sodium (Total)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Hardness (as CaCO3)	In House based on EPA 200.8 by ICPMS	0.03 mg/L	All	Auckland
Organics				
Total Organic Carbon by Non-dispersive infrared detection				
Total Organic Carbon	APHA (online edition) 5310 B	0.1 mg/L	All	Auckland
Preparations				
Digest for Total Metals in Liquids	APHA (online edition) 3030 E (modified, 4:1 Nitric:Hydrochloric Acid)		All	Auckland
Glass Fibre Filtration (1.2 µm)	APHA (online edition) 2540 C (Filtration)		All	Auckland
Membrane Filtration (0.45 µm)	APHA (online edition) 4500-P B (preliminary filtration)		All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher.

For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

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Report Signatory 19/07/2017

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Certificate of Analysis
Laboratory Reference:170708-040

Attention:	Hilltop Sampler	*Final Report:*	**235031-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**21-Jul-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**08-Jul-2017**
Client Reference:	**MAR**	*Sampled By:*	**Alice Trevelyan**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

Note: For sample 4 (Harper Road GPF162), dissolved iron higher than total iron - retested and confirmed, suspect contamination during sampling.

Sample Details		WATERS	WATERS	WATERS	WATERS
Lab Sample ID:		**170708-040-1**	**170708-040-2**	**170708-040-3**	**170708-040-4**
Client Sample ID:		20174921	20174922	20174923	20174925
Sample Date/Time:		07/07/2017 09:20	07/07/2017 09:45	07/07/2017 10:11	07/07/2017 11:50
Description:		Patterson 54 Bolitho Rd GPD115	Stuart 370 Bushmere Rd GPD147	Mc Intyre 409 Matawai Rd (SH2) GPD116	Harper Road GPF162
Chemistry Detailed					
Anions by Ion Chromatography (0.45 µm Filtered)					
Chloride	mg/L	140	310	63	30
Nitrate (as N)	mg/L	0.0022	<0.002	0.0061	0.0032
Nitrite (as N)	mg/L	<0.002	0.0028	0.0020	<0.002
Sulphate	mg/L	<0.02	<0.02	0.027	0.049
Total Oxidised Nitrogen (as N) by Calculation	mg/L	0.0022 *	0.0028 *	0.0081 *	0.0032 *
Ion Balance (Anions/Cations) by Calculation					
Anion Total	meq/L	14 *	22 *	15 *	9.4 *
Cation Total	meq/L	14 *	21 *	16 *	9.8 *
meq/L Difference	meq/L	0.42 *	1.8 *	0.41 *	0.41 *
Percent Difference	%	1.5 *	4.1 *	1.3 *	2.1 *
Sum of Anions + Cations	meq/L	28 *	43 *	31 *	19 *
General Testing					
Ammoniacal Nitrogen (as N)	mg/L	3.9	1.9	1.4	0.28
Ammoniacal Nitrogen (as NH4)	mg/L	5.0 *	2.4 *	1.8 *	0.35 *
Bicarbonate Alkalinity (as HCO3)	mg/L	620	830	840	520
Carbonate Alkalinity (as CO3)	mg/L	<4.0	<3.3	<3.3	<2.0
Hydroxide Alkalinity (as CaCO3)	mg/L	<4.0	<3.3	<3.3	<2.0
pH (at room temp c. 20 °C)	pH unit	7.1	7.2	7.1	7.3
Sulfide	mg/L	<0.1 *	<0.1 *	<0.1 *	<0.1 *
Total Alkalinity (as CaCO3)	mg/L	510	690	680	430
Total Chlorine (as Cl2)	mg/L	0.16	0.10	0.11	0.10
Total Dissolved Solids	mg/L	810	1200	870	530
Total Nitrogen (as N)	mg/L	4.0	1.9	2.2	0.32
Total Phosphorus (as P)	mg/L	0.32	0.54	0.61	0.15
Total Suspended Solids	mg/L	19	220	110	34
Turbidity	NTU	65	120	290	160
Metals					
Dissolved Metals by ICP-MS—Trace (Received Filtered)					
Arsenic (Dissolved)	mg/L	0.0056	0.0068	0.0041	0.0017
Calcium (Dissolved)	mg/L	170	210	180	120
Iron (Dissolved)	mg/L	5.6	4.2	7.3	9.2
Magnesium (Dissolved)	mg/L	19	32	24	13
Manganese (Dissolved)	mg/L	0.70	1.3	1.4	0.25
Potassium (Dissolved)	mg/L	9.4	7.2	6.1	5.1
Sodium (Dissolved)	mg/L	89	170	97	46

Sample Details (continued)		WATERS	WATERS	WATERS	WATERS
Lab Sample ID:		**170708-040-1**	**170708-040-2**	**170708-040-3**	**170708-040-4**
Client Sample ID:		20174921	20174922	20174923	20174925
Sample Date/Time:		07/07/2017 09:20	07/07/2017 09:45	07/07/2017 10:11	07/07/2017 11:50
Description:		Patterson 54 Bolitho Rd GPD115	Stuart 370 Bushmere Rd GPD147	Mc Intyre 409 Matawai Rd (SH2) GPD116	Harper Road GPF162
Metals					
Total Metals by ICP-MS—Trace (Default Digest)					
Arsenic (Total)	mg/L	0.0063	0.010	0.0046	0.0038
Calcium (Total)	mg/L	170	220	190	130
Iron (Total)	mg/L	6.2	8.7	8.8	2.0
Magnesium (Total)	mg/L	20	35	24	13
Manganese (Total)	mg/L	0.70	1.4	1.5	0.22
Potassium (Total)	mg/L	9.2	8.1	6.5	5.3
Sodium (Total)	mg/L	90	180	99	48
Total Hardness (as CaCO3)	mg/L	500	690	570	380
Organics					
Total Organic Carbon by Non-dispersive infrared detection					
Total Organic Carbon	mg/L	3.1	4.5	4.0	1.7
Microbiology					
Escherichia coli by Membrane Filtration					
Escherichia coli	cfu/100 mL	<1.6	<1.6	<1.6	<1.6

Sample Details		WATERS
Lab Sample ID:		**170708-040-5**
Client Sample ID:		20174926
Sample Date/Time:		07/07/2017 12:00
Description:		590 Matawai Rd GPF 159
Chemistry Detailed		
Anions by Ion Chromatography (0.45 µm Filtered)		
Chloride	mg/L	26
Nitrate (as N)	mg/L	0.0024
Nitrite (as N)	mg/L	<0.002
Sulphate	mg/L	0.68
Total Oxidised Nitrogen (as N) by Calculation	mg/L	0.0024 *
Ion Balance (Anions/Cations) by Calculation		
Anion Total	meq/L	9.2 *
Cation Total	meq/L	9.0 *
meq/L Difference	meq/L	0.19 *
Percent Difference	%	1.0 *
Sum of Anions + Cations	meq/L	18 *
General Testing		
Ammoniacal Nitrogen (as N)	mg/L	0.39
Ammoniacal Nitrogen (as NH4)	mg/L	0.51 *
Bicarbonate Alkalinity (as HCO3)	mg/L	510
Carbonate Alkalinity (as CO3)	mg/L	4.5
Hydroxide Alkalinity (as CaCO3)	mg/L	<3.3
pH (at room temp c. 20 °C)	pH unit	7.4
Sulfide	mg/L	<0.1 *
Total Alkalinity (as CaCO3)	mg/L	430
Total Chlorine (as Cl2)	mg/L	0.10
Total Dissolved Solids	mg/L	520
Total Nitrogen (as N)	mg/L	0.48
Total Phosphorus (as P)	mg/L	0.14
Total Suspended Solids	mg/L	5.3
Turbidity	NTU	17
Metals		
Dissolved Metals by ICP-MS—Trace (Received Filtered)		
Arsenic (Dissolved)	mg/L	0.0023
Calcium (Dissolved)	mg/L	110

Sample Details (continued)	WATERS
Lab Sample ID:	**170708-040-5**
Client Sample ID:	20174926
Sample Date/Time:	07/07/2017 12:00
Description:	590 Matawai Rd GPF 159

Metals		
Dissolved Metals by ICP-MS—Trace (Received Filtered)		
Iron (Dissolved)	mg/L	1.2
Magnesium (Dissolved)	mg/L	12
Manganese (Dissolved)	mg/L	0.34
Potassium (Dissolved)	mg/L	5.8
Sodium (Dissolved)	mg/L	53
Total Metals by ICP-MS—Trace (Default Digest)		
Arsenic (Total)	mg/L	0.0026
Calcium (Total)	mg/L	110
Iron (Total)	mg/L	1.5
Magnesium (Total)	mg/L	13
Manganese (Total)	mg/L	0.35
Potassium (Total)	mg/L	6.1
Sodium (Total)	mg/L	56
Total Hardness (as CaCO3)	mg/L	340
Organics		
Total Organic Carbon by Non-dispersive infrared detection		
Total Organic Carbon	mg/L	1.9
Microbiology		
Escherichia coli by Membrane Filtration		
Escherichia coli	cfu/100 mL	<1.6

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods

The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Chemistry Detailed				
Anions by Ion Chromatography (0.45 µm Filtered)				
Chloride	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Nitrate (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Nitrite (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Sulphate	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Total Oxidised Nitrogen (as N) by Calculation	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Ion Balance (Anions/Cations) by Calculation				
Anion Total	APHA (online edition) 1030 E	meq/L	All	Auckland
Cation Total	APHA (online edition) 1030 E	meq/L	All	Auckland
meq/L Difference	APHA (online edition) 1030 E	meq/L	All	Auckland
Percent Difference	APHA (online edition) 1030 E		All	Auckland
Sum of Anions + Cations	APHA (online edition) 1030 E		All	Auckland
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	HMSO (1981) ISBN 0117516139	0.005 mg/L	All	Auckland
Ammoniacal Nitrogen (as NH4) by Calculation	Calculation from Ammonia (as N)	0.006 mg/L	All	Auckland
Bicarbonate Alkalinity (as HCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Carbonate Alkalinity (as CO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Hydroxide Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
pH (at room temp c. 20 °C) by Electrode	APHA (online edition) 4500-H B	0.1 pH unit	All	Auckland
Sulfide by Colour Comparison (Methylene Blue Method)	APHA (online edition) 4500-S2 D	0.1 mg/L	All	Auckland
Total Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Total Chlorine (as Cl2) by Spectrophotometry according to APHA (2005) 4500-Cl G	APHA (online edition) 4500-Cl G	0.02 mg/L	All	Auckland

General Testing				
Total Dissolved Solids by Gravimetry	APHA (online edition) 2540 C (Modified: Dried at 103 - 105 ºC)	15 mg/L	All	Auckland
Total Nitrogen (as N) by Persulphate Digestion and Flow Analysis	APHA (online edition) 4500-P J (modified), 4500-NO3 I	0.010 mg/L	All	Auckland
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J (modified)	0.004 mg/L	All	Auckland
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	0.2 mg/L	All	Auckland
Turbidity by Nephelometry	APHA (online edition) 2130 B (modified)	0.05 NTU	All	Auckland
Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Arsenic (Dissolved)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Dissolved)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Dissolved)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.02 mg/L	All	Auckland
Sodium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Metals by ICP-MS—Trace (Default Digest)				
Arsenic (Total)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Total)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Total)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Total)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Total)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Total)	In House based on EPA 200.8 by ICPMS	0.05 mg/L	All	Auckland
Sodium (Total)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Hardness (as CaCO3)	In House based on EPA 200.8 by ICPMS	0.03 mg/L	All	Auckland
Organics				
Total Organic Carbon by Non-dispersive infrared detection				
Total Organic Carbon	APHA (online edition) 5310 B	0.1 mg/L	All	Auckland
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603	2 cfu/100 mL	All	Auckland
Preparations				
Digest for Total Metals in Liquids	APHA (online edition) 3030 E (modified, 4:1 Nitric:Hydrochloric Acid)		All	Auckland
Glass Fibre Filtration (1.2 µm)	APHA (online edition) 2540 C (Filtration)		All	Auckland
Membrane Filtration (0.45 µm)	APHA (online edition) 4500-P B (preliminary filtration)		All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher.

For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

Watercare Laboratory Services is a division of Watercare Services Limited .

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Report Signatory 21/07/2017

Zum Nguyen
KTP Signatory

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Certificate of Analysis
Laboratory Reference:170708-044

Attention:	Hilltop Sampler	*Final Report:*	**235032-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**21-Jul-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**08-Jul-2017**
Client Reference:	**MAR**	*Sampled By:*	**Alice Trevelyan**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

Sample Details		WATERS	WATERS	WATERS	WATERS
Lab Sample ID:		**170708-044-1**	**170708-044-2**	**170708-044-3**	**170708-044-4**
Client Sample ID:		20172884	20172819	20172818	20172817
Sample Date/Time:		07/07/2017 09:51	07/07/2017 10:00	07/07/2017 11:41	07/07/2017 10:47
Description:		598 Bushmere Rd - MAR injection bore GPE066	598 Bushmere Road MAR Pilot Bore GPE 065	599 Bushmere Road GPE010	598 Bushmere Rd at Cyclone filter
Chemistry Detailed					
Anions by Ion Chromatography (0.45 µm Filtered)					
Chloride	mg/L	11	16	140	9.5
Nitrate (as N)	mg/L	0.0024	0.0081	0.0032	0.40
Nitrite (as N)	mg/L	<0.002	0.0033	<0.002	<0.002
Sulphate	mg/L	90	85	0.028	68
Ion Balance (Anions/Cations) by Calculation					
Anion Total	meq/L	6.2 *	6.3 *	16 *	-
Cation Total	meq/L	6.1 *	6.4 *	16 *	-
meq/L Difference	meq/L	0.66e-1 *	0.055 *	0.025 *	-
Percent Difference	%	0.54 *	0.43 *	0.81e-1 *	-
Sum of Anions + Cations	meq/L	12 *	13 *	31 *	-
General Testing					
Ammoniacal Nitrogen (as N)	mg/L	0.17	1.2	2.6	0.016
Ammoniacal Nitrogen (as NH4)	mg/L	0.22 *	1.6 *	3.3 *	0.021 *
Bicarbonate Alkalinity (as HCO3)	mg/L	240	250	730	150
Carbonate Alkalinity (as CO3)	mg/L	<1.0	1.2	<4.0	8.8
Hydroxide Alkalinity (as CaCO3)	mg/L	<1.0	<1.0	<4.0	<1.0
pH (at room temp c. 20 °C)	pH unit	7.7	7.5	7.1	8.0
Sulfide	mg/L	<0.1 *	<0.1 *	<0.1 *	<0.1 *
Total Alkalinity (as CaCO3)	mg/L	200	210	600	140
Total Chlorine (as Cl2)	mg/L	0.09	0.09	0.07	0.08
Total Dissolved Solids	mg/L	390	400	880	300
Total Nitrogen (as N)	mg/L	0.28	1.6	2.3	0.73
Total Phosphorus (as P)	mg/L	0.021	0.24	0.21	0.12
Total Suspended Solids	mg/L	<0.8	6.3	45	140
Turbidity	NTU	0.15	22	160	80
Metals					
Dissolved Metals by ICP-MS—Trace (Received Filtered)					
Arsenic (Dissolved)	mg/L	0.0014	0.0040	0.0070	-
Calcium (Dissolved)	mg/L	81	76	190	-
Iron (Dissolved)	mg/L	0.0065	1.7	15	-
Magnesium (Dissolved)	mg/L	8.8	8.5	22	-
Manganese (Dissolved)	mg/L	0.086	0.38	1.1	-
Potassium (Dissolved)	mg/L	3.1	4.8	8.4	-
Sodium (Dissolved)	mg/L	29	38	80	-
Total Metals by ICP-MS—Trace (Default Digest)					
Arsenic (Total)	mg/L	0.0021	0.0046	0.0083	0.0019
Calcium (Total)	mg/L	83	76	200	61

Sample Details (continued)		WATERS	WATERS	WATERS	WATERS
Lab Sample ID:		**170708-044-1**	**170708-044-2**	**170708-044-3**	**170708-044-4**
Client Sample ID:		20172884	20172819	20172818	20172817
Sample Date/Time:		07/07/2017 09:51	07/07/2017 10:00	07/07/2017 11:41	07/07/2017 10:47
Description:		598 Bushmere Rd - MAR injection bore GPE066	598 Bushmere Road MAR Pilot Bore GPE 065	599 Bushmere Road GPE010	598 Bushmere Rd at Cyclone filter
Metals					
Total Metals by ICP-MS—Trace (Default Digest)					
Iron (Total)	mg/L	0.0058	2.0	17	3.9
Magnesium (Total)	mg/L	9.4	8.8	23	7.6
Manganese (Total)	mg/L	0.087	0.40	1.1	0.081
Potassium (Total)	mg/L	3.3	5.1	9.0	3.7
Sodium (Total)	mg/L	30	38	84	23
Total Hardness (as CaCO3)	mg/L	240	230	600	180
Organics					
Total Organic Carbon by Non-dispersive infrared detection					
Total Organic Carbon	mg/L	2.5	2.7	3.2	4.1

*Results marked with * are not accredited to International Accreditation New Zealand*

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Reference Methods

The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Chemistry Detailed				
Anions by Ion Chromatography (0.45 µm Filtered)				
Chloride	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Nitrate (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Nitrite (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Sulphate	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Ion Balance (Anions/Cations) by Calculation				
Anion Total	APHA (online edition) 1030 E	meq/L	1, 2, 3	Auckland
Cation Total	APHA (online edition) 1030 E	meq/L	1, 2, 3	Auckland
meq/L Difference	APHA (online edition) 1030 E	meq/L	1, 2, 3	Auckland
Percent Difference	APHA (online edition) 1030 E		1, 2, 3	Auckland
Sum of Anions + Cations	APHA (online edition) 1030 E		1, 2, 3	Auckland
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	HMSO (1981) ISBN 0117516139	0.005 mg/L	All	Auckland
Ammoniacal Nitrogen (as NH4) by Calculation	Calculation from Ammonia (as N)	0.006 mg/L	All	Auckland
Bicarbonate Alkalinity (as HCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Carbonate Alkalinity (as CO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Hydroxide Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
pH (at room temp c. 20 °C) by Electrode	APHA (online edition) 4500-H B	0.1 pH unit	All	Auckland
Sulfide by Colour Comparison (Methylene Blue Method)	APHA (online edition) 4500-S2 D	0.1 mg/L	All	Auckland
Total Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Total Chlorine (as Cl2) by Spectrophotometry according to APHA (2005) 4500-Cl G	APHA (online edition) 4500-Cl G	0.02 mg/L	All	Auckland
Total Dissolved Solids by Gravimetry	APHA (online edition) 2540 C (Modified: Dried at 103 - 105 ºC)	15 mg/L	All	Auckland
Total Nitrogen (as N) by Persulphate Digestion and Flow Analysis	APHA (online edition) 4500-P J (modified), 4500-NO3 I	0.010 mg/L	All	Auckland
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J (modified)	0.004 mg/L	All	Auckland
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	0.2 mg/L	All	Auckland
Turbidity by Nephelometry	APHA (online edition) 2130 B (modified)	0.05 NTU	All	Auckland
Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Arsenic (Dissolved)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	1, 2, 3	Auckland
Calcium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	1, 2, 3	Auckland
Iron (Dissolved)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	1, 2, 3	Auckland

Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Magnesium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	1, 2, 3	Auckland
Manganese (Dissolved)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	1, 2, 3	Auckland
Potassium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.02 mg/L	1, 2, 3	Auckland
Sodium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	1, 2, 3	Auckland
Total Metals by ICP-MS—Trace (Default Digest)				
Arsenic (Total)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Total)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Total)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Total)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Total)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Total)	In House based on EPA 200.8 by ICPMS	0.05 mg/L	All	Auckland
Sodium (Total)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Hardness (as CaCO3)	In House based on EPA 200.8 by ICPMS	0.03 mg/L	All	Auckland
Organics				
Total Organic Carbon by Non-dispersive infrared detection				
Total Organic Carbon	APHA (online edition) 5310 B	0.1 mg/L	All	Auckland
Preparations				
Digest for Total Metals in Liquids	APHA (online edition) 3030 E (modified, 4:1 Nitric:Hydrochloric Acid)		All	Auckland
Glass Fibre Filtration (1.2 µm)	APHA (online edition) 2540 C (Filtration)		All	Auckland
Membrane Filtration (0.45 µm)	APHA (online edition) 4500-P B (preliminary filtration)		All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher.

