Investigating the Geoheat Potential of the Tauranga Geothermal System

Yale Carden[1], Celia Wells[1], Lars Wolpmann[1], Penny Doorman[2], Dean Howie[2]

[1] GeoExchange NZ Limited: Floor 8, 152 Quay Street Auckland 1010 New Zealand

[2] Bay of Plenty Regional Council: PO Box 364, Whakatāne 3158 New Zealand

ycarden@geoexchange.nz

Keywords: *Geoheat, low temperature geothermal, regional development, Tauranga Geothermal System, decarbonisation, resource management.*

ABSTRACT

The Tauranga Geothermal System (TGS) covers an area of approximately 875 km^2, extending from Waihi Beach in the north to Te Puke-Maketu in the south. Being a low temperature single aquifer geothermal system, it ranges in temperature from ~15 °C (ambient) to ~70 °C at depths of 700m. Although these temperatures are too low for electricity generation, they have good potential for heating.

Geoheat is the use of geothermal energy for heating purposes either directly or indirectly, using heat pumps. Current geoheat applications in the TGS include bathing, space heating, water heating, irrigation and frost protection. Due to its ability to replace gas heating and to reduce electrical demand and carbon emissions, geoheat is an important part of the energy transition.

To this end, the Bay of Plenty Regional Council (BOPRC) commissioned an investigation into the geoheat potential of the TGS.

The investigation adopted a holistic approach by integrating the technical groundwater and geothermal elements with stakeholder consultation on current practices, management implications and how these align with regional economic development considerations.

Resource characterisation of the TGS presents a readily accessible source of sustainable thermal energy. Integrating this finding with socio-economic factors further concludes that geoheat use of the TGS could provide significant energy, economic, environmental and health benefits to the region.

Greater use of the TGS' geoheat potential must be balanced with sustainable management of the resource. This report outlines guidance to ensure good system design, appropriate technology selection, and ensuring compliance of installation techniques. This work will inform the Tauranga System Management Plan (which is currently being developed by BOPRC). It will also guide any future changes to balance the environmental and economic benefits of an increased uptake of geoheat with the long-term sustainability of the resource.

1. THE TAURANGA GEOTHERMAL SYSTEM

1.1 Geological setting

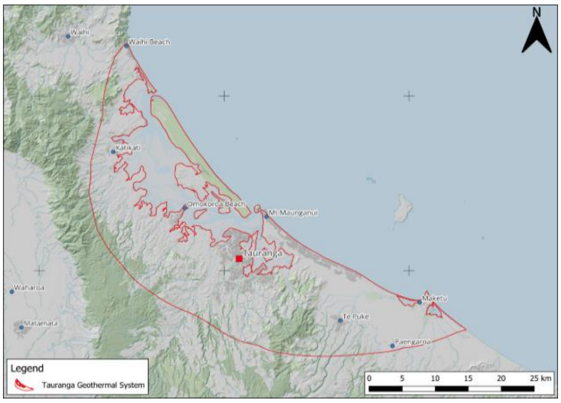

Figure 1: Geographic Setting of the Tauranga Geothermal System (Source: Topographic Basemap Land Information New Zealand (LINZ, Underlying topography NZ 8m Digital elevation model (2012).

The western Bay of Plenty landscape is the product of a complex interplay of volcanic activity, characterised by volcanic events that have resulted in ignimbrite plateaus, while effusive eruptions have formed lava domes and stratovolcanoes, as well as tectonic activity (Leonard et al., 2010).

Sitting within the Tauranga Basin, the TGS was formed around 2 to 3 million years ago (Davis and Healy, 1993). The cityscape of Tauranga features notable volcanic landforms such as Mt Maunganui (Pearson, 2018). The Tauranga Group Sediments, around 6.5 thousand years old, are found on volcanic formations, along with intertidal sediments between 3.4 and 0.7 thousand years old (Pearson, 2018 after Davis and Healy, 1993). The sediment thickness increases towards the sea, reaching depths of up to 300 meters offshore and decreasing towards the west (White, 2009).

In the Tauranga area, there are no active mapped faults; only inactive, concealed faults are present. (BOPRC, 2023 after Briggs et. al., 2006).

1.2 Low temperature geothermal

Geothermal water is designated by the Resource Management Act (RMA, 1991) as water with temperatures 30 °C or greater. The TGS qualifies as a low-temperature geothermal system, with a maximum recorded temperature of approximately 70 °C at a depth of 707 meters (Janku-Capova et al., 2022).

Proceedings 46th New Zealand Geothermal Workshop
20-22 November 2024
Auckland, New Zealand
ISSN 2703-4275

The groundwater aquifer system in the western Bay of Plenty consists of multiple hydrologically connected parts. The TGS covers the parts of this aquifer system where geothermally influenced groundwater, or water 30 °C and over is found. Therefore, the TGS is more a groundwater system warmed by geothermal influences rather than a geothermal system as per the high temperature systems in nearby Rotorua, Kawerau and Taupō.

In a further point of difference to the regional high temperature geothermal systems, the mineral content of the thermal water in the TGS is relatively low and is more similar to that of ambient temperature groundwater. While in most cases it is suitable for irrigation, storage water or for frost protection, in certain places it may have slightly elevated levels of potentially harmful minerals such as arsenic and boron (BOPRC, 2023).

In the TGS, notably high temperature gradients have been observed, ranging from of 4 to 22.5 °C per 100 meters when descending from the surface. It is these high gradients, attributed to residual heat from past tectonic and magmatic activities, that provide the notably elevated near subsurface temperatures.

2. GEOHEAT

2.1 Defining geoheat

Geothermal waters ranging in temperature between 30 °C and 70 °C are not suitable for electricity generation, but there is value in this low temperature geothermal resource in the form of renewable and affordable heat. Using geothermal heat in this way is often referred to as 'geoheat' and this term is used henceforward.

Heating is a significant driver of global energy demand, both in buildings and in industrial processes. According to the International Energy Agency (IEA), heat accounted for almost half of total final energy consumption and 38% of energy-related CO_2 emissions in 2022 (IEA, 2024).

There is nothing more efficient than harnessing available heat directly for heating. The TGS is a heat resource that, managed sustainably, could contribute to decarbonising heating systems by replacing fossil fuel combustion while also supporting sustainable growth of the region.

2.2 Geoheat uses in the western Bay of Plenty

Existing uses of the TGS include heating of public and private pools, some space heating, and irrigation - where the heat of the water is of no additional value.

By comparison, international applications access low temperature geoheat at depths of 2 km - 3 km, often deeper, to replace gas heating for whole districts and light industry. For example, the city of Munich has a target of being the first major German city to provide 100% of its district heating from renewable energies by 2040, with geothermal heat as the backbone of the heat supply. The target is the Jurassic Malm aquifer, for which a depth of approx. 2.5 km must be drilled north of Munich in order to reach a reservoir temperature of 60°C and a depth of approx. 5 km south of Munich in order to reach a reservoir temperature of 150°C (Farquharson N. et al., 2016).

Contributing to the underutilisation of available geoheat in the western Bay of Plenty is a lack of awareness of the presence and potential of the resource; this was evident in interviews conducted as research for this paper. By this we mean a lack of knowledge about different end uses of geoheat and a lack of knowledge about different technology applications and how they contribute to sustainable management practices.

3. ACCESSING GEOHEAT

3.1 System types

Geoheat can be accessed in various ways depending on the requirements of the application and the subsurface characteristics present. Therefore, which geoheat extraction technology is most appropriate for a given application is determined on a case-by-case basis.

Geoheat systems are either:

- Direct use: Systems that use available geoheat directly (e.g. a geothermal hot pool); or
- Indirect use: Systems that require a heat pump to modify the source temperatures to that required by the heating application.

3.2 Direct use

Direct use applications are the most common geoheat uses in the western Bay of Plenty. If the facility temperature requirements allow, direct use is desirable due to the very high system efficiencies possible. However, they are limited to heating only and installations are location specific - areas where the geoheat source temperature aligns with those required by the heating application. While rare, direct use installations may be vulnerable to natural temperature variation of the resource.