For more information please contact the Operations Manager

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

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ACCREDITED LABORATORY

Report Signatory 21/07/2017

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KTP Signatory

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Certificate of Analysis
Laboratory Reference:170718-092

Attention:	Hilltop Sampler	*Final Report:*	**236134-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**01-Aug-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**18-Jul-2017**
Client Reference:	**MAR**	*Sampled By:*	**Alice Trevelyan**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

Sample Details		WATERS	WATERS	WATERS	WATERS
Lab Sample ID:		**170718-092-1**	**170718-092-2**	**170718-092-3**	**170718-092-4**
Client Sample ID:		20172821	20172822	20172889	20174999
Sample Date/Time:		17/07/2017 10:19	17/07/2017 12:00	17/07/2017 11:44	17/07/2017 12:15
Description:		599 Bushmere Road GPE010	598 Bushmere Road MAR Pilot Bore GPE 065	598 Bushmere Rd - MAR injection bore GPE066	598 Bushmere Rd at Cyclone Filter
Chemistry Detailed					
Anions by Ion Chromatography (0.45 µm Filtered)					
Chloride	mg/L	140	16	12	7.7
Nitrate (as N)	mg/L	0.0022	<0.002	<0.002	0.54
Nitrite (as N)	mg/L	<0.002	<0.002	<0.002	0.0061
Sulphate	mg/L	<0.02	84	88	56
Total Oxidised Nitrogen (as N) by Calculation	mg/L	-	-	-	0.55 *
Ion Balance (Anions/Cations) by Calculation					
Anion Total	meq/L	16 *	6.4 *	6.3 *	3.5 *
Cation Total	meq/L	16 *	6.4 *	6.4 *	3.5 *
meq/L Difference	meq/L	0.33 *	0.15e-1 *	0.73e-1 *	0.28e-1 *
Percent Difference	%	1.1 *	0.11 *	0.58 *	0.40 *
Sum of Anions + Cations	meq/L	32 *	13 *	13 *	7.0 *
General Testing					
Ammoniacal Nitrogen (as N)	mg/L	2.2	1.0	0.19	0.015
Ammoniacal Nitrogen (as NH4)	mg/L	2.8 *	1.3 *	0.25 *	0.019 *
Bicarbonate Alkalinity (as HCO3)	mg/L	730	260	250	130
Carbonate Alkalinity (as CO3)	mg/L	<4.0	<2.0	<2.0	<2.0
Hydroxide Alkalinity (as CaCO3)	mg/L	<4.0	<2.0	<2.0	<2.0
pH (at room temp c. 20 °C)	pH unit	7.4	7.7	7.9	8.3
Sulfide	mg/L	<0.1 *	<0.1 *	<0.1 *	<0.1 *
Total Alkalinity (as CaCO3)	mg/L	600	210	210	110
Total Chlorine (as Cl2)	mg/L	0.15	0.08	0.07	0.08
Total Dissolved Solids	mg/L	840	400	390	230
Total Nitrogen (as N)	mg/L	2.6	1.3	0.36	0.87
Total Phosphorus (as P)	mg/L	0.17	0.26	0.018	0.19
Total Suspended Solids	mg/L	38	4.0	0.50	220
Turbidity	NTU	200	23	0.25	150
Metals					
Dissolved Metals by ICP-MS—Trace (Received Filtered)					
Arsenic (Dissolved)	mg/L	0.0078	0.0047	0.0024	0.00066
Calcium (Dissolved)	mg/L	190	76	84	43
Iron (Dissolved)	mg/L	15	1.9	0.0055	0.040
Magnesium (Dissolved)	mg/L	22	8.3	8.9	4.7
Manganese (Dissolved)	mg/L	1.2	0.39	0.10	0.0051
Potassium (Dissolved)	mg/L	8.3	4.6	3.0	2.4
Sodium (Dissolved)	mg/L	83	39	32	21
Total Metals by ICP-MS—Trace (Default Digest)					

Sample Details (continued)		WATERS	WATERS	WATERS	WATERS
Lab Sample ID:		**170718-092-1**	**170718-092-2**	**170718-092-3**	**170718-092-4**
Client Sample ID:		20172821	20172822	20172889	20174999
Sample Date/Time:		17/07/2017 10:19	17/07/2017 12:00	17/07/2017 11:44	17/07/2017 12:15
Description:		599 Bushmere Road GPE010	598 Bushmere Road MAR Pilot Bore GPE 065	598 Bushmere Rd - MAR injection bore GPE066	598 Bushmere Rd at Cyclone Filter
Metals					
Total Metals by ICP-MS—Trace (Default Digest)					
Arsenic (Total)	mg/L	0.0083	0.0046	0.0025	0.0024
Calcium (Total)	mg/L	180	74	79	46
Iron (Total)	mg/L	15	1.9	0.0099	5.9
Magnesium (Total)	mg/L	22	7.8	8.7	6.2
Manganese (Total)	mg/L	1.0	0.38	0.10	0.087
Potassium (Total)	mg/L	8.1	5.4	3.6	4.2
Sodium (Total)	mg/L	78	36	30	20
Total Hardness (as CaCO3)	mg/L	540	210	230	140
Organics					
Total Organic Carbon by Non-dispersive infrared detection					
Total Organic Carbon	mg/L	3.4	3.7	3.0	5.0

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods

The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Chemistry Detailed				
Anions by Ion Chromatography (0.45 µm Filtered)				
Chloride	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Nitrate (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Nitrite (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Sulphate	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Total Oxidised Nitrogen (as N) by Calculation	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	4	Auckland
Ion Balance (Anions/Cations) by Calculation				
Anion Total	APHA (online edition) 1030 E	meq/L	All	Auckland
Cation Total	APHA (online edition) 1030 E	meq/L	All	Auckland
meq/L Difference	APHA (online edition) 1030 E	meq/L	All	Auckland
Percent Difference	APHA (online edition) 1030 E		All	Auckland
Sum of Anions + Cations	APHA (online edition) 1030 E		All	Auckland
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	HMSO (1981) ISBN 0117516139	0.005 mg/L	All	Auckland
Ammoniacal Nitrogen (as NH4) by Calculation	Calculation from Ammonia (as N)	0.006 mg/L	All	Auckland
Bicarbonate Alkalinity (as HCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Carbonate Alkalinity (as CO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Hydroxide Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
pH (at room temp c. 20 °C) by Electrode	APHA (online edition) 4500-H B	0.1 pH unit	All	Auckland
Sulfide by Colour Comparison (Methylene Blue Method)	APHA (online edition) 4500-S2 D	0.1 mg/L	All	Auckland
Total Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Total Chlorine (as Cl2) by Spectrophotometry according to APHA (2005) 4500-Cl G	APHA (online edition) 4500-Cl G	0.02 mg/L	All	Auckland
Total Dissolved Solids by Gravimetry	APHA (online edition) 2540 C (Modified: Dried at 103 - 105 ºC)	15 mg/L	All	Auckland
Total Nitrogen (as N) by Persulphate Digestion and Flow Analysis	APHA (online edition) 4500-P J (modified), 4500-NO3 I	0.010 mg/L	All	Auckland
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J (modified)	0.004 mg/L	All	Auckland
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	0.2 mg/L	All	Auckland
Turbidity by Nephelometry	APHA (online edition) 2130 B (modified)	0.05 NTU	All	Auckland
Metals				

Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Arsenic (Dissolved)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Dissolved)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Dissolved)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.02 mg/L	All	Auckland
Sodium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Metals by ICP-MS—Trace (Default Digest)				
Arsenic (Total)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Total)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Total)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Total)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Total)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Total)	In House based on EPA 200.8 by ICPMS	0.05 mg/L	All	Auckland
Sodium (Total)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Hardness (as CaCO3)	In House based on EPA 200.8 by ICPMS	0.03 mg/L	All	Auckland
Organics				
Total Organic Carbon by Non-dispersive infrared detection				
Total Organic Carbon	APHA (online edition) 5310 B	0.1 mg/L	All	Auckland
Preparations				
Digest for Total Metals in Liquids	APHA (online edition) 3030 E (modified, 4:1 Nitric:Hydrochloric Acid)		All	Auckland
Glass Fibre Filtration (1.2 µm)	APHA (online edition) 2540 C (Filtration)		All	Auckland
Membrane Filtration (0.45 µm)	APHA (online edition) 4500-P B (preliminary filtration)		All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher.

For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

Watercare Laboratory Services is a division of Watercare Services Limited .

ACCREDITED LABORATORY

Report Signatory 01/08/2017

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KTP Signatory

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Certificate of Analysis
Laboratory Reference:170721-094

Attention:	Hilltop Sampler	*Final Report:*	**237418-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**11-Aug-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**22-Jul-2017**
Client Reference:	**MAR**	*Sampled By:*	**Alice Trevelyan**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

Note: For sample 1, dissolved manganese higher than total manganese - this has been retested and confirmed, suspect spot contamination during sampling.
Sample 2: Discrepancy in ammonia and total nitrogen observed. Results doulble-checked. Reported ammonia result by FIA.

Sample Details		WATERS	WATERS	WATERS	WATERS
Lab Sample ID:		**170721-094-1**	**170721-094-2**	**170721-094-3**	**170721-094-4**
Client Sample ID:		20174900	20174901	20174902	20175056
Sample Date/Time:		21/07/2017 10:24	21/07/2017 10:00	21/07/2017 10:43	21/07/2017 10:58
Description:		598 Bushmere Road MAR Headworks outlet	599 Bushmere Road GPE010	598 Bushmere Road MAR Pilot Bore GPE 065	Waipaoa River at Infultration Chamber
Chemistry Detailed					
Anions by Ion Chromatography (0.45 µm Filtered)					
Chloride	mg/L	10	140	10	-
Nitrate (as N)	mg/L	0.67	0.037	0.0024	-
Nitrite (as N)	mg/L	<0.002	0.016	0.0042	-
Sulphate	mg/L	82	<0.04	85	-
Ion Balance (Anions/Cations) by Calculation					
Anion Total	meq/L	5.0 *	16 *	4.9 *	-
Cation Total	meq/L	5.2 *	16 *	4.9 *	-
meq/L Difference	meq/L	0.18 *	0.060 *	0.39e-1 *	-
Percent Difference	%	1.8 *	0.19 *	0.40 *	-
Sum of Anions + Cations	meq/L	10 *	32 *	9.8 *	-
General Testing					
Ammoniacal Nitrogen (as N)	mg/L	0.013	-	1.0	-
Ammoniacal Nitrogen (as N)	mg/L	-	2.4	-	-
Ammoniacal Nitrogen (as NH4)	mg/L	0.017 *	3.3 *	1.3 *	-
Bicarbonate Alkalinity (as HCO3)	mg/L	160	740	170	-
Carbonate Alkalinity (as CO3)	mg/L	10	<4.0	1.5	-
Hydroxide Alkalinity (as CaCO3)	mg/L	<1.0	<4.0	<1.0	-
pH (at room temp c. 20 °C)	pH unit	8.1	7.2	7.6	-
Sulfide	mg/L	<0.1 *	<0.1 *	<0.1 *	-
Total Alkalinity (as CaCO3)	mg/L	150	610	140	-
Total Chlorine (as Cl2)	mg/L	0.09	0.04	0.08	-
Total Dissolved Solids	mg/L	350	940	320	-
Total Nitrogen (as N)	mg/L	0.84	2.1	1.3	-
Total Phosphorus (as P)	mg/L	0.037	0.19	0.074	-
Total Suspended Solids	mg/L	22	37	2.0	-
Turbidity	NTU	22	190	10	-
Metals					
Dissolved Metals by ICP-MS—Trace (Received Filtered)					
Arsenic (Dissolved)	mg/L	0.00087	0.0092	0.0012	-
Calcium (Dissolved)	mg/L	68	200	59	-
Iron (Dissolved)	mg/L	0.19	14	1.0	-
Magnesium (Dissolved)	mg/L	7.3	21	6.0	-
Manganese (Dissolved)	mg/L	0.029	1.1	0.30	-
Potassium (Dissolved)	mg/L	2.9	8.7	4.4	-
Sodium (Dissolved)	mg/L	25	82	28	-
Total Metals by ICP-MS—Trace (Default Digest)					
Arsenic (Total)	mg/L	0.00083	0.0077	0.0012	-
Calcium (Total)	mg/L	64	190	58	-

Sample Details (continued)		WATERS	WATERS	WATERS	WATERS
Lab Sample ID:		**170721-094-1**	**170721-094-2**	**170721-094-3**	**170721-094-4**
Client Sample ID:		20174900	20174901	20174902	20175056
Sample Date/Time:		21/07/2017 10:24	21/07/2017 10:00	21/07/2017 10:43	21/07/2017 10:58
Description:		598 Bushmere Road MAR Headworks outlet	599 Bushmere Road GPE010	598 Bushmere Road MAR Pilot Bore GPE 065	Waipaoa River at Infultration Chamber
Metals					
Total Metals by ICP-MS—Trace (Default Digest)					
Iron (Total)	mg/L	0.49	16	1.1	-
Magnesium (Total)	mg/L	7.3	22	6.4	-
Manganese (Total)	mg/L	0.013	1.1	0.29	-
Potassium (Total)	mg/L	2.9	8.3	4.8	-
Sodium (Total)	mg/L	23	82	27	-
Total Hardness (as CaCO3)	mg/L	190	570	170	-
Organics					
Total Organic Carbon by Non-dispersive infrared detection					
Total Organic Carbon	mg/L	3.6	5.3	3.1	-
Microbiology					
Escherichia coli by Membrane Filtration					
Escherichia coli	cfu/100 mL	56	<1.6	<1.6	380

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods

The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Chemistry Detailed				
Anions by Ion Chromatography (0.45 µm Filtered)				
Chloride	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	1, 2, 3	Auckland
Nitrate (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	1, 2, 3	Auckland
Nitrite (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	1, 2, 3	Auckland
Sulphate	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	1, 2, 3	Auckland
Ion Balance (Anions/Cations) by Calculation				
Anion Total	APHA (online edition) 1030 E	meq/L	1, 2, 3	Auckland
Cation Total	APHA (online edition) 1030 E	meq/L	1, 2, 3	Auckland
meq/L Difference	APHA (online edition) 1030 E	meq/L	1, 2, 3	Auckland
Percent Difference	APHA (online edition) 1030 E		1, 2, 3	Auckland
Sum of Anions + Cations	APHA (online edition) 1030 E		1, 2, 3	Auckland
General Testing				
Ammoniacal Nitrogen (as N) by Flow Analysis	APHA (online edition) 4500-NH3 H	0.005 mg/L	2	Auckland
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	HMSO (1981) ISBN 0117516139	0.005 mg/L	1, 3	Auckland
Ammoniacal Nitrogen (as NH4) by Calculation	Calculation from Ammonia (as N)	0.006 mg/L	1, 2, 3	Auckland
Bicarbonate Alkalinity (as HCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	1, 2, 3	Auckland
Carbonate Alkalinity (as CO3) by Titration	APHA (online edition) 2320 B	1 mg/L	1, 2, 3	Auckland
Hydroxide Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	1, 2, 3	Auckland
pH (at room temp c. 20 °C) by Electrode	APHA (online edition) 4500-H B	0.1 pH unit	1, 2, 3	Auckland
Sulfide by Colour Comparison (Methylene Blue Method)	APHA (online edition) 4500-S2 D	0.1 mg/L	1, 2, 3	Auckland
Total Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	1, 2, 3	Auckland
Total Chlorine (as Cl2) by Spectrophotometry according to APHA (2005) 4500-Cl G	APHA (online edition) 4500-Cl G	0.02 mg/L	1, 2, 3	Auckland
Total Dissolved Solids by Gravimetry	APHA (online edition) 2540 C (Modified: Dried at 103 - 105 ºC)	15 mg/L	1, 2, 3	Auckland
Total Nitrogen (as N) by Persulphate Digestion and Flow Analysis	APHA (online edition) 4500-P J (modified), 4500-NO3 I	0.010 mg/L	1, 2, 3	Auckland
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J (modified)	0.004 mg/L	1, 2, 3	Auckland
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	0.2 mg/L	1, 2, 3	Auckland
Turbidity by Nephelometry	APHA (online edition) 2130 B (modified)	0.05 NTU	1, 2, 3	Auckland
Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Arsenic (Dissolved)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	1, 2, 3	Auckland
Calcium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	1, 2, 3	Auckland

Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Iron (Dissolved)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	1, 2, 3	Auckland
Magnesium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	1, 2, 3	Auckland
Manganese (Dissolved)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	1, 2, 3	Auckland
Potassium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.02 mg/L	1, 2, 3	Auckland
Sodium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	1, 2, 3	Auckland
Total Metals by ICP-MS—Trace (Default Digest)				
Arsenic (Total)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	1, 2, 3	Auckland
Calcium (Total)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	1, 2, 3	Auckland
Iron (Total)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	1, 2, 3	Auckland
Magnesium (Total)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	1, 2, 3	Auckland
Manganese (Total)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	1, 2, 3	Auckland
Potassium (Total)	In House based on EPA 200.8 by ICPMS	0.05 mg/L	1, 2, 3	Auckland
Sodium (Total)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	1, 2, 3	Auckland
Total Hardness (as CaCO3)	In House based on EPA 200.8 by ICPMS	0.03 mg/L	1, 2, 3	Auckland
Organics				
Total Organic Carbon by Non-dispersive infrared detection				
Total Organic Carbon	APHA (online edition) 5310 B	0.1 mg/L	1, 2, 3	Auckland
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603	2 cfu/100 mL	All	Auckland
Preparations				
Digest for Total Metals in Liquids	APHA (online edition) 3030 E (modified, 4:1 Nitric:Hydrochloric Acid)		1, 2, 3	Auckland
Glass Fibre Filtration (1.2 µm)	APHA (online edition) 2540 C (Filtration)		1, 2, 3	Auckland
Membrane Filtration (0.45 µm)	APHA (online edition) 4500-P B (preliminary filtration)		1, 2, 3	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher. For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

Watercare Laboratory Services is a division of Watercare Services Limited .

Report Signatory 11/08/2017

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KTP Signatory

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Certificate of Analysis
Laboratory Reference:170729-052

Attention:	Hilltop Sampler	*Final Report:*	**237454-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**11-Aug-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**29-Jul-2017**
Client Reference:	**MAR**	*Sampled By:*	**Alice Trevelyan**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

Sample Details		WATERS	WATERS	WATERS	WATERS
Lab Sample ID:		**170729-052-1**	**170729-052-2**	**170729-052-3**	**170729-052-5**
Client Sample ID:		20175069	20175070	20175071	20175073
Sample Date/Time:		28/07/2017 10:38	28/07/2017 10:24	29/07/2017 10:30	29/07/2017 11:00
Description:		598 Bushmere Road MAR Headworks outlet	599 Bushmere Road GPE010	598 Bushmere Road MAR Pilot Bore GPE 065	598 Bushmere Rd - MAR injection bore GPE066
Chemistry Detailed					
Anions by Ion Chromatography (0.45 µm Filtered)					
Chloride	mg/L	9.6	140	9.5	9.6
Nitrate (as N)	mg/L	0.54	<0.004	0.0032	0.54
Nitrite (as N)	mg/L	<0.002	<0.004	0.0036	0.0021
Sulphate	mg/L	80	<0.04	80	79
Total Oxidised Nitrogen (as N) by Calculation	mg/L	-	-	-	0.55 *
Ion Balance (Anions/Cations) by Calculation					
Anion Total	meq/L	4.9 *	16 *	4.7 *	4.9 *
Cation Total	meq/L	4.9 *	17 *	4.7 *	4.9 *
meq/L Difference	meq/L	0.41e-1 *	0.99 *	0.67e-2 *	0.47e-1 *
Percent Difference	%	0.41 *	3.0 *	0.71e-1 *	0.48 *
Sum of Anions + Cations	meq/L	9.9 *	32 *	9.4 *	9.8 *
General Testing					
Ammoniacal Nitrogen (as N)	mg/L	<0.005	2.3	0.95	0.0090
Ammoniacal Nitrogen (as NH4)	mg/L	<0.006 *	2.9 *	1.2 *	0.012 *
Bicarbonate Alkalinity (as HCO3)	mg/L	160	720	160	160
Carbonate Alkalinity (as CO3)	mg/L	9.6	<3.3	4.5	7.3
Hydroxide Alkalinity (as CaCO3)	mg/L	<1.0	<3.3	<1.0	<1.0
pH (at room temp c. 20 °C)	pH unit	8.1	7.2	7.8	7.9
Sulfide	mg/L	<0.1 *	<0.1 *	<0.1 *	<0.1 *
Total Alkalinity (as CaCO3)	mg/L	150	590	140	150
Total Chlorine (as Cl2)	mg/L	0.12	0.11	0.10	0.14
Total Dissolved Solids	mg/L	300	840	270	320
Total Nitrogen (as N)	mg/L	0.66	2.1	1.1	0.69
Total Phosphorus (as P)	mg/L	0.021	0.20	0.015	0.021
Total Suspended Solids	mg/L	3.8	38	1.0	1.8
Turbidity	NTU	3.1	200	1.4	0.55
Metals					
Dissolved Metals by ICP-MS—Trace (Received Filtered)					
Arsenic (Dissolved)	mg/L	0.00068	0.010	0.00049	0.00084
Calcium (Dissolved)	mg/L	66	200	59	66
Iron (Dissolved)	mg/L	0.0033	14	0.085	0.0022
Magnesium (Dissolved)	mg/L	7.2	24	6.4	7.1
Manganese (Dissolved)	mg/L	0.011	1.2	0.22	0.0098
Potassium (Dissolved)	mg/L	2.5	9.8	4.5	2.5
Sodium (Dissolved)	mg/L	23	85	24	23
Total Metals by ICP-MS—Trace (Default Digest)					
Arsenic (Total)	mg/L	0.00066	0.0080	0.00050	0.00081
Calcium (Total)	mg/L	66	200	59	66
Iron (Total)	mg/L	0.097	15	0.16	0.020

Sample Details (continued)		WATERS	WATERS	WATERS	WATERS
Lab Sample ID:		**170729-052-1**	**170729-052-2**	**170729-052-3**	**170729-052-5**
Client Sample ID:		20175069	20175070	20175071	20175073
Sample Date/Time:		28/07/2017 10:38	28/07/2017 10:24	29/07/2017 10:30	29/07/2017 11:00
Description:		598 Bushmere Road MAR Headworks outlet	599 Bushmere Road GPE010	598 Bushmere Road MAR Pilot Bore GPE 065	598 Bushmere Rd - MAR injection bore GPE066
Metals					
Total Metals by ICP-MS—Trace (Default Digest)					
Magnesium (Total)	mg/L	7.3	24	6.4	7.2
Manganese (Total)	mg/L	0.012	1.1	0.23	0.0095
Potassium (Total)	mg/L	2.6	8.8	4.2	2.5
Sodium (Total)	mg/L	24	85	25	24
Total Hardness (as CaCO3)	mg/L	190	590	170	190
Organics					
Total Organic Carbon by Non-dispersive infrared detection					
Total Organic Carbon	mg/L	2.1	4.8	2.0	2.3

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods

The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Chemistry Detailed				
Anions by Ion Chromatography (0.45 µm Filtered)				
Chloride	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Nitrate (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Nitrite (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Sulphate	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Total Oxidised Nitrogen (as N) by Calculation	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	5	Auckland
Ion Balance (Anions/Cations) by Calculation				
Anion Total	APHA (online edition) 1030 E	meq/L	All	Auckland
Cation Total	APHA (online edition) 1030 E	meq/L	All	Auckland
meq/L Difference	APHA (online edition) 1030 E	meq/L	All	Auckland
Percent Difference	APHA (online edition) 1030 E		All	Auckland
Sum of Anions + Cations	APHA (online edition) 1030 E		All	Auckland
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	HMSO (1981) ISBN 0117516139	0.005 mg/L	All	Auckland
Ammoniacal Nitrogen (as NH4) by Calculation	Calculation from Ammonia (as N)	0.006 mg/L	All	Auckland
Bicarbonate Alkalinity (as HCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Carbonate Alkalinity (as CO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Hydroxide Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
pH (at room temp c. 20 °C) by Electrode	APHA (online edition) 4500-H B	0.1 pH unit	All	Auckland
Sulfide by Colour Comparison (Methylene Blue Method)	APHA (online edition) 4500-S2 D	0.1 mg/L	All	Auckland
Total Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Total Chlorine (as Cl2) by Spectrophotometry according to APHA (2005) 4500-Cl G	APHA (online edition) 4500-Cl G	0.02 mg/L	All	Auckland
Total Dissolved Solids by Gravimetry	APHA (online edition) 2540 C (Modified: Dried at 103 - 105 ºC)	15 mg/L	All	Auckland
Total Nitrogen (as N) by Persulphate Digestion and Flow Analysis	APHA (online edition) 4500-P J (modified), 4500-NO3 I	0.010 mg/L	All	Auckland
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J (modified)	0.004 mg/L	All	Auckland
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	0.2 mg/L	All	Auckland
Turbidity by Nephelometry	APHA (online edition) 2130 B (modified)	0.05 NTU	All	Auckland
Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Arsenic (Dissolved)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Dissolved)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Dissolved)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland

Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Potassium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.02 mg/L	All	Auckland
Sodium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Metals by ICP-MS—Trace (Default Digest)				
Arsenic (Total)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Total)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Total)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Total)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Total)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Total)	In House based on EPA 200.8 by ICPMS	0.05 mg/L	All	Auckland
Sodium (Total)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Hardness (as CaCO3)	In House based on EPA 200.8 by ICPMS	0.03 mg/L	All	Auckland
Organics				
Total Organic Carbon by Non-dispersive infrared detection				
Total Organic Carbon	APHA (online edition) 5310 B	0.1 mg/L	All	Auckland
Preparations				
Digest for Total Metals in Liquids	APHA (online edition) 3030 E (modified, 4:1 Nitric:Hydrochloric Acid)		All	Auckland
Glass Fibre Filtration (1.2 µm)	APHA (online edition) 2540 C (Filtration)		All	Auckland
Membrane Filtration (0.45 µm)	APHA (online edition) 4500-P B (preliminary filtration)		All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher. For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

Watercare Laboratory Services is a division of Watercare Services Limited .

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Report Signatory 11/08/2017

Zum Nguyen
KTP Signatory

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Certificate of Analysis
Laboratory Reference:170805-052

Attention:	Hilltop Sampler	*Final Report:*	**238411-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**22-Aug-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**05-Aug-2017**
Client Reference:	**MAR**	*Sampled By:*	**Alice Trevelyan**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

Note: No sulphide bottles were received. Sample was subsampled from the bulk.