As the TGS is a low-temperature system the direct utilisation potential is limited to lower temperature applications. However, this is still very useful, especially if favourable temperatures are available at relatively shallow depths. Potential applications include pools and spas, covered crops, commercial and residential buildings and some lower temperature industrial processes.

Industrial sites can use available heat for the parts of their operations which have lower temperature demand, in many instances, this will serve a majority of the energy use at site. In this pre-heating scenario, other energy sources will be needed for peak temperatures.

3.3 Indirect use

Indirect use systems use the geoheat resource as a starting point for heating and / or cooling. For example, a nominal 15 °C geoheat source (ambient groundwater) could be used by a ground source heat pump (GSHP) to heat or cool a building.

Similarly, a nominal 50 °C geoheat source (geothermal water) could be used by a high temperature GSHP to produce higher temperatures, including steam, for an industrial process. Industrial high-temperature GSHPs are technically advancing rapidly and are now capable of delivering 150°C (see EECA, 2024 case study at Port of Tauranga) with expectations of 200 °C within a few years.

Indirect use is more flexible and has wider application than direct use as it does not rely on subsurface temperature. The GSHP will work with whatever source temperature is present and deliver the required temperature efficiently. This also means that a GSHP will maintain delivery temperature even if natural variation in the subsurface occurs.

In comparison to direct use, a GSHP indirect use system can utilise relatively shallow groundwater which may reduce drilling depth requirements and thus expense. This can also result in less extractive use of the resource and thus be more conducive to sustainable management.

GSHP heating efficiency is enhanced by warmer source temperatures, another reason why their use is suited to the TGS. However, there is a limit to this depending on the individual heat pump refrigeration cycle. Table 1 has been developed to demonstrate the influence of source temperature on thermal efficiencies. It is based on a nominal 12 kW GSHP with all variables identical except the source temperature. Output temperature from the GSHP has been nominated as 45 °C in heating mode and 12 °C in cooling mode and a source flow of 0.5 L/s. Heat pumps are no longer required as the source temperature approaches the output temperature as at this level direct heat exchange becomes possible. Hence, for purposes of this paper a source temperature above 30°C is not shown and, in this instance, a direct use application would apply. However, if much higher output temperatures are required, a high temperature GSHP could be utilised and then higher source temperatures are desirable.

Source Temperature (°C)	Heating COP	Heating Output (kW)	Cooling COP	Cooling Output (kW)
10	4.15	13.7	9.4	17.3
15	4.6	15.2	8.0	16.7
20	5.0	16.7	6.5	16.0
25	5.15	17.7	5.7	15.2
30	5.3	18.6	4.8	14.3
35	Direct Use Zone*		4.4	13.6
40			3.9	12.9
45			3.4	12.2

Table 1: Impact of source temperature on heat pump efficiency and output

Whether direct or indirect use is selected will be determined by the demand needs of the application, the available natural resource (i.e. temperature and flow), and, potentially, resource consenting parameters. However, the benefits highlighted in this section regarding heat pump assisted applications merit a recommendation of wider use than currently exists in the TGS.

4. SYSTEM CHARACTERISATION

4.1 Methodology

The available scientific literature reviewed to characterise the TGS corresponds for the most part to the reading list of the Tauranga Geothermal System Science Summary Report (BOPRC, 2023). A data gap analysis was conducted to enable a comprehensive assessment of the available data and to identify possible gaps. Closing these gaps may assist with better characterisation or management of the TGS with respect to its sustainable geoheat potential. Improvement of data quality is essential to predict subsurface temperatures, heat flow and the distribution of potential geothermal reservoirs for both the design of individual heating systems as well as sustainable management of the aquifer system.

4.2 Geoheat potential

To estimate the potential for direct use applications, a temperature threshold of 30 °C was adopted to align with the RMA definition of geothermal waters. Temperature values were obtained from the available borehole drilling data provided by BOPRC.