Sample Details		WATERS	WATERS	WATERS	WATERS
Lab Sample ID:		**170805-052-1**	**170805-052-2**	**170805-052-3**	**170805-052-5**
Client Sample ID:		20175197	20175198	20175199	20175200
Sample Date/Time:		04/08/2017 09:30	04/08/2017 10:30	04/08/2017 09:10	04/08/2017 09:20
Description:		598 Bushmere Road MAR Headworks outlet	599 Bushmere Road GPE010	598 Bushmere Road MAR Pilot Bore GPE 065	598 Bushmere Rd - MAR injection bore GPE066
Chemistry Detailed					
Anions by Ion Chromatography (0.45 µm Filtered)					
Chloride	mg/L	10	140	10	10
Nitrate (as N)	mg/L	0.43	<0.002	0.17	0.44
Nitrite (as N)	mg/L	<0.002	0.0039	0.0097	0.0050
Sulphate	mg/L	80	<0.02	82	82
Total Oxidised Nitrogen (as N) by Calculation	mg/L	-	-	-	0.44 *
Ion Balance (Anions/Cations) by Calculation					
Anion Total	meq/L	5.0 *	16 *	5.1 *	5.0 *
Cation Total	meq/L	5.0 *	17 *	5.0 *	5.0 *
meq/L Difference	meq/L	0.71e-1 *	0.61 *	0.47e-1 *	0.78e-2 *
Percent Difference	%	0.71 *	1.9 *	0.47 *	0.78e-1 *
Sum of Anions + Cations	meq/L	10 *	33 *	10 *	10 *
General Testing					
Ammoniacal Nitrogen (as N)	mg/L	0.0070	2.3	0.69	0.021
Ammoniacal Nitrogen (as NH4)	mg/L	0.0090 *	3.0 *	0.89 *	0.027 *
Bicarbonate Alkalinity (as HCO3)	mg/L	190	740	170	170
Carbonate Alkalinity (as CO3)	mg/L	<1.0	<4.0	8.6	6.8
Hydroxide Alkalinity (as CaCO3)	mg/L	<1.0	<4.0	<1.0	<1.0
pH (at room temp c. 20 °C)	pH unit	8.1	7.1	7.9	7.9
Sulfide	mg/L	<0.1 *	-	-	<0.1 *
Total Alkalinity (as CaCO3)	mg/L	150	610	150	150
Total Chlorine (as Cl2)	mg/L	0.10	0.07	0.08	0.08
Total Dissolved Solids	mg/L	330	890	330	330
Total Nitrogen (as N)	mg/L	0.58	2.4	0.97	0.59
Total Phosphorus (as P)	mg/L	0.034	0.37	0.017	0.027
Total Suspended Solids	mg/L	11	33	0.80	1.6
Turbidity	NTU	9.4	100	0.45	1.2
Metals					
Dissolved Metals by ICP-MS—Trace (Received Filtered)					
Arsenic (Dissolved)	mg/L	0.00065	0.0094	0.00064	0.00079
Calcium (Dissolved)	mg/L	66	200	66	67
Iron (Dissolved)	mg/L	0.0056	12	0.013	0.0057
Magnesium (Dissolved)	mg/L	7.2	23	7.0	7.4
Manganese (Dissolved)	mg/L	0.015	1.1	0.16	0.0071
Potassium (Dissolved)	mg/L	2.7	11	4.2	2.6
Sodium (Dissolved)	mg/L	23	87	23	23
Total Metals by ICP-MS—Trace (Default Digest)					
Arsenic (Total)	mg/L	0.00071	0.0091	0.00063	0.00076
Calcium (Total)	mg/L	66	200	65	65

Sample Details (continued)		WATERS	WATERS	WATERS	WATERS
Lab Sample ID:		**170805-052-1**	**170805-052-2**	**170805-052-3**	**170805-052-5**
Client Sample ID:		20175197	20175198	20175199	20175200
Sample Date/Time:		04/08/2017 09:30	04/08/2017 10:30	04/08/2017 09:10	04/08/2017 09:20
Description:		598 Bushmere Road MAR Headworks outlet	599 Bushmere Road GPE010	598 Bushmere Road MAR Pilot Bore GPE 065	598 Bushmere Rd - MAR injection bore GPE066
Metals					
Total Metals by ICP-MS—Trace (Default Digest)					
Iron (Total)	mg/L	0.24	13	0.047	0.026
Magnesium (Total)	mg/L	7.0	23	6.7	6.9
Manganese (Total)	mg/L	0.020	1.2	0.16	0.0084
Potassium (Total)	mg/L	2.7	8.7	4.2	2.6
Sodium (Total)	mg/L	25	85	25	25
Total Hardness (as CaCO3)	mg/L	190	600	190	190
Organics					
Total Organic Carbon by Non-dispersive infrared detection					
Total Organic Carbon	mg/L	2.7	4.9	2.5	2.8

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods

The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Chemistry Detailed				
Anions by Ion Chromatography (0.45 µm Filtered)				
Chloride	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Nitrate (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Nitrite (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Sulphate	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Total Oxidised Nitrogen (as N) by Calculation	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	5	Auckland
Ion Balance (Anions/Cations) by Calculation				
Anion Total	APHA (online edition) 1030 E	meq/L	All	Auckland
Cation Total	APHA (online edition) 1030 E	meq/L	All	Auckland
meq/L Difference	APHA (online edition) 1030 E	meq/L	All	Auckland
Percent Difference	APHA (online edition) 1030 E		All	Auckland
Sum of Anions + Cations	APHA (online edition) 1030 E		All	Auckland
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	HMSO (1981) ISBN 0117516139	0.005 mg/L	All	Auckland
Ammoniacal Nitrogen (as NH4) by Calculation	Calculation from Ammonia (as N)	0.006 mg/L	All	Auckland
Bicarbonate Alkalinity (as HCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Carbonate Alkalinity (as CO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Hydroxide Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
pH (at room temp c. 20 °C) by Electrode	APHA (online edition) 4500-H B	0.1 pH unit	All	Auckland
Sulfide by Colour Comparison (Methylene Blue Method)	APHA (online edition) 4500-S2 D	0.1 mg/L	1, 5	Auckland
Total Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Total Chlorine (as Cl2) by Spectrophotometry according to APHA (2005) 4500-Cl G	APHA (online edition) 4500-Cl G	0.02 mg/L	All	Auckland
Total Dissolved Solids by Gravimetry	APHA (online edition) 2540 C (Modified: Dried at 103 - 105 ºC)	15 mg/L	All	Auckland
Total Nitrogen (as N) by Persulphate Digestion and Flow Analysis	APHA (online edition) 4500-P J (modified), 4500-NO3 I	0.010 mg/L	All	Auckland
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J (modified)	0.004 mg/L	All	Auckland
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	0.2 mg/L	All	Auckland
Turbidity by Nephelometry	APHA (online edition) 2130 B (modified)	0.05 NTU	All	Auckland
Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Arsenic (Dissolved)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Dissolved)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland

Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Manganese (Dissolved)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.02 mg/L	All	Auckland
Sodium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Metals by ICP-MS—Trace (Default Digest)				
Arsenic (Total)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Total)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Total)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Total)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Total)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Total)	In House based on EPA 200.8 by ICPMS	0.05 mg/L	All	Auckland
Sodium (Total)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Hardness (as CaCO3)	In House based on EPA 200.8 by ICPMS	0.03 mg/L	All	Auckland
Organics				
Total Organic Carbon by Non-dispersive infrared detection				
Total Organic Carbon	APHA (online edition) 5310 B	0.1 mg/L	All	Auckland
Preparations				
Digest for Total Metals in Liquids	APHA (online edition) 3030 E (modified, 4:1 Nitric:Hydrochloric Acid)		All	Auckland
Glass Fibre Filtration (1.2 µm)	APHA (online edition) 2540 C (Filtration)		All	Auckland
Membrane Filtration (0.45 µm)	APHA (online edition) 4500-P B (preliminary filtration)		All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher. For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

Watercare Laboratory Services is a division of Watercare Services Limited .

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Report Signatory 22/08/2017

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Certificate of Analysis
Laboratory Reference:170805-053

Attention:	Hilltop Sampler	*Final Report:*	**238412-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**22-Aug-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**05-Aug-2017**
Client Reference:	**MAR**	*Sampled By:*	**Daniel Williams**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

Note: No sulphide bottles were received. Sample was subsampled from the bulk.

Sample Details		WATERS	WATERS	WATERS	WATERS
Lab Sample ID:		**170805-053-1**	**170805-053-2**	**170805-053-3**	**170805-053-4**
Client Sample ID:		20175201	20175202	20175203	20175205
Sample Date/Time:		04/08/2017 11:10	04/08/2017 11:44	04/08/2017 10:40	04/08/2017 09:40
Description:		Patterson 54 Bolitho Rd GPD115	Stuart 370 Bushmere Rd GPD147	Mc Intyre 409 Matawai Rd (SH2) GPD116	Harper Road GPF162
Chemistry Detailed					
Anions by Ion Chromatography (0.45 µm Filtered)					
Chloride	mg/L	130	320	65	30
Nitrate (as N)	mg/L	0.0020	<0.004	<0.002	0.0064
Nitrite (as N)	mg/L	0.0041	0.0053	<0.002	<0.002
Sulphate	mg/L	<0.02	<0.04	<0.02	0.044
Total Oxidised Nitrogen (as N) by Calculation	mg/L	0.0061 *	0.0053 *	<0.002 *	0.0064 *
Ion Balance (Anions/Cations) by Calculation					
Anion Total	meq/L	14 *	22 *	16 *	9.9 *
Cation Total	meq/L	14 *	22 *	16 *	9.9 *
meq/L Difference	meq/L	0.00043 *	0.70 *	0.029 *	0.12e-1 *
Percent Difference	%	0.15e-2 *	1.6 *	0.92e-1 *	0.59e-1 *
Sum of Anions + Cations	meq/L	29 *	44 *	32 *	20 *
General Testing					
Ammoniacal Nitrogen (as N)	mg/L	3.8	1.9	1.3	0.23
Ammoniacal Nitrogen (as NH4)	mg/L	4.9 *	2.5 *	1.7 *	0.30 *
Bicarbonate Alkalinity (as HCO3)	mg/L	650	830	860	550
Carbonate Alkalinity (as CO3)	mg/L	<3.3	<4.0	<4.0	<3.3
Hydroxide Alkalinity (as CaCO3)	mg/L	<3.3	<4.0	<4.0	<3.3
pH (at room temp c. 20 °C)	pH unit	7.2	7.3	7.3	7.5
Sulfide	mg/L	<0.1 *	<0.1 *	<0.1 *	<0.1 *
Total Alkalinity (as CaCO3)	mg/L	530	680	710	450
Total Chlorine (as Cl2)	mg/L	0.06	0.09	0.10	0.09
Total Dissolved Solids	mg/L	810	1300	880	530
Total Nitrogen (as N)	mg/L	3.9	2.0	1.4	0.26
Total Phosphorus (as P)	mg/L	0.33	0.77	0.77	0.17
Total Suspended Solids	mg/L	15	260	70	37
Turbidity	NTU	55	130	100	170
Metals					
Dissolved Metals by ICP-MS—Trace (Received Filtered)					
Arsenic (Dissolved)	mg/L	0.0062	0.0072	0.0046	0.00054
Calcium (Dissolved)	mg/L	170	220	180	120
Iron (Dissolved)	mg/L	4.9	3.9	6.9	11
Magnesium (Dissolved)	mg/L	19	33	24	12
Manganese (Dissolved)	mg/L	0.71	1.4	1.5	0.27
Potassium (Dissolved)	mg/L	8.4	7.0	5.7	4.8
Sodium (Dissolved)	mg/L	89	180	99	47
Total Metals by ICP-MS—Trace (Default Digest)					
Arsenic (Total)	mg/L	0.0062	0.0089	0.0047	<0.001
Calcium (Total)	mg/L	160	220	180	120
Iron (Total)	mg/L	5.6	9.4	8.2	15

Sample Details (continued)		WATERS	WATERS	WATERS	WATERS
Lab Sample ID:		**170805-053-1**	**170805-053-2**	**170805-053-3**	**170805-053-4**
Client Sample ID:		20175201	20175202	20175203	20175205
Sample Date/Time:		04/08/2017 11:10	04/08/2017 11:44	04/08/2017 10:40	04/08/2017 09:40
Description:		Patterson 54 Bolitho Rd GPD115	Stuart 370 Bushmere Rd GPD147	Mc Intyre 409 Matawai Rd (SH2) GPD116	Harper Road GPF162
Metals					
Total Metals by ICP-MS—Trace (Default Digest)					
Magnesium (Total)	mg/L	18	36	24	12
Manganese (Total)	mg/L	0.70	1.4	1.3	0.27
Potassium (Total)	mg/L	9.1	8.2	6.3	5.0
Sodium (Total)	mg/L	88	180	95	46
Total Hardness (as CaCO3)	mg/L	490	700	550	360
Organics					
Total Organic Carbon by Non-dispersive infrared detection					
Total Organic Carbon	mg/L	3.4	5.0	4.6	2.0
Microbiology					
Escherichia coli by Membrane Filtration					
Escherichia coli	cfu/100 mL	<1.7	<1.6	<1.7	<1.6

Sample Details		WATERS
Lab Sample ID:		**170805-053-5**
Client Sample ID:		20175206
Sample Date/Time:		04/08/2017 10:15
Description:		590 Matawai Rd GPF 159
Chemistry Detailed		
Anions by Ion Chromatography (0.45 µm Filtered)		
Chloride	mg/L	25
Nitrate (as N)	mg/L	0.0021
Nitrite (as N)	mg/L	<0.002
Sulphate	mg/L	0.66
Total Oxidised Nitrogen (as N) by Calculation	mg/L	0.0021 *
Ion Balance (Anions/Cations) by Calculation		
Anion Total	meq/L	9.3 *
Cation Total	meq/L	9.3 *
meq/L Difference	meq/L	0.022 *
Percent Difference	%	0.12 *
Sum of Anions + Cations	meq/L	19 *
General Testing		
Ammoniacal Nitrogen (as N)	mg/L	0.39
Ammoniacal Nitrogen (as NH4)	mg/L	0.50 *
Bicarbonate Alkalinity (as HCO3)	mg/L	520
Carbonate Alkalinity (as CO3)	mg/L	<3.3
Hydroxide Alkalinity (as CaCO3)	mg/L	<3.3
pH (at room temp c. 20 °C)	pH unit	7.5
Sulfide	mg/L	<0.1 *
Total Alkalinity (as CaCO3)	mg/L	430
Total Chlorine (as Cl2)	mg/L	0.06
Total Dissolved Solids	mg/L	520
Total Nitrogen (as N)	mg/L	0.40
Total Phosphorus (as P)	mg/L	0.14
Total Suspended Solids	mg/L	3.8
Turbidity	NTU	14
Metals		
Dissolved Metals by ICP-MS—Trace (Received Filtered)		
Arsenic (Dissolved)	mg/L	0.0026
Calcium (Dissolved)	mg/L	110
Iron (Dissolved)	mg/L	1.0
Magnesium (Dissolved)	mg/L	12
Manganese (Dissolved)	mg/L	0.35
Potassium (Dissolved)	mg/L	5.5
Sodium (Dissolved)	mg/L	55
Total Metals by ICP-MS—Trace (Default Digest)		
Arsenic (Total)	mg/L	0.0026

Sample Details (continued)

WATERS

Lab Sample ID:	**170805-053-5**
Client Sample ID:	20175206
Sample Date/Time:	04/08/2017 10:15
Description:	590 Matawai Rd GPF 159

Metals

Total Metals by ICP-MS—Trace (Default Digest)

Calcium (Total)	mg/L	110
Iron (Total)	mg/L	1.2
Magnesium (Total)	mg/L	12
Manganese (Total)	mg/L	0.33
Potassium (Total)	mg/L	5.8
Sodium (Total)	mg/L	53
Total Hardness (as CaCO3)	mg/L	330

Organics

Total Organic Carbon by Non-dispersive infrared detection

Total Organic Carbon	mg/L	2.5

Microbiology

Escherichia coli by Membrane Filtration

Escherichia coli	cfu/100 mL	<1.6

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods

The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Chemistry Detailed				
Anions by Ion Chromatography (0.45 µm Filtered)				
Chloride	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Nitrate (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Nitrite (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Sulphate	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Total Oxidised Nitrogen (as N) by Calculation	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Ion Balance (Anions/Cations) by Calculation				
Anion Total	APHA (online edition) 1030 E	meq/L	All	Auckland
Cation Total	APHA (online edition) 1030 E	meq/L	All	Auckland
meq/L Difference	APHA (online edition) 1030 E	meq/L	All	Auckland
Percent Difference	APHA (online edition) 1030 E		All	Auckland
Sum of Anions + Cations	APHA (online edition) 1030 E		All	Auckland
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	HMSO (1981) ISBN 0117516139	0.005 mg/L	All	Auckland
Ammoniacal Nitrogen (as NH4) by Calculation	Calculation from Ammonia (as N)	0.006 mg/L	All	Auckland
Bicarbonate Alkalinity (as HCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Carbonate Alkalinity (as CO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Hydroxide Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
pH (at room temp c. 20 °C) by Electrode	APHA (online edition) 4500-H B	0.1 pH unit	All	Auckland
Sulfide by Colour Comparison (Methylene Blue Method)	APHA (online edition) 4500-S2 D	0.1 mg/L	All	Auckland
Total Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Total Chlorine (as Cl2) by Spectrophotometry according to APHA (2005) 4500-Cl G	APHA (online edition) 4500-Cl G	0.02 mg/L	All	Auckland
Total Dissolved Solids by Gravimetry	APHA (online edition) 2540 C (Modified: Dried at 103 - 105 °C)	15 mg/L	All	Auckland
Total Nitrogen (as N) by Persulphate Digestion and Flow Analysis	APHA (online edition) 4500-P J (modified), 4500-NO3 I	0.010 mg/L	All	Auckland
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J (modified)	0.004 mg/L	All	Auckland
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	0.2 mg/L	All	Auckland
Turbidity by Nephelometry	APHA (online edition) 2130 B (modified)	0.05 NTU	All	Auckland
Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Arsenic (Dissolved)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland

Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Calcium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Dissolved)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Dissolved)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.02 mg/L	All	Auckland
Sodium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Metals by ICP-MS—Trace (Default Digest)				
Arsenic (Total)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Total)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Total)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Total)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Total)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Total)	In House based on EPA 200.8 by ICPMS	0.05 mg/L	All	Auckland
Sodium (Total)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Hardness (as CaCO3)	In House based on EPA 200.8 by ICPMS	0.03 mg/L	All	Auckland
Organics				
Total Organic Carbon by Non-dispersive infrared detection				
Total Organic Carbon	APHA (online edition) 5310 B	0.1 mg/L	All	Auckland
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603	2 cfu/100 mL	All	Auckland
Preparations				
Digest for Total Metals in Liquids	APHA (online edition) 3030 E (modified, 4:1 Nitric:Hydrochloric Acid)		All	Auckland
Glass Fibre Filtration (1.2 µm)	APHA (online edition) 2540 C (Filtration)		All	Auckland
Membrane Filtration (0.45 µm)	APHA (online edition) 4500-P B (preliminary filtration)		All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher. For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

Watercare Laboratory Services is a division of Watercare Services Limited .

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Report Signatory 22/08/2017

Zum Nguyen
KTP Signatory

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Certificate of Analysis
Laboratory Reference:170814-091

Attention:	Hilltop Sampler	*Final Report:*	**238970-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**24-Aug-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**14-Aug-2017**
Client Reference:	**MAR**	*Sampled By:*	**Alice Trevelyan**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

Samples received and tested outside of holding time.

Sample Details		WATERS	WATERS	WATERS
Lab Sample ID:		**170814-091-1**	**170814-091-2**	**170814-091-3**
Client Sample ID:		20175218	20175220	20175221
Sample Date/Time:		11/08/2017 09:04	11/08/2017 09:50	11/08/2017 10:04
Description:		598 Bushmere Road MAR Headworks outlet	598 Bushmere Road MAR Pilot Bore GPE 065	598 Bushmere Rd - MAR Injection Bore GPE066
Chemistry Detailed				
Anions by Ion Chromatography (0.45 µm Filtered)				
Chloride	mg/L	9.2	9.5	9.1
Nitrate (as N)	mg/L	0.43	0.23	0.33
Nitrite (as N)	mg/L	<0.002	0.036	0.046
Sulphate	mg/L	91	84	74
Total Oxidised Nitrogen (as N) by Calculation	mg/L	-	-	0.38 *
Ion Balance (Anions/Cations) by Calculation				
Anion Total	meq/L	5.1 *	5.2 *	4.8 *
Cation Total	meq/L	4.7 *	5.0 *	4.7 *
meq/L Difference	meq/L	0.37 *	0.23 *	0.10 *
Percent Difference	%	3.8 *	2.3 *	1.1 *
Sum of Anions + Cations	meq/L	9.8 *	10 *	9.5 *
General Testing				
Ammoniacal Nitrogen (as N)	mg/L	<0.005	0.61	0.0060
Ammoniacal Nitrogen (as NH4)	mg/L	<0.006 *	0.79 *	0.0077 *
Bicarbonate Alkalinity (as HCO3)	mg/L	180	190	180
Carbonate Alkalinity (as CO3)	mg/L	<1.0	<1.0	<1.0
Hydroxide Alkalinity (as CaCO3)	mg/L	<1.0	<1.0	<1.0
pH (at room temp c. 20 °C)	pH unit	8.0	8.2	7.7
Sulfide	mg/L	<0.1 *	<0.1 *	<0.1 *
Total Alkalinity (as CaCO3)	mg/L	150	160	150
Total Chlorine (as Cl2)	mg/L	0.05	0.05	0.07
Total Dissolved Solids	mg/L	320	310	320
Total Nitrogen (as N)	mg/L	0.45	0.92	0.49
Total Phosphorus (as P)	mg/L	0.021	0.010	0.019
Total Suspended Solids	mg/L	2.0	<0.5	1.6
Turbidity	NTU	3.0	0.25	1.1
Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Arsenic (Dissolved)	mg/L	0.00065	0.0012	0.00075
Calcium (Dissolved)	mg/L	62	65	62
Iron (Dissolved)	mg/L	0.0081	0.013	0.0037
Magnesium (Dissolved)	mg/L	6.6	6.7	6.3
Manganese (Dissolved)	mg/L	0.022	0.090	0.0049
Potassium (Dissolved)	mg/L	2.5	4.4	2.3
Sodium (Dissolved)	mg/L	23	24	23
Total Metals by ICP-MS—Trace (Default Digest)				
Arsenic (Total)	mg/L	0.00063	0.0011	0.00075
Calcium (Total)	mg/L	60	63	62

Sample Details (continued)		WATERS	WATERS	WATERS
Lab Sample ID:		**170814-091-1**	**170814-091-2**	**170814-091-3**
Client Sample ID:		20175218	20175220	20175221
Sample Date/Time:		11/08/2017 09:04	11/08/2017 09:50	11/08/2017 10:04
Description:		598 Bushmere Road MAR Headworks outlet	598 Bushmere Road MAR Pilot Bore GPE 065	598 Bushmere Rd - MAR Injection Bore GPE066
Metals				
Total Metals by ICP-MS—Trace (Default Digest)				
Iron (Total)	mg/L	0.056	0.021	0.029
Magnesium (Total)	mg/L	6.3	6.5	6.5
Manganese (Total)	mg/L	0.023	0.078	0.0057
Potassium (Total)	mg/L	2.4	4.1	2.3
Sodium (Total)	mg/L	22	24	23
Total Hardness (as CaCO3)	mg/L	170	180	180
Organics				
Total Organic Carbon by Non-dispersive infrared detection				
Total Organic Carbon	mg/L	2.6	2.4	2.5

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods

The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Chemistry Detailed				
Anions by Ion Chromatography (0.45 µm Filtered)				
Chloride	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Nitrate (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Nitrite (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Sulphate	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Total Oxidised Nitrogen (as N) by Calculation	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	3	Auckland
Ion Balance (Anions/Cations) by Calculation				
Anion Total	APHA (online edition) 1030 E	meq/L	All	Auckland
Cation Total	APHA (online edition) 1030 E	meq/L	All	Auckland
meq/L Difference	APHA (online edition) 1030 E	meq/L	All	Auckland
Percent Difference	APHA (online edition) 1030 E		All	Auckland
Sum of Anions + Cations	APHA (online edition) 1030 E		All	Auckland
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	HMSO (1981) ISBN 0117516139	0.005 mg/L	All	Auckland
Ammoniacal Nitrogen (as NH4) by Calculation	Calculation from Ammonia (as N)	0.006 mg/L	All	Auckland
Bicarbonate Alkalinity (as HCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Carbonate Alkalinity (as CO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Hydroxide Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
pH (at room temp c. 20 °C) by Electrode	APHA (online edition) 4500-H B	0.1 pH unit	All	Auckland
Sulfide by Colour Comparison (Methylene Blue Method)	APHA (online edition) 4500-S2 D	0.1 mg/L	All	Auckland
Total Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Total Chlorine (as Cl2) by Spectrophotometry according to APHA (2005) 4500-Cl G	APHA (online edition) 4500-Cl G	0.02 mg/L	All	Auckland
Total Dissolved Solids by Gravimetry	APHA (online edition) 2540 C (Modified: Dried at 103 - 105 ºC)	15 mg/L	All	Auckland
Total Nitrogen (as N) by Persulphate Digestion and Flow Analysis	APHA (online edition) 4500-P J (modified), 4500-NO3 I	0.010 mg/L	All	Auckland
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J (modified)	0.004 mg/L	All	Auckland
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	0.2 mg/L	All	Auckland
Turbidity by Nephelometry	APHA (online edition) 2130 B (modified)	0.05 NTU	All	Auckland
Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Arsenic (Dissolved)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Dissolved)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland

Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Manganese (Dissolved)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.02 mg/L	All	Auckland
Sodium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Metals by ICP-MS—Trace (Default Digest)				
Arsenic (Total)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Total)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Total)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Total)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Total)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Total)	In House based on EPA 200.8 by ICPMS	0.05 mg/L	All	Auckland
Sodium (Total)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Hardness (as CaCO3)	In House based on EPA 200.8 by ICPMS	0.03 mg/L	All	Auckland
Organics				
Total Organic Carbon by Non-dispersive infrared detection				
Total Organic Carbon	APHA (online edition) 5310 B	0.1 mg/L	All	Auckland
Preparations				
Digest for Total Metals in Liquids	APHA (online edition) 3030 E (modified, 4:1 Nitric:Hydrochloric Acid)		All	Auckland
Glass Fibre Filtration (1.2 µm)	APHA (online edition) 2540 C (Filtration)		All	Auckland
Membrane Filtration (0.45 µm)	APHA (online edition) 4500-P B (preliminary filtration)		All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher. For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

Watercare Laboratory Services is a division of Watercare Services Limited .

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Report Signatory 24/08/2017

Peter Boniface
KTP Signatory

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Certificate of Analysis
Laboratory Reference:170826-054

Attention:	Hilltop Sampler	*Final Report:*	**240926-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**11-Sep-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**26-Aug-2017**
Client Reference:	**MAR**	*Sampled By:*	**Alice Trevelyan**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

Micro test for sample ID 20175495 is logged on a separate project (Project ID: 170826-055).
Extra sulphide bottles received for sample IDs 20175493 and 20175494. Total sulphide test was added as requested by Alice.

Sample Details		WATERS	WATERS	WATERS	WATERS
Lab Sample ID:		**170826-054-1**	**170826-054-2**	**170826-054-3**	**170826-054-5**
Client Sample ID:		20175492	20175493	20175494	20175495
Sample Date/Time:		25/08/2017 09:39	25/08/2017 09:10	25/08/2017 10:03	25/08/2017 10:13
Description:		598 Bushmere Road MAR Headworks outlet	599 Bushmere Road GPE010	598 Bushmere Road MAR Pilot Bore GPE 065	598 Bushmere Rd - MAR injection bore GPE066
Chemistry Detailed					
Anions by Ion Chromatography (0.45 µm Filtered)					
Chloride	mg/L	9.1	140	9.0	9.1
Nitrate (as N)	mg/L	0.30	0.0069	0.50	0.31
Nitrite (as N)	mg/L	<0.002	0.0059	0.050	<0.002
Sulphate	mg/L	67	<0.02	67	67
Total Oxidised Nitrogen (as N) by Calculation	mg/L	-	-	-	0.31 *
Ion Balance (Anions/Cations) by Calculation					
Anion Total	meq/L	4.9 *	16 *	4.9 *	4.9 *
Cation Total	meq/L	4.8 *	17 *	4.9 *	4.9 *
meq/L Difference	meq/L	0.43e-1 *	0.46 *	0.19e-1 *	0.16e-1 *
Percent Difference	%	0.44 *	1.4 *	0.19 *	0.16 *
Sum of Anions + Cations	meq/L	9.7 *	33 *	9.8 *	9.7 *
General Testing					
Ammoniacal Nitrogen (as N)	mg/L	0.010	2.4	0.082	0.010
Ammoniacal Nitrogen (as NH4)	mg/L	0.013 *	3.1 *	0.11 *	0.013 *
Bicarbonate Alkalinity (as HCO3)	mg/L	200	740	200	200
Carbonate Alkalinity (as CO3)	mg/L	<1.0	<5.0	<1.0	<1.0
Hydroxide Alkalinity (as CaCO3)	mg/L	<1.0	<5.0	<1.0	<1.0
pH (at room temp c. 20 °C)	pH unit	7.7	7.2	7.9	7.7
Sulfide	mg/L	<0.1 *	<0.1 *	<0.1 *	<0.1 *
Total Alkalinity (as CaCO3)	mg/L	160	600	160	160
Total Chlorine (as Cl2)	mg/L	0.09	0.03	0.03	0.08
Total Dissolved Solids	mg/L	280	830	280	280
Total Nitrogen (as N)	mg/L	0.42	2.5	0.68	0.46
Total Phosphorus (as P)	mg/L	0.024	0.25	0.013	0.023
Total Suspended Solids	mg/L	0.75	36	<0.5	1.0
Turbidity	NTU	0.75	180	0.20	1.0
Metals					
Dissolved Metals by ICP-MS—Trace (Received Filtered)					
Arsenic (Dissolved)	mg/L	0.00062	0.010	0.0012	0.00066
Calcium (Dissolved)	mg/L	66	200	66	66
Iron (Dissolved)	mg/L	0.0075	13	0.0024	0.0028
Magnesium (Dissolved)	mg/L	7.1	23	6.9	7.2
Manganese (Dissolved)	mg/L	0.033	1.1	0.0060	0.012
Potassium (Dissolved)	mg/L	2.5	9.2	3.5	2.3
Sodium (Dissolved)	mg/L	21	85	21	21
Total Metals by ICP-MS—Trace (Default Digest)					
Arsenic (Total)	mg/L	0.00065	0.011	0.0011	0.00067
Calcium (Total)	mg/L	67	200	65	66

Sample Details (continued)		WATERS	WATERS	WATERS	WATERS
Lab Sample ID:		**170826-054-1**	**170826-054-2**	**170826-054-3**	**170826-054-5**
Client Sample ID:		20175492	20175493	20175494	20175495
Sample Date/Time:		25/08/2017 09:39	25/08/2017 09:10	25/08/2017 10:03	25/08/2017 10:13
Description:		598 Bushmere Road MAR Headworks outlet	599 Bushmere Road GPE010	598 Bushmere Road MAR Pilot Bore GPE 065	598 Bushmere Rd - MAR injection bore GPE066
Metals					
Total Metals by ICP-MS—Trace (Default Digest)					
Iron (Total)	mg/L	0.021	14	0.0096	0.018
Magnesium (Total)	mg/L	7.1	23	6.8	7.1
Manganese (Total)	mg/L	0.034	1.1	0.0083	0.014
Potassium (Total)	mg/L	2.4	10	3.7	2.5
Sodium (Total)	mg/L	21	87	21	21
Total Hardness (as CaCO3)	mg/L	200	580	190	190
Organics					
Total Organic Carbon by Non-dispersive infrared detection					
Total Organic Carbon	mg/L	2.4	5.0	2.6	2.7

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods

The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Chemistry Detailed				
Anions by Ion Chromatography (0.45 µm Filtered)				
Chloride	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Nitrate (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Nitrite (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Sulphate	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Total Oxidised Nitrogen (as N) by Calculation	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	5	Auckland
Ion Balance (Anions/Cations) by Calculation				
Anion Total	APHA (online edition) 1030 E	meq/L	All	Auckland
Cation Total	APHA (online edition) 1030 E	meq/L	All	Auckland
meq/L Difference	APHA (online edition) 1030 E	meq/L	All	Auckland
Percent Difference	APHA (online edition) 1030 E		All	Auckland
Sum of Anions + Cations	APHA (online edition) 1030 E		All	Auckland
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	HMSO (1981) ISBN 0117516139	0.005 mg/L	All	Auckland
Ammoniacal Nitrogen (as NH4) by Calculation	Calculation from Ammonia (as N)	0.006 mg/L	All	Auckland
Bicarbonate Alkalinity (as HCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Carbonate Alkalinity (as CO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Hydroxide Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
pH (at room temp c. 20 °C) by Electrode	APHA (online edition) 4500-H B	0.1 pH unit	All	Auckland
Sulfide by Colour Comparison (Methylene Blue Method)	APHA (online edition) 4500-S2 D	0.1 mg/L	All	Auckland
Total Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Total Chlorine (as Cl2) by Spectrophotometry according to APHA (2005) 4500-Cl G	APHA (online edition) 4500-Cl G	0.02 mg/L	All	Auckland
Total Dissolved Solids by Gravimetry	APHA (online edition) 2540 C (Modified: Dried at 103 - 105 ºC)	15 mg/L	All	Auckland
Total Nitrogen (as N) by Persulphate Digestion and Flow Analysis	APHA (online edition) 4500-P J (modified), 4500-NO3 I	0.010 mg/L	All	Auckland
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J (modified)	0.004 mg/L	All	Auckland
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	0.2 mg/L	All	Auckland
Turbidity by Nephelometry	APHA (online edition) 2130 B (modified)	0.05 NTU	All	Auckland
Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Arsenic (Dissolved)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Dissolved)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland

Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Manganese (Dissolved)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.02 mg/L	All	Auckland
Sodium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Metals by ICP-MS—Trace (Default Digest)				
Arsenic (Total)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Total)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Total)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Total)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Total)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Total)	In House based on EPA 200.8 by ICPMS	0.05 mg/L	All	Auckland
Sodium (Total)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Hardness (as CaCO3)	In House based on EPA 200.8 by ICPMS	0.03 mg/L	All	Auckland
Organics				
Total Organic Carbon by Non-dispersive infrared detection				
Total Organic Carbon	APHA (online edition) 5310 B	0.1 mg/L	All	Auckland
Preparations				
Digest for Total Metals in Liquids	APHA (online edition) 3030 E (modified, 4:1 Nitric:Hydrochloric Acid)		All	Auckland
Glass Fibre Filtration (1.2 µm)	APHA (online edition) 2540 C (Filtration)		All	Auckland
Membrane Filtration (0.45 µm)	APHA (online edition) 4500-P B (preliminary filtration)		All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher. For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

Watercare Laboratory Services is a division of Watercare Services Limited .

ilac-MRA IANZ ACCREDITED LABORATORY

Report Signatory 11/09/2017

Zum Nguyen
KTP Signatory

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Certificate of Analysis
Laboratory Reference:170909-055

Attention:	Hilltop Sampler	*Final Report:*	**242389-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**24-Sep-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**09-Sep-2017**
Client Reference:	**MAR**	*Sampled By:*	**Alice Trevelyan**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

Sulphide bottles were received for sample IDs 20175598 and 20175599 but Total Sulphide was not requested on the COC. Test added for these samples as requested by Alice.

Sample Details		WATERS	WATERS	WATERS	WATERS
Lab Sample ID:		**170909-055-1**	**170909-055-2**	**170909-055-3**	**170909-055-4**
Client Sample ID:		20175597	20175598	20175599	20175600
Sample Date/Time:		08/09/2017 10:47	08/09/2017 09:10	08/09/2017 10:35	08/09/2017 11:15
Description:		598 Bushmere Road MAR Headworks outlet	599 Bushmere Road GPE010	598 Bushmere Road MAR Pilot Bore GPE 065	598 Bushmere Rd - MAR injection bore GPE066
Chemistry Detailed					
Anions by Ion Chromatography (0.45 µm Filtered)					
Chloride	mg/L	8.1	140	9.7	8.1
Nitrate (as N)	mg/L	0.35	0.0046	0.0079	0.34
Nitrite (as N)	mg/L	0.0047	0.0033	0.035	0.0064
Sulphate	mg/L	61	<0.02	56	60
Total Oxidised Nitrogen (as N) by Calculation	mg/L	-	-	-	0.34 *
Ion Balance (Anions/Cations) by Calculation					
Anion Total	meq/L	4.2 *	15 *	4.6 *	4.3 *
Cation Total	meq/L	4.2 *	16 *	4.5 *	4.2 *
meq/L Difference	meq/L	0.24e-1 *	0.48 *	0.12 *	0.54e-1 *
Percent Difference	%	0.28 *	1.5 *	1.3 *	0.64 *
Sum of Anions + Cations	meq/L	8.4 *	31 *	9.2 *	8.5 *
General Testing					
Ammoniacal Nitrogen (as N)	mg/L	0.0060	2.4	0.061	0.013
Ammoniacal Nitrogen (as NH4)	mg/L	0.0077 *	3.2 *	0.079 *	0.017 *
Bicarbonate Alkalinity (as HCO3)	mg/L	160	700	200	170
Carbonate Alkalinity (as CO3)	mg/L	<1.0	<4.0	<1.0	<1.0
Hydroxide Alkalinity (as CaCO3)	mg/L	<1.0	<4.0	<1.0	<1.0
pH (at room temp c. 20 °C)	pH unit	7.8	7.2	7.8	7.8
Sulfide	mg/L	<0.1 *	<0.1 *	<0.1 *	<0.1 *
Total Alkalinity (as CaCO3)	mg/L	130	570	160	140
Total Chlorine (as Cl2)	mg/L	0.06	0.07	0.07	0.08
Total Dissolved Solids	mg/L	250	420	280	250
Total Nitrogen (as N)	mg/L	0.51	2.2	0.65	0.50
Total Phosphorus (as P)	mg/L	0.028	0.28	0.020	0.046
Total Suspended Solids	mg/L	3.0	39	0.50	28
Turbidity	NTU	3.2	200	0.25	21
Metals					
Dissolved Metals by ICP-MS—Trace (Received Filtered)					
Arsenic (Dissolved)	mg/L	0.00073	0.0098	0.0013	0.00085
Calcium (Dissolved)	mg/L	56	200	60	56
Iron (Dissolved)	mg/L	0.012	11	0.0066	0.0042
Magnesium (Dissolved)	mg/L	6.1	22	6.4	5.8
Manganese (Dissolved)	mg/L	0.0095	1.1	0.015	0.010
Potassium (Dissolved)	mg/L	2.4	8.8	3.2	2.3

Sample Details (continued)		WATERS	WATERS	WATERS	WATERS
Lab Sample ID:		**170909-055-1**	**170909-055-2**	**170909-055-3**	**170909-055-4**
Client Sample ID:		20175597	20175598	20175599	20175600
Sample Date/Time:		08/09/2017 10:47	08/09/2017 09:10	08/09/2017 10:35	08/09/2017 11:15
Description:		598 Bushmere Road MAR Headworks outlet	599 Bushmere Road GPE010	598 Bushmere Road MAR Pilot Bore GPE 065	598 Bushmere Rd - MAR injection bore GPE066
Metals					
Dissolved Metals by ICP-MS—Trace (Received Filtered)					
Sodium (Dissolved)	mg/L	20	81	21	20
Total Metals by ICP-MS—Trace (Default Digest)					
Arsenic (Total)	mg/L	0.00073	0.010	0.0015	0.0011
Calcium (Total)	mg/L	55	200	61	59
Iron (Total)	mg/L	0.090	13	0.014	0.51
Magnesium (Total)	mg/L	6.1	23	6.6	6.4
Manganese (Total)	mg/L	0.012	1.1	0.015	0.052
Potassium (Total)	mg/L	2.4	9.0	3.2	2.5
Sodium (Total)	mg/L	20	85	22	21
Total Hardness (as CaCO3)	mg/L	160	600	180	170
Organics					
Total Organic Carbon by Non-dispersive infrared detection					
Total Organic Carbon	mg/L	2.8	5.8	3.0	3.1

Sample Details		WATERS
Lab Sample ID:		**170909-055-5**
Client Sample ID:		20175601
Sample Date/Time:		08/09/2017 09:54
Description:		645 Bushmere Road GPE030
Chemistry Detailed		
Anions by Ion Chromatography (0.45 µm Filtered)		
Chloride	mg/L	220
Nitrate (as N)	mg/L	0.0061
Nitrite (as N)	mg/L	0.0046
Sulphate	mg/L	<0.04
Total Oxidised Nitrogen (as N) by Calculation	mg/L	0.011 *
Ion Balance (Anions/Cations) by Calculation		
Anion Total	meq/L	18 *
Cation Total	meq/L	18 *
meq/L Difference	meq/L	0.60 *
Percent Difference	%	1.6 *
Sum of Anions + Cations	meq/L	36 *
General Testing		
Ammoniacal Nitrogen (as N)	mg/L	3.3
Ammoniacal Nitrogen (as NH4)	mg/L	4.2 *
Bicarbonate Alkalinity (as HCO3)	mg/L	750
Carbonate Alkalinity (as CO3)	mg/L	<4.0
Hydroxide Alkalinity (as CaCO3)	mg/L	<4.0
pH (at room temp c. 20 °C)	pH unit	7.2
Sulfide	mg/L	<0.1 *
Total Alkalinity (as CaCO3)	mg/L	620
Total Chlorine (as Cl2)	mg/L	0.07
Total Dissolved Solids	mg/L	980
Total Nitrogen (as N)	mg/L	3.4
Total Phosphorus (as P)	mg/L	0.29
Total Suspended Solids	mg/L	32
Turbidity	NTU	160
Metals		
Dissolved Metals by ICP-MS—Trace (Received Filtered)		
Arsenic (Dissolved)	mg/L	0.027
Calcium (Dissolved)	mg/L	180
Iron (Dissolved)	mg/L	11

Sample Details (continued)

WATERS

Lab Sample ID:	**170909-055-5**
Client Sample ID:	20175601
Sample Date/Time:	08/09/2017 09:54
Description:	645 Bushmere Road GPE030

Metals

Dissolved Metals by ICP-MS—Trace (Received Filtered)

Magnesium (Dissolved)	mg/L	21
Manganese (Dissolved)	mg/L	0.81
Potassium (Dissolved)	mg/L	6.7
Sodium (Dissolved)	mg/L	150

Total Metals by ICP-MS—Trace (Default Digest)

Arsenic (Total)	mg/L	0.029
Calcium (Total)	mg/L	170
Iron (Total)	mg/L	12
Magnesium (Total)	mg/L	21
Manganese (Total)	mg/L	0.83
Potassium (Total)	mg/L	6.8
Sodium (Total)	mg/L	160
Total Hardness (as CaCO3)	mg/L	520

Organics

Total Organic Carbon by Non-dispersive infrared detection

Total Organic Carbon	mg/L	6.9

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods

The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Chemistry Detailed				
Anions by Ion Chromatography (0.45 µm Filtered)				
Chloride	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Nitrate (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Nitrite (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Sulphate	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Total Oxidised Nitrogen (as N) by Calculation	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	4, 5	Auckland
Ion Balance (Anions/Cations) by Calculation				
Anion Total	APHA (online edition) 1030 E	meq/L	All	Auckland
Cation Total	APHA (online edition) 1030 E	meq/L	All	Auckland
meq/L Difference	APHA (online edition) 1030 E	meq/L	All	Auckland
Percent Difference	APHA (online edition) 1030 E		All	Auckland
Sum of Anions + Cations	APHA (online edition) 1030 E		All	Auckland
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	HMSO (1981) ISBN 0117516139	0.005 mg/L	All	Auckland
Ammoniacal Nitrogen (as NH4) by Calculation	Calculation from Ammonia (as N)	0.006 mg/L	All	Auckland
Bicarbonate Alkalinity (as HCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Carbonate Alkalinity (as CO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Hydroxide Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
pH (at room temp c. 20 °C) by Electrode	APHA (online edition) 4500-H B	0.1 pH unit	All	Auckland
Sulfide by Colour Comparison (Methylene Blue Method)	APHA (online edition) 4500-S2 D	0.1 mg/L	All	Auckland
Total Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Total Chlorine (as Cl2) by Spectrophotometry according to APHA (2005) 4500-Cl G	APHA (online edition) 4500-Cl G	0.02 mg/L	All	Auckland
Total Dissolved Solids by Gravimetry	APHA (online edition) 2540 C (Modified: Dried at 103 - 105 °C)	15 mg/L	All	Auckland
Total Nitrogen (as N) by Persulphate Digestion and Flow Analysis	APHA (online edition) 4500-P J (modified), 4500-NO3 I	0.010 mg/L	All	Auckland

General Testing				
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J (modified)	0.004 mg/L	All	Auckland
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	0.2 mg/L	All	Auckland
Turbidity by Nephelometry	APHA (online edition) 2130 B (modified)	0.05 NTU	All	Auckland
Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Arsenic (Dissolved)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Dissolved)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Dissolved)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.02 mg/L	All	Auckland
Sodium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Metals by ICP-MS—Trace (Default Digest)				
Arsenic (Total)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Total)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Total)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Total)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Total)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Total)	In House based on EPA 200.8 by ICPMS	0.05 mg/L	All	Auckland
Sodium (Total)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Hardness (as CaCO3)	In House based on EPA 200.8 by ICPMS	0.03 mg/L	All	Auckland
Organics				
Total Organic Carbon by Non-dispersive infrared detection				
Total Organic Carbon	APHA (online edition) 5310 B	0.1 mg/L	All	Auckland
Preparations				
Digest for Total Metals in Liquids	APHA (online edition) 3030 E (modified, 4:1 Nitric:Hydrochloric Acid)		All	Auckland
Glass Fibre Filtration (1.2 µm)	APHA (online edition) 2540 C (Filtration)		All	Auckland
Membrane Filtration (0.45 µm)	APHA (online edition) 4500-P B (preliminary filtration)		All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher.