As indicated in figure 2, the probability of encountering geothermal water at a temperature of 30 °C or more (yellow to red) at a depth of 150 m b.s.l. is most likely in and around the Tauranga City area and harbour, and to the south-east in the Maketū area.

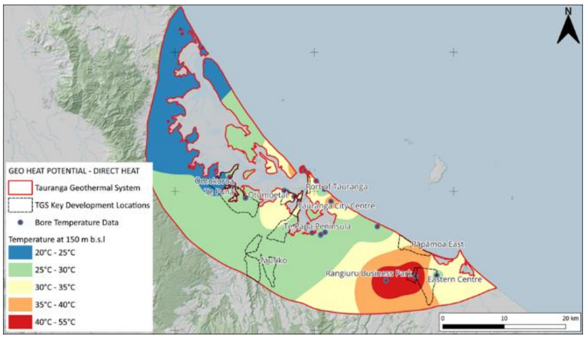

Figure 2: Interpolated temperature at 150 m b.s.l. across the TGS.

Due to insufficient data, an interpolated spatial map of 50 °C temperatures was not created. Rather, the areas in which wells have recorded a temperature higher than 50 °C and the corresponding depth range have been shown in figure 3. The limited data means that further investigation is required for a more in-depth analysis to prepare an interpolated 50 °C temperature map.

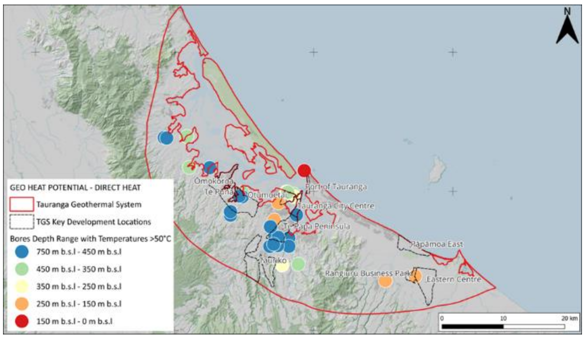

Figure 3: Distribution of wells and depth with temperatures greater than 50 °C.

4.3 Closed loop potential

A closed loop ground heat exchanger (GHX) can be installed as either a direct or indirect use application. These systems use polyethylene (PE) pipe, filled with a water-antifreeze (or brine) mixture, that by circulating around either absorb heat from the ground for heating purpose, or reject heat to the ground for cooling purpose. They are most commonly installed as an indirect use application with a GSHP that can provide heating and cooling.

The assessment of the potential for closed loop GHXs was based on the geological conditions within the TGS and an evaluation of whether there are areas that constitute challenges for the installation of vertical wells. Potential impediments include sulphate bearing rock, water protection zones, artesian groundwater conditions, and heritage and cultural considerations.

The implementation of closed loop GHXs within the TGS is not characterised by any perceptible restrictions. The entire TGS region can be considered favourable for their use.

4.4 Open loop potential

Open loop groundwater systems require an aquifer of sufficient quality and capacity to sustainably supply groundwater to a heat exchanger (direct use) or a heat pump (indirect use), which then typically re-injects it back into the aquifer.

Open loop GHX systems are dependent on sufficiently good groundwater conditions. The TGS aquifer system, according to initial estimates, has a good distribution across its areal extent for open loop systems. In addition, this aquifer benefits from the high geothermal gradient of the TGS.

The New Zealand Aquifer Potential Map demonstrates a preliminary assessment of aquifer potential, based on the data described in Tschritter et al. (2017). It is important to recognise the inherent limitations and uncertainties of the data, with some boundaries remaining unchanged since 2001. Therefore, the accuracy of the maps may vary depending on specific conditions.

The potential constraints mentioned for the closed loop system, which arise from the presence of sulphate-bearing rocks, artesian conditions and water protection zones, equally apply.

In comparison to the closed loop application, there are some limitations to the favourability of open loop. However, as with the closed loop systems, there are significantly more favourable areas than less favourable, again reflecting the unique conditions of the TGS. The actual potential of a site can only be properly determined by drilling test wells and a subsequent aquifer investigation.