For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

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Report Signatory 24/09/2017

Rachel Hwang
KTP Signatory

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Certificate of Analysis
Laboratory Reference:170916-049

Attention:	Hilltop Sampler	*Final Report:*	**242390-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**24-Sep-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**16-Sep-2017**
Client Reference:	**MAR**	*Sampled By:*	**Alice Trevelyan**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

Received sulphide bottles for sample IDs 20175637 and 20175638. Total sulphide test added for these samples as requested by Alice Trevelyan.

Sample Details		WATERS	WATERS	WATERS
Lab Sample ID:		**170916-049-1**	**170916-049-2**	**170916-049-3**
Client Sample ID:		20175637	20175638	20175639
Sample Date/Time:		15/09/2017 08:38	15/09/2017 10:05	15/09/2017 09:26
Description:		599 Bushmere Road GPE010	598 Bushmere Road MAR Pilot Bore GPE 065	645 Bushmere Road GPE030
Chemistry Detailed				
Anions by Ion Chromatography (0.45 µm Filtered)				
Chloride	mg/L	140	12	200
Nitrate (as N)	mg/L	0.0082	0.044	0.010
Nitrite (as N)	mg/L	0.0022	0.018	<0.004
Sulphate	mg/L	<0.02	68	<0.04
Total Oxidised Nitrogen (as N) by Calculation	mg/L	-	-	0.010 *
Ion Balance (Anions/Cations) by Calculation				
Anion Total	meq/L	16 *	5.2 *	18 *
Cation Total	meq/L	16 *	5.1 *	18 *
meq/L Difference	meq/L	0.24 *	0.84e-2 *	0.28 *
Percent Difference	%	0.74 *	0.81e-1 *	0.78 *
Sum of Anions + Cations	meq/L	32 *	10 *	36 *
General Testing				
Ammoniacal Nitrogen (as N)	mg/L	2.4	0.37	3.1
Ammoniacal Nitrogen (as NH4)	mg/L	3.1 *	0.48 *	4.0 *
Bicarbonate Alkalinity (as HCO3)	mg/L	740	210	750
Carbonate Alkalinity (as CO3)	mg/L	<4.0	<2.0	<4.0
Hydroxide Alkalinity (as CaCO3)	mg/L	<4.0	<2.0	<4.0
pH (at room temp c. 20 °C)	pH unit	7.2	7.7	7.1
Sulfide	mg/L	<0.1 *	<0.1 *	<0.1 *
Total Alkalinity (as CaCO3)	mg/L	610	170	610
Total Chlorine (as Cl2)	mg/L	0.07	0.07	0.07
Total Dissolved Solids	mg/L	870	300	940
Total Nitrogen (as N)	mg/L	2.5	0.88	3.4
Total Phosphorus (as P)	mg/L	0.36	0.067	0.29
Total Suspended Solids	mg/L	27	3.4	36
Turbidity	NTU	140	4.7	160
Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Arsenic (Dissolved)	mg/L	0.011	0.0011	0.027
Calcium (Dissolved)	mg/L	200	67	170
Iron (Dissolved)	mg/L	11	0.43	12
Magnesium (Dissolved)	mg/L	22	7.3	21
Manganese (Dissolved)	mg/L	1.1	0.12	0.80
Potassium (Dissolved)	mg/L	8.7	3.4	6.5
Sodium (Dissolved)	mg/L	83	25	150

Sample Details (continued)		WATERS	WATERS	WATERS
Lab Sample ID:		**170916-049-1**	**170916-049-2**	**170916-049-3**
Client Sample ID:		20175637	20175638	20175639
Sample Date/Time:		15/09/2017 08:38	15/09/2017 10:05	15/09/2017 09:26
Description:		599 Bushmere Road GPE010	598 Bushmere Road MAR Pilot Bore GPE 065	645 Bushmere Road GPE030
Metals				
Total Metals by ICP-MS—Trace (Default Digest)				
Arsenic (Total)	mg/L	0.011	0.0013	0.028
Calcium (Total)	mg/L	200	65	170
Iron (Total)	mg/L	12	0.52	12
Magnesium (Total)	mg/L	23	7.4	22
Manganese (Total)	mg/L	1.1	0.13	0.82
Potassium (Total)	mg/L	9.1	3.6	6.8
Sodium (Total)	mg/L	83	25	150
Total Hardness (as CaCO3)	mg/L	590	190	520
Organics				
Total Organic Carbon by Non-dispersive infrared detection				
Total Organic Carbon	mg/L	4.4	2.5	7.6

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods

The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Chemistry Detailed				
Anions by Ion Chromatography (0.45 µm Filtered)				
Chloride	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Nitrate (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Nitrite (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Sulphate	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Total Oxidised Nitrogen (as N) by Calculation	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	3	Auckland
Ion Balance (Anions/Cations) by Calculation				
Anion Total	APHA (online edition) 1030 E	meq/L	All	Auckland
Cation Total	APHA (online edition) 1030 E	meq/L	All	Auckland
meq/L Difference	APHA (online edition) 1030 E	meq/L	All	Auckland
Percent Difference	APHA (online edition) 1030 E		All	Auckland
Sum of Anions + Cations	APHA (online edition) 1030 E		All	Auckland
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	HMSO (1981) ISBN 0117516139	0.005 mg/L	All	Auckland
Ammoniacal Nitrogen (as NH4) by Calculation	Calculation from Ammonia (as N)	0.006 mg/L	All	Auckland
Bicarbonate Alkalinity (as HCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Carbonate Alkalinity (as CO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Hydroxide Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
pH (at room temp c. 20 °C) by Electrode	APHA (online edition) 4500-H B	0.1 pH unit	All	Auckland
Sulfide by Colour Comparison (Methylene Blue Method)	APHA (online edition) 4500-S2 D	0.1 mg/L	All	Auckland
Total Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Total Chlorine (as Cl2) by Spectrophotometry according to APHA (2005) 4500-Cl G	APHA (online edition) 4500-Cl G	0.02 mg/L	All	Auckland
Total Dissolved Solids by Gravimetry	APHA (online edition) 2540 C (Modified: Dried at 103 - 105 ºC)	15 mg/L	All	Auckland
Total Nitrogen (as N) by Persulphate Digestion and Flow Analysis	APHA (online edition) 4500-P J (modified), 4500-NO3 I	0.010 mg/L	All	Auckland
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J (modified)	0.004 mg/L	All	Auckland
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	0.2 mg/L	All	Auckland
Turbidity by Nephelometry	APHA (online edition) 2130 B (modified)	0.05 NTU	All	Auckland
Metals				

Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Arsenic (Dissolved)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Dissolved)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Dissolved)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.02 mg/L	All	Auckland
Sodium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Metals by ICP-MS—Trace (Default Digest)				
Arsenic (Total)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Total)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Total)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Total)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Total)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Total)	In House based on EPA 200.8 by ICPMS	0.05 mg/L	All	Auckland
Sodium (Total)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Hardness (as CaCO3)	In House based on EPA 200.8 by ICPMS	0.03 mg/L	All	Auckland
Organics				
Total Organic Carbon by Non-dispersive infrared detection				
Total Organic Carbon	APHA (online edition) 5310 B	0.1 mg/L	All	Auckland
Preparations				
Digest for Total Metals in Liquids	APHA (online edition) 3030 E (modified, 4:1 Nitric:Hydrochloric Acid)		All	Auckland
Glass Fibre Filtration (1.2 µm)	APHA (online edition) 2540 C (Filtration)		All	Auckland
Membrane Filtration (0.45 µm)	APHA (online edition) 4500-P B (preliminary filtration)		All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher.

For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

Watercare Laboratory Services is a division of Watercare Services Limited .

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Report Signatory 24/09/2017

Zum Nguyen
KTP Signatory

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Certificate of Analysis
Laboratory Reference:170925-118

Attention:	Hilltop Sampler	*Final Report:*	**245373-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**19-Oct-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**26-Sep-2017**
Client Reference:	**MAR**	*Sampled By:*	**Alice Trevelyan**
Purchase Order:	**37/00/01/2014**	*Quote Reference :*	**5880**

Unable to perform 1-1-1-2-Tetrachloroethane test as no bottle was provided for this to be done for sample 20175729.

Sample Details		WATERS	WATERS	WATERS	WATERS
Lab Sample ID:		**170925-118-1**	**170925-118-2**	**170925-118-3**	**170925-118-4**
Client Sample ID:		20175729	20175730	20175732	20175733
Sample Date/Time:		25/09/2017 09:00	25/09/2017 10:00	25/09/2017 08:30	25/09/2017 09:30
Description:		Patterson 54 Bolitho Rd GPD115	Stuart 370 Bushmere Rd GPD147	Harper Road GPF162	590 Matawai Rd GPF 159
Chemistry Detailed					
Anions by Ion Chromatography (0.45 µm Filtered)					
Chloride	mg/L	140	340	30	26
Nitrate (as N)	mg/L	<0.004	0.0057	0.0032	0.0032
Nitrite (as N)	mg/L	<0.004	<0.004	0.0027	0.0035
Sulphate	mg/L	<0.04	<0.04	0.035	0.65
Total Oxidised Nitrogen (as N) by Calculation	mg/L	<0.004 *	0.0057 *	0.0059 *	0.0067 *
Ion Balance (Anions/Cations) by Calculation					
Anion Total	meq/L	14 *	22 *	8.8 *	8.9 *
Cation Total	meq/L	15 *	23 *	9.7 *	9.0 *
meq/L Difference	meq/L	0.72 *	0.55 *	0.84 *	0.84e-1 *
Percent Difference	%	2.5 *	1.2 *	4.5 *	0.47 *
Sum of Anions + Cations	meq/L	28 *	45 *	18 *	18 *
General Testing					
Ammoniacal Nitrogen (as N)	mg/L	4.1	2.2	0.27	0.43
Ammoniacal Nitrogen (as NH4)	mg/L	5.3 *	2.8 *	0.35 *	0.55 *
Bicarbonate Alkalinity (as HCO3)	mg/L	600	790	450	450
Carbonate Alkalinity (as CO3)	mg/L	<3.3	<4.0	18	22
Hydroxide Alkalinity (as CaCO3)	mg/L	<3.3	<4.0	<4.0	<4.0
pH (at room temp c. 20 °C)	pH unit	7.1	7.2	7.3	7.3
Sulfide	mg/L	<0.1 *	<0.1 *	<0.1 *	<0.1 *
Total Alkalinity (as CaCO3)	mg/L	490	650	400	410
Total Chlorine (as Cl2)	mg/L	0.06	0.13	0.13	0.09
Total Dissolved Solids	mg/L	800	1300	500	520
Total Phosphorus (as P)	mg/L	0.28	0.82	0.096	0.13
Total Suspended Solids	mg/L	13	310	33	2.3
Turbidity	NTU	55	150	180	13
Metals					
Dissolved Metals by ICP-MS—Trace (Received Filtered)					
Arsenic (Dissolved)	mg/L	0.0064	0.018	0.0013	0.0027
Calcium (Dissolved)	mg/L	170	230	120	110
Iron (Dissolved)	mg/L	5.6	5.1	12	1.2
Magnesium (Dissolved)	mg/L	18	37	12	12
Manganese (Dissolved)	mg/L	0.69	1.7	0.26	0.34
Potassium (Dissolved)	mg/L	9.4	7.7	5.2	5.8
Sodium (Dissolved)	mg/L	89	190	45	52
Total Metals by ICP-MS—Trace (Default Digest)					
Arsenic (Total)	mg/L	0.0062	0.024	0.0013	0.0027

Sample Details (continued)		WATERS	WATERS	WATERS	WATERS
Lab Sample ID:		**170925-118-1**	**170925-118-2**	**170925-118-3**	**170925-118-4**
Client Sample ID:		20175729	20175730	20175732	20175733
Sample Date/Time:		25/09/2017 09:00	25/09/2017 10:00	25/09/2017 08:30	25/09/2017 09:30
Description:		Patterson 54 Bolitho Rd GPD115	Stuart 370 Bushmere Rd GPD147	Harper Road GPF162	590 Matawai Rd GPF 159
Metals					
Total Metals by ICP-MS—Trace (Default Digest)					
Calcium (Total)	mg/L	170	220	120	110
Iron (Total)	mg/L	5.5	14	14	1.3
Magnesium (Total)	mg/L	19	37	12	12
Manganese (Total)	mg/L	0.66	1.8	0.25	0.33
Potassium (Total)	mg/L	9.7	9.6	5.7	6.4
Sodium (Total)	mg/L	89	180	46	55
Total Hardness (as CaCO3)	mg/L	480	710	350	330
Organics					
Total Organic Carbon by Non-dispersive infrared detection					
Total Organic Carbon	mg/L	5.6	4.5	1.3	8.8
Microbiology					
Escherichia coli by Membrane Filtration					
Escherichia coli	cfu/100 mL	<1.6	<1.6	<1.6	<1.6

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods

The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Chemistry Detailed				
Anions by Ion Chromatography (0.45 µm Filtered)				
Chloride	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Nitrate (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Nitrite (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Sulphate	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Total Oxidised Nitrogen (as N) by Calculation	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Ion Balance (Anions/Cations) by Calculation				
Anion Total	APHA (online edition) 1030 E	meq/L	All	Auckland
Cation Total	APHA (online edition) 1030 E	meq/L	All	Auckland
meq/L Difference	APHA (online edition) 1030 E	meq/L	All	Auckland
Percent Difference	APHA (online edition) 1030 E		All	Auckland
Sum of Anions + Cations	APHA (online edition) 1030 E		All	Auckland
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	HMSO (1981) ISBN 0117516139	0.005 mg/L	All	Auckland
Ammoniacal Nitrogen (as NH4) by Calculation	Calculation from Ammonia (as N)	0.006 mg/L	All	Auckland
Bicarbonate Alkalinity (as HCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Carbonate Alkalinity (as CO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Hydroxide Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
pH (at room temp c. 20 °C) by Electrode	APHA (online edition) 4500-H B	0.1 pH unit	All	Auckland
Sulfide by Colour Comparison (Methylene Blue Method)	APHA (online edition) 4500-S2 D	0.1 mg/L	All	Auckland
Total Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Total Chlorine (as Cl2) by Spectrophotometry according to APHA (2005) 4500-Cl G	APHA (online edition) 4500-Cl G	0.02 mg/L	All	Auckland
Total Dissolved Solids by Gravimetry	APHA (online edition) 2540 C (Modified: Dried at 103 - 105 ºC)	15 mg/L	All	Auckland
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J (modified)	0.004 mg/L	All	Auckland
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	0.2 mg/L	All	Auckland
Turbidity by Nephelometry	APHA (online edition) 2130 B (modified)	0.05 NTU	All	Auckland
Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				

Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Arsenic (Dissolved)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Dissolved)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Dissolved)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.02 mg/L	All	Auckland
Sodium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Metals by ICP-MS—Trace (Default Digest)				
Arsenic (Total)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Total)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Total)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Total)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Total)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Total)	In House based on EPA 200.8 by ICPMS	0.05 mg/L	All	Auckland
Sodium (Total)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Hardness (as CaCO3)	In House based on EPA 200.8 by ICPMS	0.03 mg/L	All	Auckland
Organics				
Total Organic Carbon by Non-dispersive infrared detection				
Total Organic Carbon	APHA (online edition) 5310 B	0.1 mg/L	All	Auckland
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603	2 cfu/100 mL	All	Auckland
Preparations				
Digest for Total Metals in Liquids	APHA (online edition) 3030 E (modified, 4:1 Nitric:Hydrochloric Acid)		All	Auckland
Glass Fibre Filtration (1.2 µm)	APHA (online edition) 2540 C (Filtration)		All	Auckland
Membrane Filtration (0.45 µm)	APHA (online edition) 4500-P B (preliminary filtration)		All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher.

For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

Watercare Laboratory Services is a division of Watercare Services Limited .

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Report Signatory 19/10/2017

Rachel Hwang
KTP Signatory

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Certificate of Analysis
Laboratory Reference:170926-090

Attention:	Hilltop Sampler	*Final Report:*	**245374-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**19-Oct-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**26-Sep-2017**
Client Reference:	**MAR**	*Sampled By:*	**Alice Trevelyan**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

Note: Extra sulphide bottles received for sample IDs 20175723 and 20172754. Peter wants total sulphide tested for these samples.
599 Bushmere Road GPE 010 - dissolved Manganese higher than Total, results confirmed by retest

Sample Details		WATERS	WATERS	WATERS
Lab Sample ID:		**170926-090-1**	**170926-090-2**	**170926-090-3**
Client Sample ID:		20175723	20175724	20175725
Sample Date/Time:		25/09/2017 08:35	25/09/2017 09:05	25/09/2017 09:53
Description:		599 Bushmere Road GPE010	598 Bushmere Road MAR Pilot Bore GPE 065	645 Bushmere Road GPE030
Chemistry Detailed				
Anions by Ion Chromatography (0.45 µm Filtered)				
Chloride	mg/L	150	10	240
Nitrate (as N)	mg/L	0.040	0.0026	0.011
Nitrite (as N)	mg/L	0.0020	0.0030	<0.004
Sulphate	mg/L	<0.02	74	1.5
Total Oxidised Nitrogen (as N) by Calculation	mg/L	0.042 *	0.0056 *	0.011 *
Ion Balance (Anions/Cations) by Calculation				
Anion Total	meq/L	15 *	5.1 *	18 *
Cation Total	meq/L	16 *	5.2 *	19 *
meq/L Difference	meq/L	0.66 *	0.17 *	0.71 *
Percent Difference	%	2.1 *	1.6 *	2.0 *
Sum of Anions + Cations	meq/L	32 *	10 *	37 *
General Testing				
Ammoniacal Nitrogen (as N)	mg/L	2.5	0.11	3.5
Ammoniacal Nitrogen (as NH4)	mg/L	3.3 *	0.15 *	4.5 *
Bicarbonate Alkalinity (as HCO3)	mg/L	690	200	690
Carbonate Alkalinity (as CO3)	mg/L	<4.0	<1.0	<4.0
Hydroxide Alkalinity (as CaCO3)	mg/L	<4.0	<1.0	<4.0
pH (at room temp c. 20 °C)	pH unit	7.1	7.8	7.1
Sulfide	mg/L	<0.1 *	<0.1 *	<0.1 *
Total Alkalinity (as CaCO3)	mg/L	560	160	560
Total Chlorine (as Cl2)	mg/L	0.10	0.10	0.08
Total Dissolved Solids	mg/L	840	320	1000
Total Nitrogen (as N)	mg/L	2.5	0.21	3.2
Total Phosphorus (as P)	mg/L	0.27	0.044	0.33
Total Suspended Solids	mg/L	66	4.2	43
Turbidity	NTU	100	1.9	200
Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Arsenic (Dissolved)	mg/L	0.0097	0.0015	0.032
Calcium (Dissolved)	mg/L	180	70	180
Iron (Dissolved)	mg/L	9.8	0.21	17
Magnesium (Dissolved)	mg/L	26	7.7	22
Manganese (Dissolved)	mg/L	1.0	0.059	0.83
Potassium (Dissolved)	mg/L	8.6	3.3	6.6
Sodium (Dissolved)	mg/L	90	24	160

Sample Details (continued)		WATERS	WATERS	WATERS
Lab Sample ID:		**170926-090-1**	**170926-090-2**	**170926-090-3**
Client Sample ID:		20175723	20175724	20175725
Sample Date/Time:		25/09/2017 08:35	25/09/2017 09:05	25/09/2017 09:53
Description:		599 Bushmere Road GPE010	598 Bushmere Road MAR Pilot Bore GPE 065	645 Bushmere Road GPE030
Metals				
Total Metals by ICP-MS—Trace (Default Digest)				
Arsenic (Total)	mg/L	0.027	0.0015	0.032
Calcium (Total)	mg/L	180	69	170
Iron (Total)	mg/L	19	0.25	16
Magnesium (Total)	mg/L	22	7.3	21
Manganese (Total)	mg/L	1.0	0.040	0.78
Potassium (Total)	mg/L	9.4	3.4	7.2
Sodium (Total)	mg/L	84	23	160
Total Hardness (as CaCO3)	mg/L	550	200	520
Organics				
Total Organic Carbon by Non-dispersive infrared detection				
Total Organic Carbon	mg/L	4.6	2.4	6.1

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods

The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Chemistry Detailed				
Anions by Ion Chromatography (0.45 µm Filtered)				
Chloride	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Nitrate (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Nitrite (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Sulphate	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Total Oxidised Nitrogen (as N) by Calculation	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Ion Balance (Anions/Cations) by Calculation				
Anion Total	APHA (online edition) 1030 E	meq/L	All	Auckland
Cation Total	APHA (online edition) 1030 E	meq/L	All	Auckland
meq/L Difference	APHA (online edition) 1030 E	meq/L	All	Auckland
Percent Difference	APHA (online edition) 1030 E		All	Auckland
Sum of Anions + Cations	APHA (online edition) 1030 E		All	Auckland
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	HMSO (1981) ISBN 0117516139	0.005 mg/L	All	Auckland
Ammoniacal Nitrogen (as NH4) by Calculation	Calculation from Ammonia (as N)	0.006 mg/L	All	Auckland
Bicarbonate Alkalinity (as HCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Carbonate Alkalinity (as CO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Hydroxide Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
pH (at room temp c. 20 °C) by Electrode	APHA (online edition) 4500-H B	0.1 pH unit	All	Auckland
Sulfide by Colour Comparison (Methylene Blue Method)	APHA (online edition) 4500-S2 D	0.1 mg/L	All	Auckland
Total Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Total Chlorine (as Cl2) by Spectrophotometry according to APHA (2005) 4500-Cl G	APHA (online edition) 4500-Cl G	0.02 mg/L	All	Auckland
Total Dissolved Solids by Gravimetry	APHA (online edition) 2540 C (Modified: Dried at 103 - 105 ºC)	15 mg/L	All	Auckland
Total Nitrogen (as N) by Persulphate Digestion and Flow Analysis	APHA (online edition) 4500-P J (modified), 4500-NO3 I	0.010 mg/L	All	Auckland
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J (modified)	0.004 mg/L	All	Auckland
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	0.2 mg/L	All	Auckland
Turbidity by Nephelometry	APHA (online edition) 2130 B (modified)	0.05 NTU	All	Auckland
Metals				

Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Arsenic (Dissolved)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Dissolved)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Dissolved)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.02 mg/L	All	Auckland
Sodium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Metals by ICP-MS—Trace (Default Digest)				
Arsenic (Total)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Total)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Total)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Total)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Total)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Total)	In House based on EPA 200.8 by ICPMS	0.05 mg/L	All	Auckland
Sodium (Total)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Hardness (as CaCO3)	In House based on EPA 200.8 by ICPMS	0.03 mg/L	All	Auckland
Organics				
Total Organic Carbon by Non-dispersive infrared detection				
Total Organic Carbon	APHA (online edition) 5310 B	0.1 mg/L	All	Auckland
Preparations				
Digest for Total Metals in Liquids	APHA (online edition) 3030 E (modified, 4:1 Nitric:Hydrochloric Acid)		All	Auckland
Glass Fibre Filtration (1.2 µm)	APHA (online edition) 2540 C (Filtration)		All	Auckland
Membrane Filtration (0.45 µm)	APHA (online edition) 4500-P B (preliminary filtration)		All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher.

For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

Watercare Laboratory Services is a division of Watercare Services Limited .