5. STRATEGIC RELEVANCE AND FUTURE OPPORTUNITIES

5.1 Regional development planning

The western Bay of Plenty is one of the fastest growing areas of the country. A further 43,000 homes are required to accommodate 290,000 people, an increase of 160 000, who will live there by 2054. The challenges of this rapid growth are addressed by SmartGrowth. The SmartGrowth strategy provides a 50-year direction for housing, employment, and people's wellbeing in the face of rapid and sustained long term growth, while safeguarding what people value most about the region. It provides a framework to manage growth in an integrated and collaborative way in order to address complex planning issues, especially matters that cross over council boundaries (SmartGrowth, 2024).

Table 2 has been developed to summarise the ground temperatures encountered at each potential development zone/ growth areas as identified in SmartGrowth (2024). Of note, the Port of Tauranga encounters higher temperatures at shallow depths which potentially aligns with industrial heating requirements in the industrial area. Rangiuru Business Park similarly encounters 30°C temperatures at a depth of less than 75 m b.s.l. but does not encounter 50°C until a depth of 350m.

Potential Development Zone	Land Use Zoning	Depth Range Encountered	
		30°C	50°C
Port of Tauranga	Industrial	<125 m b.s.l	<500 m b.s.l
City Centre	Mixed Use: Residential / Commercial	<125 m b.s.l	<500 m b.s.l
Te Papa Peninsula	Mixed Use: Residential / Commercial	<125 m b.s.l	<600 m b.s.l
Tauriko	Residential	<125 m b.s.l	<700 m b.s.l
	Industrial		
Rangiuru Business Park	Industrial	<75 m b.s.l	<200 m b.s.l
Eastern Centre	Residential	<75 m b.s.l	<200 m b.s.l
Ōmokoroa / Te Puna	Residential	<175 m b.s.l	<500 m b.s.l
	Industrial		
Otūmoetai	Residential	<75 m b.s.l	<450 m b.s.l
Pāpāmoa East	Residential	<125 m b.s.l	>150 m b.s.l

Table 2: Depth range of ground temperatures underlying the potential development zones

The desktop assessment results for direct use, indirect use, open and closed loop systems are largely positive for each development zone. For a developer interested in the geoheat potential for an individual site or district scheme in one of these zones, this information could act as a first pass review as to whether investment in a site-specific feasibility study is warranted.

Of course, a table like this cannot stand alone as a decision-making tool, other values must be considered. For example, the drive to lower emissions of operators at the Port is of value to the region and for national emissions reduction targets. Due to constrained electrical infrastructure and a lack of available storage space for biomass at the Port, the geoheat potential for this area is attractive. Furthermore, at Rangiuru Business Park, the greenfield development makes the installation of geoheat technology more straightforward, and being able to offer clean and affordable heat for industrial purposes could be an attractive value proposition for the development.

5.2 Tāngata Whenua interests in geoheat

Legislation requires councils to engage with tāngata whenua when carrying out their functions, and for the sustainable management of natural and physical resources, while recognising and providing for the relationship of tāngata whenua with their taonga. The relationship of tāngata whenua with geothermal resources are described in Treaty claims relating to geothermal water and is outlined in many iwi and hapū management plans.

For tāngata whenua, environmental health, and social, cultural and economic wellbeing are all intimately linked. A key consideration is Te Taiao: that the health and wellbeing of our natural environment is not compromised further as a result of land use and development (SmartGrowth, 2024). So sustainable management is key. This is especially the case in areas where tāngata whenua have traditionally used geothermal or geothermally influenced springs, such as at Maketū.

Geoheat is strategically relevant for Māori development, including the development of Māori land. For example, papakāinga (housing on Māori land) in the region is supported in the Tauranga City Council's Long-term Plan and SmartGrowth. Papakāinga would include homes, communal areas and in some cases co-location of hauora (health), employment and/or education facilities on multiple owned Māori land (TCC, 2024). The co-location of community facilities alongside homes is an excellent opportunity for district geoheat schemes, delivering affordable and sustainable heating and cooling with positive community outcomes. Overseas, district schemes are often owned by the community, and thus, for the community, this ownership model and its outcomes is compatible with the aspirations of papakāinga.