ACCREDITED LABORATORY

Report Signatory 19/10/2017

Rachel Hwang
KTP Signatory

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Certificate of Analysis
Laboratory Reference:170930-048

Attention:	Hilltop Sampler	*Final Report:*	**245376-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**19-Oct-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**30-Sep-2017**
Client Reference:	**MAR**	*Sampled By:*	**Alice Trevelyan**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

Sulphide bottles were received for sample IDs 20175758 and 20175759 but Total Sulphdie test was not requested on the COC.
Total Sulphide test were added to these samples as advised by Peter.

Sample Details		WATERS	WATERS	WATERS
Lab Sample ID:		**170930-048-1**	**170930-048-2**	**170930-048-3**
Client Sample ID:		20175758	20175759	20175760
Sample Date/Time:		29/09/2017 09:18	29/09/2017 08:36	29/09/2017 08:00
Description:		599 Bushmere Road GPE010	598 Bushmere Road MAR Pilot Bore GPE 065	645 Bushmere Road GPE030
Chemistry Detailed				
Anions by Ion Chromatography (0.45 µm Filtered)				
Chloride	mg/L	140	10	230
Nitrate (as N)	mg/L	0.0072	0.0045	0.0081
Nitrite (as N)	mg/L	<0.004	<0.002	<0.004
Sulphate	mg/L	<0.04	75	<0.04
Total Oxidised Nitrogen (as N) by Calculation	mg/L	-	-	0.0081 *
Ion Balance (Anions/Cations) by Calculation				
Anion Total	meq/L	16 *	5.2 *	19 *
Cation Total	meq/L	16 *	4.9 *	18 *
meq/L Difference	meq/L	0.068 *	0.26 *	0.43 *
Percent Difference	%	0.22 *	2.6 *	1.2 *
Sum of Anions + Cations	meq/L	32 *	10 *	37 *
General Testing				
Ammoniacal Nitrogen (as N)	mg/L	2.5	0.099	3.3
Ammoniacal Nitrogen (as NH4)	mg/L	3.2 *	0.13 *	4.5 *
Bicarbonate Alkalinity (as HCO3)	mg/L	720	190	740
Carbonate Alkalinity (as CO3)	mg/L	<4.0	8.6	<4.0
Hydroxide Alkalinity (as CaCO3)	mg/L	<4.0	<1.0	<4.0
pH (at room temp c. 20 °C)	pH unit	7.2	7.9	7.1
Sulfide	mg/L	<0.1 *	<0.1 *	<0.1 *
Total Alkalinity (as CaCO3)	mg/L	590	170	610
Total Chlorine (as Cl2)	mg/L	0.08	0.09	0.08
Total Dissolved Solids	mg/L	880	320	1000
Total Nitrogen (as N)	mg/L	3.0	0.17	3.4
Total Phosphorus (as P)	mg/L	0.39	0.035	0.37
Total Suspended Solids	mg/L	65	<0.8	53
Turbidity	NTU	160	0.95	190
Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Arsenic (Dissolved)	mg/L	0.0097	0.0013	0.030
Calcium (Dissolved)	mg/L	190	65	170
Iron (Dissolved)	mg/L	17	0.15	15
Magnesium (Dissolved)	mg/L	22	7.3	21
Manganese (Dissolved)	mg/L	1.1	0.050	0.81
Potassium (Dissolved)	mg/L	8.8	3.3	6.7
Sodium (Dissolved)	mg/L	81	22	160

Sample Details (continued)		WATERS	WATERS	WATERS
Lab Sample ID:		**170930-048-1**	**170930-048-2**	**170930-048-3**
Client Sample ID:		20175758	20175759	20175760
Sample Date/Time:		29/09/2017 09:18	29/09/2017 08:36	29/09/2017 08:00
Description:		599 Bushmere Road GPE010	598 Bushmere Road MAR Pilot Bore GPE 065	645 Bushmere Road GPE030
Metals				
Total Metals by ICP-MS—Trace (Default Digest)				
Arsenic (Total)	mg/L	0.060	0.0014	0.029
Calcium (Total)	mg/L	190	68	180
Iron (Total)	mg/L	30	0.18	16
Magnesium (Total)	mg/L	24	7.5	22
Manganese (Total)	mg/L	1.2	0.048	0.84
Potassium (Total)	mg/L	8.9	3.1	6.7
Sodium (Total)	mg/L	84	22	160
Total Hardness (as CaCO3)	mg/L	570	200	530
Organics				
Total Organic Carbon by Non-dispersive infrared detection				
Total Organic Carbon	mg/L	7.0	3.0	8.7

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods

The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Chemistry Detailed				
Anions by Ion Chromatography (0.45 µm Filtered)				
Chloride	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Nitrate (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Nitrite (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Sulphate	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Total Oxidised Nitrogen (as N) by Calculation	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	3	Auckland
Ion Balance (Anions/Cations) by Calculation				
Anion Total	APHA (online edition) 1030 E	meq/L	All	Auckland
Cation Total	APHA (online edition) 1030 E	meq/L	All	Auckland
meq/L Difference	APHA (online edition) 1030 E	meq/L	All	Auckland
Percent Difference	APHA (online edition) 1030 E		All	Auckland
Sum of Anions + Cations	APHA (online edition) 1030 E		All	Auckland
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	HMSO (1981) ISBN 0117516139	0.005 mg/L	All	Auckland
Ammoniacal Nitrogen (as NH4) by Calculation	Calculation from Ammonia (as N)	0.006 mg/L	All	Auckland
Bicarbonate Alkalinity (as HCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Carbonate Alkalinity (as CO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Hydroxide Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
pH (at room temp c. 20 °C) by Electrode	APHA (online edition) 4500-H B	0.1 pH unit	All	Auckland
Sulfide by Colour Comparison (Methylene Blue Method)	APHA (online edition) 4500-S2 D	0.1 mg/L	All	Auckland
Total Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Total Chlorine (as Cl2) by Spectrophotometry according to APHA (2005) 4500-Cl G	APHA (online edition) 4500-Cl G	0.02 mg/L	All	Auckland
Total Dissolved Solids by Gravimetry	APHA (online edition) 2540 C (Modified: Dried at 103 - 105 ºC)	15 mg/L	All	Auckland
Total Nitrogen (as N) by Persulphate Digestion and Flow Analysis	APHA (online edition) 4500-P J (modified), 4500-NO3 I	0.010 mg/L	All	Auckland
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J (modified)	0.004 mg/L	All	Auckland
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	0.2 mg/L	All	Auckland
Turbidity by Nephelometry	APHA (online edition) 2130 B (modified)	0.05 NTU	All	Auckland
Metals				

Metals

Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Arsenic (Dissolved)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Dissolved)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Dissolved)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.02 mg/L	All	Auckland
Sodium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Metals by ICP-MS—Trace (Default Digest)				
Arsenic (Total)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Total)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Total)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Total)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Total)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Total)	In House based on EPA 200.8 by ICPMS	0.05 mg/L	All	Auckland
Sodium (Total)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Hardness (as CaCO3)	In House based on EPA 200.8 by ICPMS	0.03 mg/L	All	Auckland

Organics

Total Organic Carbon by Non-dispersive infrared detection				
Total Organic Carbon	APHA (online edition) 5310 B	0.1 mg/L	All	Auckland

Preparations

Digest for Total Metals in Liquids	APHA (online edition) 3030 E (modified, 4:1 Nitric:Hydrochloric Acid)	All	Auckland
Glass Fibre Filtration (1.2 µm)	APHA (online edition) 2540 C (Filtration)	All	Auckland
Membrane Filtration (0.45 µm)	APHA (online edition) 4500-P B (preliminary filtration)	All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher.

For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

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Report Signatory 19/10/2017

Chandra Sharma
KTP Signatory

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Certificate of Analysis
Laboratory Reference:171007-050

Attention:	Hilltop Sampler	*Final Report:*	**245649-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**24-Oct-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**07-Oct-2017**
Client Reference:	**MAR**	*Sampled By:*	**Alice Trevelyan**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

No micro bottles received. MAR micro samples logged on separate project - Project 171007-053.

Sample Details		WATERS	WATERS	WATERS
Lab Sample ID:		**171007-050-1**	**171007-050-2**	**171007-050-3**
Client Sample ID:		20175793	20175794	20175795
Sample Date/Time:		06/10/2017 09:00	06/10/2017 08:20	06/10/2017 09:45
Description:		598 Bushmere Road MAR Pilot Bore GPE 065	599 Bushmere Road GPE010	645 Bushmere Road GPE030
Chemistry Detailed				
Anions by Ion Chromatography (0.45 µm Filtered)				
Chloride	mg/L	10	140	230
Nitrate (as N)	mg/L	0.0029	0.0047	0.0053
Nitrite (as N)	mg/L	<0.002	0.0050	0.0050
Sulphate	mg/L	74	<0.02	<0.02
Total Oxidised Nitrogen (as N) by Calculation	mg/L	0.0029 *	0.0097 *	0.010 *
Ion Balance (Anions/Cations) by Calculation				
Anion Total	meq/L	5.2 *	16 *	19 *
Cation Total	meq/L	5.3 *	16 *	19 *
meq/L Difference	meq/L	0.78e-1 *	0.84 *	0.093 *
Percent Difference	%	0.75 *	2.6 *	0.25 *
Sum of Anions + Cations	meq/L	10 *	32 *	38 *
Sample Parameters and Field Testing				
External Provided by Client				
Conductivity	mS/cm	485.5 *	1478 *	1794 *
Dissolved Oxygen	mg/L	3.92 *	1.64 *	3.28 *
Dissolved Oxygen %	%	38.6 *	16.4 *	33.1 *
pH	pH unit	7.81 *	7.34 *	7.17 *
Salinity	ppt	0.24 *	0.75 *	0.92 *
Temperature	°C	14.7 *	15.6 *	15.5 *
Time		09:00:00 AM *	08:20:00 AM *	09:45:00 AM *
General Testing				
Ammoniacal Nitrogen (as N)	mg/L	0.11	2.3	3.0
Ammoniacal Nitrogen (as NH4)	mg/L	0.14 *	2.9 *	3.9 *
Bicarbonate Alkalinity (as HCO3)	mg/L	210	710	750
Carbonate Alkalinity (as CO3)	mg/L	<1.0	<4.0	<4.0
Hydroxide Alkalinity (as CaCO3)	mg/L	<1.0	<4.0	<4.0
pH (at room temp c. 20 °C)	pH unit	7.8	7.1	7.0
Sulfide	mg/L	<0.1 *	<0.1 *	<0.1 *
Total Alkalinity (as CaCO3)	mg/L	170	580	620
Total Chlorine (as Cl2)	mg/L	0.04	0.10	0.09
Total Dissolved Solids	mg/L	330	890	1000
Total Nitrogen (as N)	mg/L	0.27	1.9	3.0
Total Phosphorus (as P)	mg/L	0.024	0.23	0.30
Total Suspended Solids	mg/L	0.80	64	50
Turbidity	NTU	0.65	150	170

Sample Details (continued)		WATERS	WATERS	WATERS
Lab Sample ID:		**171007-050-1**	**171007-050-2**	**171007-050-3**
Client Sample ID:		20175793	20175794	20175795
Sample Date/Time:		06/10/2017 09:00	06/10/2017 08:20	06/10/2017 09:45
Description:		598 Bushmere Road MAR Pilot Bore GPE 065	599 Bushmere Road GPE010	645 Bushmere Road GPE030
Metals				
Dissolved Metals by ICP-MS—Trace (Received Filtered)				
Arsenic (Dissolved)	mg/L	0.0011	0.010	0.033
Calcium (Dissolved)	mg/L	70	200	180
Iron (Dissolved)	mg/L	0.097	16	17
Magnesium (Dissolved)	mg/L	7.6	23	22
Manganese (Dissolved)	mg/L	0.073	1.1	0.81
Potassium (Dissolved)	mg/L	3.3	8.6	6.7
Sodium (Dissolved)	mg/L	24	82	160
Total Metals by ICP-MS—Trace (Default Digest)				
Arsenic (Total)	mg/L	0.0010	0.017	0.035
Calcium (Total)	mg/L	74	210	190
Iron (Total)	mg/L	0.13	18	18
Magnesium (Total)	mg/L	8.0	24	22
Manganese (Total)	mg/L	0.072	1.1	0.82
Potassium (Total)	mg/L	3.5	9.3	7.0
Sodium (Total)	mg/L	24	86	160
Total Hardness (as CaCO3)	mg/L	220	620	560
Organics				
Total Organic Carbon by Non-dispersive infrared detection				
Total Organic Carbon	mg/L	8.4	32	28

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods

The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Chemistry Detailed				
Anions by Ion Chromatography (0.45 µm Filtered)				
Chloride	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Nitrate (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Nitrite (as N)	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Sulphate	In House based on APHA (online edition) 4110 B and EPA 300.0	0.02 mg/L	All	Auckland
Total Oxidised Nitrogen (as N) by Calculation	In House based on APHA (online edition) 4110 B and EPA 300.0	0.002 mg/L	All	Auckland
Ion Balance (Anions/Cations) by Calculation				
Anion Total	APHA (online edition) 1030 E	meq/L	All	Auckland
Cation Total	APHA (online edition) 1030 E	meq/L	All	Auckland
meq/L Difference	APHA (online edition) 1030 E	meq/L	All	Auckland
Percent Difference	APHA (online edition) 1030 E		All	Auckland
Sum of Anions + Cations	APHA (online edition) 1030 E		All	Auckland
Sample Parameters and Field Testing				
External Provided by Client				
Conductivity		mS/cm	All	Auckland
Dissolved Oxygen %		%	All	Auckland
Dissolved Oxygen		mg/L	All	Auckland
pH		pH unit	All	Auckland
Salinity		ppt	All	Auckland
Temperature			All	Auckland
Time			All	Auckland
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	HMSO (1981) ISBN 0117516139	0.005 mg/L	All	Auckland

General Testing

Ammoniacal Nitrogen (as NH4) by Calculation	Calculation from Ammonia (as N)	0.006 mg/L	All	Auckland
Bicarbonate Alkalinity (as HCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Carbonate Alkalinity (as CO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Hydroxide Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
pH (at room temp c. 20 °C) by Electrode	APHA (online edition) 4500-H B	0.1 pH unit	All	Auckland
Sulfide by Colour Comparison (Methylene Blue Method)	APHA (online edition) 4500-S2 D	0.1 mg/L	All	Auckland
Total Alkalinity (as CaCO3) by Titration	APHA (online edition) 2320 B	1 mg/L	All	Auckland
Total Chlorine (as Cl2) by Spectrophotometry according to APHA (2005) 4500-Cl G	APHA (online edition) 4500-Cl G	0.02 mg/L	All	Auckland
Total Dissolved Solids by Gravimetry	APHA (online edition) 2540 C (Modified: Dried at 103 - 105 ºC)	15 mg/L	All	Auckland
Total Nitrogen (as N) by Persulphate Digestion and Flow Analysis	APHA (online edition) 4500-P J (modified), 4500-NO3 I	0.010 mg/L	All	Auckland
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J (modified)	0.004 mg/L	All	Auckland
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	0.2 mg/L	All	Auckland
Turbidity by Nephelometry	APHA (online edition) 2130 B (modified)	0.05 NTU	All	Auckland

Metals

Dissolved Metals by ICP-MS—Trace (Received Filtered)

Arsenic (Dissolved)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Dissolved)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Dissolved)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.02 mg/L	All	Auckland
Sodium (Dissolved)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland

Total Metals by ICP-MS—Trace (Default Digest)

Arsenic (Total)	In House based on EPA 200.8 by ICPMS	0.00010 mg/L	All	Auckland
Calcium (Total)	In House based on EPA 200.8 by ICPMS	0.010 mg/L	All	Auckland
Iron (Total)	In House based on EPA 200.8 by ICPMS	0.002 mg/L	All	Auckland
Magnesium (Total)	In House based on EPA 200.8 by ICPMS	0.001 mg/L	All	Auckland
Manganese (Total)	In House based on EPA 200.8 by ICPMS	0.0005 mg/L	All	Auckland
Potassium (Total)	In House based on EPA 200.8 by ICPMS	0.05 mg/L	All	Auckland
Sodium (Total)	In House based on EPA 200.8 by ICPMS	0.1 mg/L	All	Auckland
Total Hardness (as CaCO3)	In House based on EPA 200.8 by ICPMS	0.03 mg/L	All	Auckland

Organics

Total Organic Carbon by Non-dispersive infrared detection

Total Organic Carbon	APHA (online edition) 5310 B	0.1 mg/L	All	Auckland

Preparations

Digest for Total Metals in Liquids	APHA (online edition) 3030 E (modified, 4:1 Nitric:Hydrochloric Acid)		All	Auckland
Glass Fibre Filtration (1.2 µm)	APHA (online edition) 2540 C (Filtration)		All	Auckland
Membrane Filtration (0.45 µm)	APHA (online edition) 4500-P B (preliminary filtration)		All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher.

For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

Watercare Laboratory Services is a division of Watercare Services Limited .

ACCREDITED LABORATORY

Report Signatory 24/10/2017

Peter Boniface
KTP Signatory

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Certificate of Analysis
Laboratory Reference:170624-052

Attention:	Hilltop Sampler	*Final Report:*	**232100-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**26-Jun-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**24-Jun-2017**
Client Reference:	**MAR (Micro)**	*Sampled By:*	**Alice Trevelyan**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

Sample Details		WATERS	WATERS
Lab Sample ID:		**170624-052-1**	**170624-052-2**
Client Sample ID:		20172875	20172878
Sample Date/Time:		23/06/2017 09:42	23/06/2017 10:49
Description:		599 Bushmere Road GPE010	598 Bushmere Road MAR Pilot Bore GPE 065
Microbiology			
Escherichia coli by Membrane Filtration			
Escherichia coli	cfu/100 mL	<1.6	6.6

*Results marked with * are not accredited to International Accreditation New Zealand*

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Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603	2 cfu/100 mL	All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher.

For more information please contact the Operations Manager

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

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ACCREDITED LABORATORY

Report Signatory 26/06/2017

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Certificate of Analysis
Laboratory Reference:170627-092

Attention:	Hilltop Sampler	*Final Report:*	**232646-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**29-Jun-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**27-Jun-2017**
Client Reference:	**MAR (Micro)**	*Sampled By:*	**Alice Trevelyan**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

Sample Details

	WATERS
Lab Sample ID:	**170627-092-1**
Client Sample ID:	20172897
Sample Date/Time:	26/06/2017 09:20
Description:	598 Bushmere Rd - MAR injection bore GPE066

Microbiology

Escherichia coli by Membrane Filtration

Escherichia coli	cfu/100 mL	6.5

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Reference Methods

The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603	2 cfu/100 mL	All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher. For more information please contact the Operations Manager.

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Certificate of Analysis
Laboratory Reference:170630-117

Attention:	Hilltop Sampler	*Final Report:*	**233039-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**03-Jul-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**01-Jul-2017**
Client Reference:	**MAR (Micro)**	*Sampled By:*	**Alice Trevelyan**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

Sample Details		WATERS	WATERS	WATERS
Lab Sample ID:		**170630-117-1**	**170630-117-2**	**170630-117-3**
Client Sample ID:		20172880	20172881	20172282
Sample Date/Time:		30/06/2017 09:26	30/06/2017 10:45	30/06/2017 10:17
Description:		599 Bushmere Road GPE010	598 Bushmere Road MAR Pilot Bore GPE 065	598 Bushmere Rd - MAR injection bore - GPE066
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	cfu/100 mL	<1.6	<1.6	<1.6

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Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603	2 cfu/100 mL	All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher. For more information please contact the Operations Manager.

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Certificate of Analysis
Laboratory Reference:170707-112

Attention:	Hilltop Sampler	*Final Report:*	**233763-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**10-Jul-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**08-Jul-2017**
Client Reference:	**MAR (Micro)**	*Sampled By:*	**Alice Trevelyan**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

Sample Details	WATERS	WATERS	WATERS	WATERS
Lab Sample ID:	**170707-112-1**	**170707-112-2**	**170707-112-3**	**170707-112-4**
Client Sample ID:	20172885	20172886	20172887	20172888
Sample Date/Time:	07/07/2017 10:47	07/07/2017 11:41	07/07/2017 10:00	07/07/2017 09:51
Description:	598 Bushmere Rd at Cyclone Filter	599 Bushmere Road GPE010	598 Bushmere Road MAR Pilot Bore GPE 065	598 Bushmere Rd - MAR injection bore GPE066
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli cfu/100 mL	1100	<1.6	<1.6	<1.6

Sample Details	WATERS
Lab Sample ID:	**170707-112-5**
Client Sample ID:	20174939
Sample Date/Time:	07/07/2017 10:58
Description:	Waipaoa River at Infultration Chamber
Microbiology	
Escherichia coli by Membrane Filtration	
Escherichia coli cfu/100 mL	1600

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Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603	2 cfu/100 mL	All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher. For more information please contact the Operations Manager.

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Report Signatory 10/07/2017

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Certificate of Analysis
Laboratory Reference:170729-060

Attention:	Hilltop Sampler	*Final Report:*	**235986-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**31-Jul-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**29-Jul-2017**
Client Reference:	**MAR (Micro)**	*Sampled By:*	**Alice Trevelyan**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

Sample Details		WATERS	WATERS	WATERS	WATERS
Lab Sample ID:		**170729-060-1**	**170729-060-2**	**170729-060-3**	**170729-060-4**
Client Sample ID:		20175074	20175075	20175076	20175077
Sample Date/Time:		28/07/2017 10:38	28/07/2017 10:24	28/07/2017 10:30	28/07/2017 09:20
Description:		598 Bushmere Road MAR Headworks outlet	598 Bushmere Road MAR Pilot Bore GPE 065	598 Bushmere Rd - MAR injection bore GPE066	599 Bushmere Road GPE010
Microbiology					
Escherichia coli by Membrane Filtration					
Escherichia coli	cfu/100 mL	4.9	1.6	15	1.6

Sample Details		WATERS
Lab Sample ID:		**170729-060-5**
Client Sample ID:		20175078
Sample Date/Time:		28/07/2017 11:00
Description:		Waipaoa River at Infultration Chamber
Microbiology		
Escherichia coli by Membrane Filtration		
Escherichia coli	cfu/100 mL	210

*Results marked with * are not accredited to International Accreditation New Zealand*

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Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603	2 cfu/100 mL	All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher.

For more information please contact the Operations Manager

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Certificate of Analysis
Laboratory Reference:170814-090

Attention:	Hilltop Sampler	*Final Report:*	**237795-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**15-Aug-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**14-Aug-2017**
Client Reference:	**MAR (Micro)**	*Sampled By:*	**Alice Trevelyan**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

Samples received and tested outside of holding time.

Sample Details		WATERS	WATERS	WATERS	WATERS
Lab Sample ID:		**170814-090-2**	**170814-090-3**	**170814-090-4**	**170814-090-5**
Client Sample ID:		20175223	20175224	20175225	20175226
Sample Date/Time:		11/08/2017 09:50	11/08/2017 09:04	11/08/2017 10:49	11/08/2017 10:04
Description:		598 Bushmere Road MAR Pilot Bore GPE 065	598 Bushmere Rd - MAR Headworks Outlet	Waipaoa River at Infultration Chamber	598 Bushmere Rd - MAR Injection Bore GPE066
Microbiology					
Escherichia coli by Membrane Filtration					
Escherichia coli	cfu/100 mL	<1.6	1.6	210	4.9

*Results marked with * are not accredited to International Accreditation New Zealand*

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Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603	2 cfu/100 mL	All	Auckland

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Report Signatory 15/08/2017

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Certificate of Analysis
Laboratory Reference:170819-048

Attention:	Hilltop Sampler	*Final Report:*	**238309-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**21-Aug-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**19-Aug-2017**
Client Reference:	**MAR (Micro)**	*Sampled By:*	**Alice Trevelyan**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

Sample Details	WATERS	WATERS	WATERS	WATERS
Lab Sample ID:	**170819-048-1**	**170819-048-2**	**170819-048-3**	**170819-048-4**
Client Sample ID:	20175249	20175250	20175251	20175252
Sample Date/Time:	18/08/2017 10:20	18/08/2017 11:00	18/08/2017 10:44	18/08/2017 12:00
Description:	599 Bushmere Road GPE010	598 Bushmere Road MAR Pilot Bore GPE 065	598 Bushmere Rd MAR Headworks Outlet	Waipaoa River at Infultration Chamber
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli cfu/100 mL	<1.6	<1.6	<1.6	48

Sample Details	WATERS
Lab Sample ID:	**170819-048-5**
Client Sample ID:	20175253
Sample Date/Time:	18/08/2017 11:10
Description:	598 Bushmere Rd - MAR injection bore GPE066
Microbiology	
Escherichia coli by Membrane Filtration	
Escherichia coli cfu/100 mL	4.9

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Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603	2 cfu/100 mL	All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher. For more information please contact the Operations Manager.

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Report Signatory 21/08/2017

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Certificate of Analysis
Laboratory Reference:170823-096

Attention:	Hilltop Sampler	*Final Report:*	**239269-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**27-Aug-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**23-Aug-2017**
Client Reference:	**MAR - 598 Bushmere Rd**	*Sampled By:*	**Alice Trevelyan**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

Sample Details	WATERS
Lab Sample ID:	**170823-096-1**
Client Sample ID:	20175377
Sample Date/Time:	22/08/2017 10:20
Description:	598 Bushmere Rd - MAR injection bore GPE066
General Testing	
Chlorophyll A mg/L	0.00068
Microbiology	
Escherichia coli by Membrane Filtration	
Escherichia coli cfu/100 mL	16

*Results marked with * are not accredited to International Accreditation New Zealand*

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Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
General Testing				
Chlorophyll A by Aqueous Acetone Extraction and Spectrophotometry	APHA (online edition) 10200 H	0.0006 mg/L	All	Auckland
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603	2 cfu/100 mL	All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher. For more information please contact the Operations Manager.

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ACCREDITED LABORATORY

Report Signatory 27/08/2017

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Certificate of Analysis
Laboratory Reference:170902-058

Attention:	Hilltop Sampler	*Final Report:*	**240144-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**04-Sep-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**02-Sep-2017**
Client Reference:	**MAR (Micro)**	*Sampled By:*	**Alice Trevelyan**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

Sample Details	WATERS	WATERS	WATERS	WATERS
Lab Sample ID:	**170902-058-1**	**170902-058-2**	**170902-058-3**	**170902-058-4**
Client Sample ID:	20175512	20175513	20175514	20175515
Sample Date/Time:	01/09/2017 09:20	01/09/2017 10:30	01/09/2017 10:20	01/09/2017 11:25
Description:	599 Bushmere Road GPE010	598 Bushmere Road MAR Pilot Bore GPE 065	598 Bushmere Road MAR Headworks outlet	Waipaoa River at Infultration Chamber
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli cfu/100 mL	<1.6	<1.6	<1.6	460

Sample Details	WATERS
Lab Sample ID:	**170902-058-5**
Client Sample ID:	20175516
Sample Date/Time:	01/09/2017 10:33
Description:	598 Bushmere Rd - MAR injection bore GPE066
Microbiology	
Escherichia coli by Membrane Filtration	
Escherichia coli cfu/100 mL	<1.6

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Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603	2 cfu/100 mL	All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher. For more information please contact the Operations Manager.

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Certificate of Analysis
Laboratory Reference:170913-097

Attention:	Hilltop Sampler	*Final Report:*	**241352-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**14-Sep-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**13-Sep-2017**
Client Reference:	**MAR (Micro)**	*Sampled By:*	**Alice Trevelyan**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

Sample Details		WATERS	WATERS	WATERS
Lab Sample ID:		**170913-097-1**	**170913-097-2**	**170913-097-3**
Client Sample ID:		20175626	20175627	20175628
Sample Date/Time:		12/09/2017 11:05	12/09/2017 11:35	12/09/2017 11:45
Description:		599 Bushmere Road GPE010	598 Bushmere Road MAR Pilot Bore GPE 065	598 Bushmere Road MAR Headworks Outlet
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	cfu/100 mL	<1.6	<1.6	23

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Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603	2 cfu/100 mL	All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher. For more information please contact the Operations Manager.

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Certificate of Analysis
Laboratory Reference:170916-048

Attention:	Hilltop Sampler	*Final Report:*	**241684-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**18-Sep-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**16-Sep-2017**
Client Reference:	**MAR (Micro)**	*Sampled By:*	**Alice Trevelyan**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

Sample Details		WATERS	WATERS	WATERS	WATERS
Lab Sample ID:		**170916-048-1**	**170916-048-2**	**170916-048-3**	**170916-048-4**
Client Sample ID:		20175630	20175631	20175633	20175635
Sample Date/Time:		15/09/2017 08:38	15/09/2017 10:05	15/09/2017 10:35	15/09/2017
Description:		599 Bushmere Road GPE010	598 Bushmere Road MAR Pilot Bore GPE 065	Waipaoa River at Infultration Chamber	645 Bushmere Road GPE030
Microbiology					
Escherichia coli by Membrane Filtration					
Escherichia coli	cfu/100 mL	<1.6	<1.6	80	<1.6

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603	2 cfu/100 mL	All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher. For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

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Report Signatory 18/09/2017

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Certificate of Analysis
Laboratory Reference:170926-089

Attention:	Hilltop Sampler	*Final Report:*	**242750-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**27-Sep-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**26-Sep-2017**
Client Reference:	**MAR (Micro)**	*Sampled By:*	**Alice Trevelyan**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

Sample Details	WATERS	WATERS	WATERS
Lab Sample ID:	**170926-089-1**	**170926-089-2**	**170926-089-3**
Client Sample ID:	20175726	20175727	20175728
Sample Date/Time:	25/09/2017 08:35	25/09/2017 09:05	25/09/2017 09:53
Description:	599 Bushmere Road GPE010	598 Bushmere Road MAR Pilot Bore GPE 065	645 Bushmere Road GPE030
Microbiology			
Escherichia coli by Membrane Filtration			
Escherichia coli cfu/100 mL	3.3	<1.6	<1.6

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Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603	2 cfu/100 mL	All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher.

For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

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ACCREDITED LABORATORY

Report Signatory 27/09/2017

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Certificate of Analysis
Laboratory Reference:170930-047

Attention:	Hilltop Sampler	*Final Report:*	**243153-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**02-Oct-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**30-Sep-2017**
Client Reference:	**MAR (Micro)**	*Sampled By:*	**Alice Trevelyan**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

Sample Details		WATERS	WATERS	WATERS
Lab Sample ID:		**170930-047-1**	**170930-047-2**	**170930-047-3**
Client Sample ID:		20175755	20175756	20175757
Sample Date/Time:		29/09/2017 09:18	29/09/2017 08:36	29/09/2017
Description:		599 Bushmere Road GPE010	598 Bushmere Road MAR Pilot Bore GPE 065	645 Bushmere Road GPE030
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	cfu/100 mL	18	<1.6	-
Escherichia coli by Presence/Absence(Colilert)				
Escherichia coli	(P/A)/100 mL	-	-	Absent
Total coliforms	(P/A)/100 mL	-	-	Present

*Results marked with * are not accredited to International Accreditation New Zealand*

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Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603	2 cfu/100 mL	1, 2	Auckland
Escherichia coli by Presence/Absence(Colilert)				
Escherichia coli	APHA (online edition) 9223 B Colilert		3	Auckland
Total coliforms	APHA (online edition) 9223 B Colilert		3	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher.

For more information please contact the Operations Manager

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Report Signatory 02/10/2017

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Certificate of Analysis
Laboratory Reference:171007-053

Attention:	Hilltop Sampler	*Final Report:*	**243779-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**09-Oct-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**07-Oct-2017**
Client Reference:	**MAR (Micro)**	*Sampled By:*	**Alice Trevelyan**
Purchase Order:	**37/00/01/2104**	*Quote Reference :*	**5880**

Sample Details		WATERS	WATERS	WATERS
Lab Sample ID:		**171007-053-1**	**171007-053-2**	**171007-053-3**
Client Sample ID:		20175796	20175797	20175798
Sample Date/Time:		06/10/2017 08:20	06/10/2017 09:00	06/10/2017 09:45
Description:		599 Bushmere Road GPE010	598 Bushmere Road MAR Pilot Bore GPE 065	645 Bushmere Road GPE030
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	cfu/100 mL	<1.6	<1.6	<1.6

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Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603	2 cfu/100 mL	All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher.

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Certificate of Analysis
Laboratory Reference:170905-086

Attention:	General Results	*Final Report:*	**241534-0**	*Replaces Report*	**241278-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**19-Sep-2017**		
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**05-Sep-2017**		
Client Reference:	**599 Bushmere Road GPE010**				
Purchase Order:	**3700012104**	*Quote Reference :*	**6374**		

Sample Details	WATERS
Lab Sample ID:	**170905-086-1**
Client Sample ID:	N/A
Sample Date/Time:	01/09/2017 09:30
Description:	599 Bushmere Rd GPE010

Organics

Dihaloacetonitriles / Disinfectant Byproducts by Gas Chromatography with Electron Capture Detector		
1,1,1-Trichloro-2-propanone	mg/L	<0.00002
1,1-Dichloro-2-propanone	mg/L	<0.00002
Bromochloroacetonitrile	mg/L	<0.00002
Chloral hydrate	mg/L	<0.00002
Chloropicrin	mg/L	<0.00002
DHA Sum Ratio		0.00
Dibromoacetonitrile	mg/L	<0.00002
Dichloroacetonitrile	mg/L	<0.00002
Tichloroacetonitrile	mg/L	<0.00002
Haloacetic Acid by Gas Chromatography with Electron Capture Detector		
HAA Bromoacetic Acid	mg/L	<0.0005 *
HAA Bromochloroacetic Acid	mg/L	<0.0005 *
HAA Chloroacetic Acid	mg/L	<0.0005 *
HAA Dibromoacetic Acid	mg/L	<0.0005 *
HAA Dichloroacetic Acid	mg/L	<0.0005 *
HAA Sum Ratio		0.00 *
HAA Trichloroacetic acid	mg/L	<0.0005 *
VOC by Gas Chromatography-Mass Spectrometry (Trace level)		
1-1-1-2-tetrachloroethane, Trace level	mg/L	<0.0001
1-1-1-trichloroethane, Trace level	mg/L	<0.0001
1-1-2-2-tetrachloroethane, Trace level	mg/L	<0.0001
1-1-2-trichloroethane, Trace level	mg/L	<0.0001
1-1-dichloroethane, Trace level	mg/L	<0.0001
1-1-dichloroethene, Trace level	mg/L	<0.0005
1-1-dichloropropene, Trace level	mg/L	<0.0001
1-2-3-trichlorobenzene, Trace level	mg/L	<0.0001
1-2-3-trichloropropane, Trace level	mg/L	<0.0001
1-2-4-trichlorobenzene, Trace level	mg/L	<0.0001
1-2-4-trimethylbenzene, Trace level	mg/L	<0.0001
1-2-dibromo-3-chloropropane, Trace level	mg/L	<0.0001
1-2-dibromoethane, Trace level	mg/L	<0.0001
1-2-dichlorobenzene, Trace level	mg/L	<0.0001
1-2-dichloroethane, Trace level	mg/L	<0.0001
1-2-dichloropropane, Trace level	mg/L	<0.0001
1-3-5-trimethylbenzene, Trace level	mg/L	<0.0001
1-3-dichlorobenzene, Trace level	mg/L	<0.0001
1-3-dichloropropane, Trace level	mg/L	<0.0001
1-4-dichlorobenzene, Trace level	mg/L	<0.0001
2-2-dichloropropane, Trace level	mg/L	<0.0005
2-chlorotoluene, Trace level	mg/L	<0.0001
4-chlorotoluene, Trace level	mg/L	<0.0001

Sample Details (continued)

WATERS

Lab Sample ID:	**170905-086-1**
Client Sample ID:	N/A
Sample Date/Time:	01/09/2017 09:30
Description:	599 Bushmere Rd GPE010

Organics

VOC by Gas Chromatography-Mass Spectrometry (Trace level)

benzene, Trace level	mg/L	<0.0001
bromobenzene, Trace level	mg/L	<0.0001
bromodichloromethane, Trace level	mg/L	<0.0001
bromoform, Trace level	mg/L	<0.0001
bromomethane, Trace level	mg/L	<0.0005
carbon tetrachloride, Trace level	mg/L	<0.0001
chlorobenzene, Trace level	mg/L	<0.0001
chloroform, Trace level	mg/L	<0.0001
chloromethane, Trace level	mg/L	<0.0005
cis-1-2-dichloroethylene, Trace level	mg/L	<0.0001
cis-1-3-dichloropropene, Trace level	mg/L	<0.0001
dibromochloromethane, Trace level	mg/L	<0.0001
dibromomethane, Trace level	mg/L	<0.0001
dichlorodifluoromethane, Trace level	mg/L	<0.0005
ethylbenzene, Trace level	mg/L	<0.0001
ethylchloride, Trace level	mg/L	<0.0001
fluorotrichloromethane, Trace level	mg/L	<0.0001
Hexachlorobutadiene, Trace level	mg/L	<0.0001
iso-propylbenzene, Trace level	mg/L	<0.0001
m- & p-xylene, Trace level	mg/L	<0.0001
methylene chloride, Trace level	mg/L	<0.0005
Naphthalene, Trace level	mg/L	<0.0001
n-butylbenzene, Trace level	mg/L	<0.0001
n-propylbenzene, Trace level	mg/L	<0.0001
o-xylene, Trace level	mg/L	<0.0001
p-isopropyl toluene, Trace level	mg/L	<0.0001
sec-butylbenzene, Trace level	mg/L	<0.0001
styrene, Trace level	mg/L	<0.0001
tert-butyl benzene, Trace level	mg/L	<0.0001
tetrachloroethylene, Trace level	mg/L	<0.0001
THM Ratio, Trace level		0
toluene, Trace level	mg/L	0.00081
trans-1-2-dichloroethene, Trace level	mg/L	<0.0001
trans-1-3-dichloropropene, Trace level	mg/L	<0.0001
trichloroethylene, Trace level	mg/L	<0.0001
vinyl chloride, Trace level	mg/L	<0.0001

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Reference Methods

The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
Organics				
Dihaloacetonitriles / Disinfectant Byproducts by Gas Chromatography with Electron Capture Detector				
1,1,1-Trichloro-2-propanone	USEPA 551.1	0.00002 mg/L	All	Auckland
1,1-Dichloro-2-propanone	USEPA 551.1	0.00002 mg/L	All	Auckland
Bromochloroacetonitrile	USEPA 551.1	0.00002 mg/L	All	Auckland
Chloral hydrate	USEPA 551.1	0.00002 mg/L	All	Auckland
Chloropicrin	USEPA 551.1	0.00002 mg/L	All	Auckland
DHA Sum Ratio	USEPA 551.1		All	Auckland
Dibromoacetonitrile	USEPA 551.1	0.00002 mg/L	All	Auckland
Dichloroacetonitrile	USEPA 551.1	0.00002 mg/L	All	Auckland
Tichloroacetonitrile	USEPA 551.1	0.00002 mg/L	All	Auckland
Haloacetic Acid by Gas Chromatography with Electron Capture Detector				
HAA Bromoacetic Acid	APHA (online edition) 6251 B (modified)	0.0005 mg/L	All	Auckland
HAA Bromochloroacetic Acid	APHA (online edition) 6251 B (modified)	0.0005 mg/L	All	Auckland
HAA Chloroacetic Acid	APHA (online edition) 6251 B (modified)	0.0005 mg/L	All	Auckland

Organics

Haloacetic Acid by Gas Chromatography with Electron Capture Detector				
HAA Dibromoacetic Acid	APHA (online edition) 6251 B (modified)	0.0005 mg/L	All	Auckland
HAA Dichloroacetic Acid	APHA (online edition) 6251 B (modified)	0.0005 mg/L	All	Auckland
HAA Sum Ratio	APHA (online edition) 6251 B (modified)		All	Auckland
HAA Trichloroacetic acid	APHA (online edition) 6251 B (modified)	0.0005 mg/L	All	Auckland
VOC by Gas Chromatography-Mass Spectrometry (Trace level)				
1-1-1-2-tetrachloroethane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
1-1-1-trichloroethane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
1-1-2-2-tetrachloroethane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
1-1-2-trichloroethane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
1-1-dichloroethane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
1-1-dichloroethene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.0005 mg/L	All	Auckland
1-1-dichloropropene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
1-2-3-trichlorobenzene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
1-2-3-trichloropropane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
1-2-4-trichlorobenzene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
1-2-4-trimethylbenzene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
1-2-dibromo-3-chloropropane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
1-2-dibromoethane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
1-2-dichlorobenzene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
1-2-dichloroethane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
1-2-dichloropropane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
1-3-5-trimethylbenzene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
1-3-dichlorobenzene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
1-3-dichloropropane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
1-4-dichlorobenzene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
2-2-dichloropropane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.0005 mg/L	All	Auckland
2-chlorotoluene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
4-chlorotoluene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
benzene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
bromobenzene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
bromodichloromethane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
bromoform, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
bromomethane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.0005 mg/L	All	Auckland
carbon tetrachloride, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
chlorobenzene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
chloroform, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
chloromethane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.0005 mg/L	All	Auckland
cis-1-2-dichloroethylene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
cis-1-3-dichloropropene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
dibromochloromethane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
dibromomethane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland

Organics

VOC by Gas Chromatography-Mass Spectrometry (Trace level)

dichlorodifluoromethane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.0005 mg/L	All	Auckland
ethylbenzene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
ethylchloride, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
fluorotrichloromethane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
Hexachlorobutadiene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
iso-propylbenzene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
m- & p-xylene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
methylene chloride, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.0005 mg/L	All	Auckland
Naphthalene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
n-butylbenzene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
n-propylbenzene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
o-xylene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
p-isopropyl toluene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
sec-butylbenzene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
styrene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
tert-butyl benzene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
tetrachloroethylene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
THM Ratio, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified		All	Auckland
toluene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
trans-1-2-dichloroethene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
trans-1-3-dichloropropene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
trichloroethylene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
vinyl chloride, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland

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Fax: (09) 539 7601

Invercargill
142 Esk Street,
PO Box 747,
Invercargill, 9840
(03) 214 4040
(03) 214 4041

Queenstown
74 Glenda Drive,
PO Box 2614,
Wakatipu,
(03) 409 0559

www.watercarelabs.co.nz
clientsupport@water.co.nz

Certificate of Analysis
Laboratory Reference:170926-086

Attention:	General Results	*Final Report:*	**243358-0**
Client:	**GISBORNE DISTRICT COUNCIL**	*Report Issue Date:*	**03-Oct-2017**
Address:	**PO Box 747, Gisborne, 4040**	*Received Date:*	**26-Sep-2017**
Client Reference:	**598 & 598 Bushmere Road**	*Sampled By:*	**Alice Trevelyan**
Purchase Order:	**3700012104**	*Quote Reference :*	**6374**

Sample Details	WATERS	WATERS
Lab Sample ID:	**170926-086-1**	**170926-086-2**
Client Sample ID:	20175738	20175739
Sample Date/Time:	25/09/2017 09:05	25/09/2017 09:35
Description:	GPE065 598 Bushmere Rd MAR Pilot Bore	GPE010 599 Bushmere Rd

Sample Parameters and Field Testing

Temperature

Temperature	°C	8.4	8.4
Time temperature taken		09:25:00 AM	09:25:00 AM

Organics

Dihaloacetonitriles / Disinfectant Byproducts by Gas Chromatography with Electron Capture Detector

1,1,1-Trichloro-2-propanone	mg/L	<0.00002	<0.00002
1,1-Dichloro-2-propanone	mg/L	<0.00002	<0.00002
Bromochloroacetonitrile	mg/L	<0.00002	<0.00002
Chloral hydrate	mg/L	<0.00002	<0.00002
Chloropicrin	mg/L	<0.00002	<0.00002
DHA Sum Ratio		0.00	0.00
Dibromoacetonitrile	mg/L	<0.00002	<0.00002
Dichloroacetonitrile	mg/L	<0.00002	<0.00002
Tichloroacetonitrile	mg/L	<0.00002	<0.00002

Haloacetic Acid by Gas Chromatography with Electron Capture Detector

HAA Bromoacetic Acid	mg/L	<0.0005 *	<0.0005 *
HAA Bromochloroacetic Acid	mg/L	<0.0005 *	<0.0005 *
HAA Chloroacetic Acid	mg/L	<0.0005 *	<0.0005 *
HAA Dibromoacetic Acid	mg/L	<0.0005 *	<0.0005 *
HAA Dichloroacetic Acid	mg/L	<0.0005 *	<0.0005 *
HAA Sum Ratio		0.00 *	0.00 *
HAA Trichloroacetic acid	mg/L	<0.0005 *	<0.0005 *

VOC by Gas Chromatography-Mass Spectrometry (Trace level)

1-1-1-2-tetrachloroethane, Trace level	mg/L	<0.0001	<0.0001
1-1-1-trichloroethane, Trace level	mg/L	<0.0001	<0.0001
1-1-2-2-tetrachloroethane, Trace level	mg/L	<0.0001	<0.0001
1-1-2-trichloroethane, Trace level	mg/L	<0.0001	<0.0001
1-1-dichloroethane, Trace level	mg/L	<0.0001	<0.0001
1-1-dichloroethene, Trace level	mg/L	<0.0005	<0.0005
1-1-dichloropropene, Trace level	mg/L	<0.0001	<0.0001
1-2-3-trichlorobenzene, Trace level	mg/L	<0.0001	<0.0001
1-2-3-trichloropropane, Trace level	mg/L	<0.0001	<0.0001
1-2-4-trichlorobenzene, Trace level	mg/L	<0.0001	<0.0001
1-2-4-trimethylbenzene, Trace level	mg/L	0.0017	<0.0001
1-2-dibromo-3-chloropropane, Trace level	mg/L	<0.0001	<0.0001
1-2-dibromoethane, Trace level	mg/L	<0.0001	<0.0001
1-2-dichlorobenzene, Trace level	mg/L	<0.0001	<0.0001

Sample Details (continued)		WATERS	WATERS
Lab Sample ID:		**170926-086-1**	**170926-086-2**
Client Sample ID:		20175738	20175739
Sample Date/Time:		25/09/2017 09:05	25/09/2017 09:35
Description:		GPE065 598 Bushmere Rd MAR Pilot Bore	GPE010 599 Bushmere Rd
Organics			
VOC by Gas Chromatography-Mass Spectrometry (Trace level)			
1-2-dichloroethane, Trace level	mg/L	<0.0001	<0.0001
1-2-dichloropropane, Trace level	mg/L	<0.0001	<0.0001
1-3-5-trimethylbenzene, Trace level	mg/L	<0.0001	<0.0001
1-3-dichlorobenzene, Trace level	mg/L	<0.0001	<0.0001
1-3-dichloropropane, Trace level	mg/L	<0.0001	<0.0001
1-4-dichlorobenzene, Trace level	mg/L	<0.0001	<0.0001
2-2-dichloropropane, Trace level	mg/L	<0.0005	<0.0005
2-chlorotoluene, Trace level	mg/L	<0.0001	<0.0001
4-chlorotoluene, Trace level	mg/L	<0.0001	<0.0001
benzene, Trace level	mg/L	<0.0001	<0.0001
bromobenzene, Trace level	mg/L	<0.0001	<0.0001
bromodichloromethane, Trace level	mg/L	<0.0001	<0.0001
bromoform, Trace level	mg/L	<0.0001	<0.0001
bromomethane, Trace level	mg/L	<0.0005	<0.0005
carbon tetrachloride, Trace level	mg/L	<0.0001	<0.0001
chlorobenzene, Trace level	mg/L	<0.0001	<0.0001
chloroform, Trace level	mg/L	<0.0001	<0.0001
chloromethane, Trace level	mg/L	<0.0005	<0.0005
cis-1-2-dichloroethylene, Trace level	mg/L	<0.0001	<0.0001
cis-1-3-dichloropropene, Trace level	mg/L	<0.0001	<0.0001
dibromochloromethane, Trace level	mg/L	<0.0001	<0.0001
dibromomethane, Trace level	mg/L	<0.0001	<0.0001
dichlorodifluoromethane, Trace level	mg/L	<0.0005	<0.0005
ethylbenzene, Trace level	mg/L	<0.0001	<0.0001
ethylchloride, Trace level	mg/L	<0.0001	<0.0001
fluorotrichloromethane, Trace level	mg/L	<0.0001	<0.0001
Hexachlorobutadiene, Trace level	mg/L	<0.0001	<0.0001
iso-propylbenzene, Trace level	mg/L	<0.0001	<0.0001
m- & p-xylene, Trace level	mg/L	<0.0001	<0.0001
methylene chloride, Trace level	mg/L	<0.0005	<0.0005
Naphthalene, Trace level	mg/L	<0.0001	<0.0001
n-butylbenzene, Trace level	mg/L	<0.0001	<0.0001
n-propylbenzene, Trace level	mg/L	<0.0001	<0.0001
o-xylene, Trace level	mg/L	<0.0001	<0.0001
p-isopropyl toluene, Trace level	mg/L	<0.0001	<0.0001
sec-butylbenzene, Trace level	mg/L	<0.0001	<0.0001
styrene, Trace level	mg/L	<0.0001	<0.0001
tert-butyl benzene, Trace level	mg/L	<0.0001	<0.0001
tetrachloroethylene, Trace level	mg/L	<0.0001	<0.0001
THM Ratio, Trace level		0	0
toluene, Trace level	mg/L	<0.0001	0.0022
trans-1-2-dichloroethene, Trace level	mg/L	<0.0001	<0.0001
trans-1-3-dichloropropene, Trace level	mg/L	<0.0001	<0.0001
trichloroethylene, Trace level	mg/L	<0.0001	<0.0001
vinyl chloride, Trace level	mg/L	<0.0001	<0.0001

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods

The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location

Sample Parameters and Field Testing				
Temperature				
Temperature	APHA (online edition) 2550 B		All	Auckland
Time temperature taken	APHA (online edition) 2550 B		All	Auckland
Organics				
Dihaloacetonitriles / Disinfectant Byproducts by Gas Chromatography with Electron Capture Detector				
1,1,1-Trichloro-2-propanone	USEPA 551.1	0.00002 mg/L	All	Auckland
1,1-Dichloro-2-propanone	USEPA 551.1	0.00002 mg/L	All	Auckland
Bromochloroacetonitrile	USEPA 551.1	0.00002 mg/L	All	Auckland
Chloral hydrate	USEPA 551.1	0.00002 mg/L	All	Auckland
Chloropicrin	USEPA 551.1	0.00002 mg/L	All	Auckland
DHA Sum Ratio	USEPA 551.1		All	Auckland
Dibromoacetonitrile	USEPA 551.1	0.00002 mg/L	All	Auckland
Dichloroacetonitrile	USEPA 551.1	0.00002 mg/L	All	Auckland
Tichloroacetonitrile	USEPA 551.1	0.00002 mg/L	All	Auckland
Haloacetic Acid by Gas Chromatography with Electron Capture Detector				
HAA Bromoacetic Acid	APHA (online edition) 6251 B (modified)	0.0005 mg/L	All	Auckland
HAA Bromochloroacetic Acid	APHA (online edition) 6251 B (modified)	0.0005 mg/L	All	Auckland
HAA Chloroacetic Acid	APHA (online edition) 6251 B (modified)	0.0005 mg/L	All	Auckland
HAA Dibromoacetic Acid	APHA (online edition) 6251 B (modified)	0.0005 mg/L	All	Auckland
HAA Dichloroacetic Acid	APHA (online edition) 6251 B (modified)	0.0005 mg/L	All	Auckland
HAA Sum Ratio	APHA (online edition) 6251 B (modified)		All	Auckland
HAA Trichloroacetic acid	APHA (online edition) 6251 B (modified)	0.0005 mg/L	All	Auckland
VOC by Gas Chromatography-Mass Spectrometry (Trace level)				
1-1-1-2-tetrachloroethane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
1-1-1-trichloroethane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
1-1-2-2-tetrachloroethane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
1-1-2-trichloroethane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
1-1-dichloroethane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
1-1-dichloroethene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.0005 mg/L	All	Auckland
1-1-dichloropropene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
1-2-3-trichlorobenzene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
1-2-3-trichloropropane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
1-2-4-trichlorobenzene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
1-2-4-trimethylbenzene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
1-2-dibromo-3-chloropropane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
1-2-dibromoethane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
1-2-dichlorobenzene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
1-2-dichloroethane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
1-2-dichloropropane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
1-3-5-trimethylbenzene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
1-3-dichlorobenzene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
1-3-dichloropropane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
1-4-dichlorobenzene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
2-2-dichloropropane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.0005 mg/L	All	Auckland
2-chlorotoluene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland

Organics

VOC by Gas Chromatography-Mass Spectrometry (Trace level)

4-chlorotoluene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
benzene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
bromobenzene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
bromodichloromethane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
bromoform, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
bromomethane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.0005 mg/L	All	Auckland
carbon tetrachloride, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
chlorobenzene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
chloroform, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
chloromethane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.0005 mg/L	All	Auckland
cis-1-2-dichloroethylene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
cis-1-3-dichloropropene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
dibromochloromethane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
dibromomethane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
dichlorodifluoromethane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.0005 mg/L	All	Auckland
ethylbenzene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
ethylchloride, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
fluorotrichloromethane, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
Hexachlorobutadiene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
iso-propylbenzene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
m- & p-xylene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
methylene chloride, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.0005 mg/L	All	Auckland
Naphthalene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
n-butylbenzene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
n-propylbenzene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
o-xylene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
p-isopropyl toluene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
sec-butylbenzene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
styrene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
tert-butyl benzene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
tetrachloroethylene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
THM Ratio, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified		All	Auckland
toluene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
trans-1-2-dichloroethene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
trans-1-3-dichloropropene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland

Organics

VOC by Gas Chromatography-Mass Spectrometry (Trace level)

trichloroethylene, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland
vinyl chloride, Trace level	APHA (online edition) 6200 B (Purge and Trap) Modified	0.00010 mg/L	All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher.

For more information please contact the Operations Manager

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

Watercare Laboratory Services is a division of Watercare Services Limited .

ACCREDITED LABORATORY

Report Signatory 03/10/2017

Peter Boniface
KTP Signatory

APPENDIX E

Solute Transport Calculations

Introduction

Several processes determine the transport of substances dissolved (solutes) in groundwater:

- Advection is the process in which solutes are carried with the same speed and direction as the groundwater it is dissolved in. This speed, or pore water flow velocity (Ve), equals the Darcy flow velocity divided by the effective porosity.
- Retardation is a process in which solutes are partially adsorbed by organic matter or clay in the aquifer material, which has a net effect of delaying the break-through of that solute. The pore water flow velocity is divided by the retardation factor (R) to derive the retarded velocity.
- Dispersion and diffusion indicate the scattering or spreading of particles. The effect is that the front of a migrating solute plume will be smeared out, which cause lower concentrations to arrive earlier than would be expected from the groundwater flow velocity. Longitudinal dispersion occurs in the direction of the flow at the front end of the plume. Transverse dispersion occurs at the side of the plume.
- Some solutes are subject to decay which will reduce concentrations.

Domenico (1987) derived an analytical solution to calculate the break-through of a solute plume:

$$C(x,t) = \frac{C_0}{2}\exp\left[\frac{x}{2\alpha_x}\left(1-\sqrt{1+\frac{4\lambda\alpha_x}{v}}\right)\right]\operatorname{erfc}\left(\frac{x-vt\sqrt{1+\frac{4\lambda\alpha_x}{v}}}{2\sqrt{\alpha_x vt}}\right)\operatorname{erf}\left(\frac{Y}{2\sqrt{\alpha_y x}}\right)$$

With,

C (x,t): concentration at distance x from the source of the plume at time t (g/m^3)

C_0: initial concentration in the aquifer (g/m^3)

x: travelled distance from the source of the plume (m)

λ: decay constant (-)

v: (retarded) pore water flow velocity = Ve/R (m/day)

t: travelled time (day)

R: retardation factor (-)

α_x: longitudinal dispersivity (m)

α_y: transverse dispersivity (m)

Y: source width (m)

Injection Water Break-through at Poverty Bay MAR Project

The Domenico (1987) formula was used to assess the break-through of the injection water bubble in monitoring wells downgradient from the MAR injection well (GPE066). Sulphate break-through was simulated as this solute is much higher in the injection water (86 g/m^3) than in the aquifer water (less than 1 g/m^3) and therefore a good indicator parameter. The assumed input parameter values are listed in Table 1 below.

It is assumed that the sulphate concentration is not affected by decay or by retardation. Dispersivity assumptions are based on Gelhar (1985). The results of the injection solute transport calculations are shown in Figure 1.

Table 1: Break-through calculation input parameters.

Parameter	Symbol	Unit	Value
Source concentration	C0	mg/L	86
Background concentration	Ci	mg/L	0
Retardation	R	-	1
Groundwater effective velocity (initial 200 m during injection)	V	m/day	1.47
Groundwater effective velocity (irrigation season)	V		0.93
Longitudinal Dispersivity percentage of travelled distance	α_x	-	10 % of travelled distance
Transverse Dispersivity percentage of travelled distance	α_y	-	1 % of travelled distance
Source Width	Y	m	20
Decay constant	λ	-	0
Start date			6/06/2017

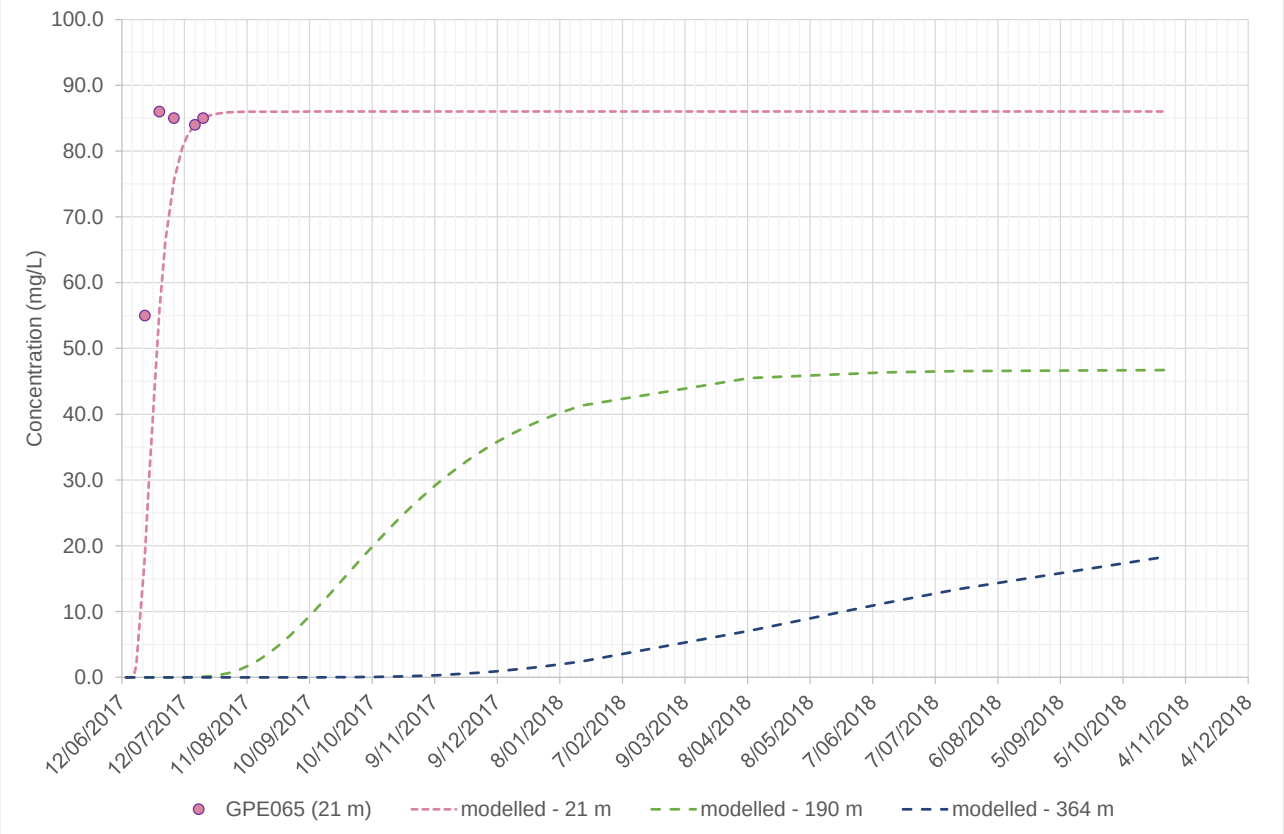

Figure 1: Modelled and recorded break-through of sulphate at several distances from the MAR injection well (GPE066).

References

Domenico, P.A., 1987, An Analytical Model for Multi-dimensional Transport of Decaying Contaminant Species, Journal of Hydrology, 91 (1987) 49-58

Gelhar, L., W., 1992, A Critical Review of Data on Field-scale Dispersion in Aquifers, Water Resources Research, Vol. 28, No. 7, Pages 1955-1974, July 1992.

APPENDIX F

Confirmation of Compliance with Australian Guidelines for Water Recycling

Introduction

Several processes determine the transport of substances dissolved (solutes) in groundwater:

- Advection is the process in which solutes are carried with the same speed and direction as the groundwater it is dissolved in. This speed, or pore water flow velocity (Ve), equals the Darcy flow velocity divided by the effective porosity.
- Retardation is a process in which solutes are partially adsorbed by organic matter or clay in the aquifer material, which has a net effect of delaying the break-through of that solute. The pore water flow velocity is divided by the retardation factor (R) to derive the retarded velocity.
- Dispersion and diffusion indicate the scattering or spreading of particles. The effect is that the front of a migrating solute plume will be smeared out, which cause lower concentrations to arrive earlier than would be expected from the groundwater flow velocity. Longitudinal dispersion occurs in the direction of the flow at the front end of the plume. Transverse dispersion occurs at the side of the plume.
- Some solutes are subject to decay which will reduce concentrations.

Domenico (1987) derived an analytical solution to calculate the break-through of a solute plume:

$$C(x,t) = \frac{C_0}{2}\exp\left[\frac{x}{2\alpha_x}\left(1-\sqrt{1+\frac{4\lambda\alpha_x}{v}}\right)\right]\operatorname{erfc}\left(\frac{x-vt\sqrt{1+\frac{4\lambda\alpha_x}{v}}}{2\sqrt{\alpha_x vt}}\right)\operatorname{erf}\left(\frac{Y}{2\sqrt{\alpha_y x}}\right)$$

With,

C (x,t): concentration at distance x from the source of the plume at time t (g/m^3)

C_0: initial concentration in the aquifer (g/m^3)

x: travelled distance from the source of the plume (m)

λ: decay constant (-)

v: (retarded) pore water flow velocity = Ve/R (m/day)

t: travelled time (day)

R: retardation factor (-)

α_x: longitudinal dispersivity (m)

α_y: transverse dispersivity (m)

Y: source width (m)

Injection Water Break-through at Poverty Bay MAR Project

The Domenico (1987) formula was used to assess the break-through of the injection water bubble in monitoring wells downgradient from the MAR injection well (GPE066). Sulphate break-through was simulated as this solute is much higher in the injection water (86 g/m^3) than in the aquifer water (less than 1 g/m^3) and therefore a good indicator parameter. The assumed input parameter values are listed in Table 1 below.

It is assumed that the sulphate concentration is not affected by decay or by retardation. Dispersivity assumptions are based on Gelhar (1985). The results of the injection solute transport calculations are shown in Figure 1.

Table 1: Break-through calculation input parameters.

Parameter	Symbol	Unit	Value
Source concentration	C0	mg/L	86
Background concentration	Ci	mg/L	0
Retardation	R	-	1
Groundwater effective velocity (initial 200 m during injection)	V	m/day	1.47
Groundwater effective velocity (irrigation season)	V		0.93
Longitudinal Dispersivity percentage of travelled distance	α_x	-	10 % of travelled distance
Transverse Dispersivity percentage of travelled distance	α_y	-	1 % of travelled distance
Source Width	Y	m	20
Decay constant	λ	-	0
Start date			6/06/2017

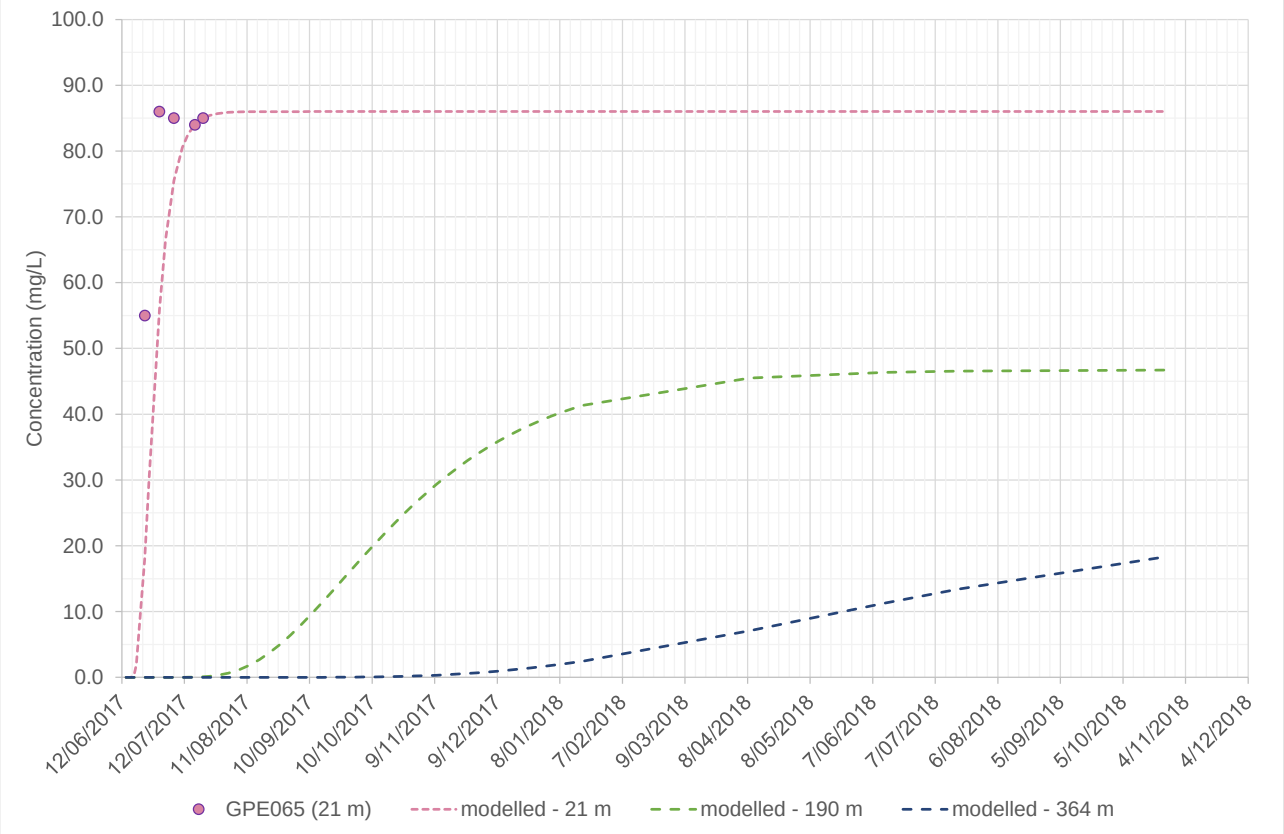

Figure 1: Modelled and recorded break-through of sulphate at several distances from the MAR injection well (GPE066).

References

Domenico, P.A., 1987, An Analytical Model for Multi-dimensional Transport of Decaying Contaminant Species, Journal of Hydrology, 91 (1987) 49-58

Gelhar, L., W., 1992, A Critical Review of Data on Field-scale Dispersion in Aquifers, Water Resources Research, Vol. 28, No. 7, Pages 1955-1974, July 1992.

APPENDIX G

Flow Meter Calibration Certificate

2017

Attention: Alex Reid

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Re: Water Meter Verification

We confirm the following water meter verification tests and findings as follows.

Name of Permit Holder	**Gisborne District Council**
Permit number	**DW-2016-107113-00**
Date of Verification	**23 May 2017**

Water Meter/ Water Measuring Device Details

Make	**Krohne**
Meter Size (mm dia.)	**150mm**
Model	**Optiflux 2000**
Pulse Output	**100l/pulse**
Serial Number	**S16313419**
Meter Reading Volume	**189.65m3**
Tamper Seal Number	**nil**

Verification Details

Is a clamp on water meter used for verification: **No**

If No, describe the method used (e.g. reservoir/ time calculation/ volumetric, etc)

Flow rig, manual reversion/time calculation.	
Verification flow meter brand & type	**Krohne Waterflux 3070**
Verification flow meter serial number	**S13311259**
Last calibration date of verification meter	**31 March 2016**

(Calibration certificates need to be sent to the regulatory authority after calibration)

Verification Parameters

Pipe diameter	**150mm**
Pipe wall thickness	**n/a**
Pipe material	**Galvanised Steel**

Sketch of system showing the location of the verification meter in relation to the meter being verified:

Measured flows

Verification flows should be taken at or around the consented flow rate and/or the flow rate the supply is usually pumped at.

No. of different flow rates tested	Installed system measurement	Reference measurement		Percentage Variation (%)	Under/Over Reading (Installed system meter)
	Average measurement (L/Min)	Average measurement (L/Min)	Uncertainty (L/Min)		
1	**1604**	**1601.04**	**6.4**	**0.02%**	**Over**

Uncertainty is based on the reference meter calibration uncertainty of 0.4%

General

This test was conducted over a 10 minute period taking a start and stop total off the site meter and taking 20 second instantaneous flow rate readings off the flow rig which were then averaged and calculated into a total volume for the same period.

Note that there is a 100mm mechanical meter in the toby box in the picture. This is a management meter measuring the flow to waste.

Certification

We have found that the installed water meter is within the required accuracy of ± 5%.

Recommended remedial action:

Nil

Verified by: **Scott McKenzie**
Signed by (Verifier):

Date: **23/5/2017**

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APPENDIX H

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