5.3 Resilience and stability of energy supply

Rapid growth in Tauranga City has put pressure on critical infrastructure. The electrical load in the western Bay of Plenty has approximately tripled over the last 25 years and is one of the highest load growth areas in New Zealand (SmartGrowth, 2024). Additional electrical demand is expected and thus a requirement for significant planning and investment in grid expansion, which is being driven by further population growth as well as decarbonization / electrification of buildings, transport and industry.

Utilising geoheat in future developments has the potential to increase the resilience of the electrical grid by reducing peak demand and potentially reducing the required investment in supply infrastructure. A 2023 report funded by the US Department of Energy calculated that mass deployment of geothermal heat pumps for the electrification of building heating and cooling in the US would reduce national transmission expansion requirements by 33-38% (Liu, et al. 2023).

Electricity transmission and distribution companies will play a major role in enabling the reduction of GHG emissions and increasing energy resilience in the region. Arguably it is within their interests that geoheat is adopted as the western Bay of Plenty grows, due to its potential to reduce electrical demand, particularly peak demand and adoption would assist to minimise over investment in grid infrastructure. Targeted investments in geoheat could be central to electricity supply and distribution companies' strategic growth plans, alongside investment in other renewable energy sources like solar and regional battery solutions.

5.4 Pools

Heating of public and commercial pools is one of the most established and successful uses of geoheat in the western Bay of Plenty. While some facilities value the thermal minerals present, the main driver for public pools using geoheat are energy cost savings: according to Tauranga City Council, their larger facilities save between $200-330k annually on energy costs.

New community pool developments are listed in the 'Development Infrastructure' section of SmartGrowth and it is public knowledge that a new aquatic centre is being established in Tauranga City at Memorial Park. To maximise public investment in wells for community pools, they should have multiple uses (e.g. space heating and cooling and hot water in addition to the pool heating) and multiple users (adjacent business or buildings) where possible.

5.5 Horticulture

Geoheat is compatible with many industries, but its use in horticulture deserves dedicated discussion. Covered crops (glasshouses) require 24/7 heating during colder seasons to supply New Zealanders with capsicums, tomatoes, cucumbers and other produce year-round. Most use gas for heating and have limited options when considering switching to renewables.

Modelling conducted for EECA's Regional Energy Transition Accelerator (RETA) for the Bay of Plenty (Carey et al, 2024) demonstrated favourable economic outcomes if growers were to access elevated aquifer temperatures for a GSHP compared with standard aquifer temperatures. A 3.2 ha greenhouse located within the BOP region and outside the TGS was first modelled with up to 4.8 MWth GSHPs supplying 65°C water into the greenhouse from the 15°C Matahina formation near Whakatane.

To demonstrate the efficiency of higher source temperatures, the same greenhouse was modelled with source temperatures of up to 30 °C, which reflects temperatures found in some shallow aquifers in the broader Tauranga area. It did not consider direct use options. The result was that a 25 °C increase in aquifer water temperature resulted in both a 40% reduction in capital of the installation and of the annual electricity costs for the facility. The ambient GSHP installation which was used as a benchmark had a ROI of a few years. ROI periods reduced even further with access to higher subsurface temperatures. Although ambient and low temperature geoheat infrastructure case studies are often replicable over broader areas, a specific design feasibility will always be required.

Not only does the western Bay of Plenty have available geoheat for covered crops, it has excellent sunshine hours, access to domestic and international freight routes and an existing horticulture labour market.

5.6 Public buildings

When public institutions adopt geothermal heating and cooling systems, they communicate the potential of geoheat within the region, educate about different technological applications, as well as demonstrate a commitment to environmental stewardship.

One of the findings of stakeholder research for this report is that awareness of Tauranga's available geoheat and potential applications is relatively low, therefore public education efforts, such as this report, are recommended. This was also evident with Tauranga City Council and Western Bay of Plenty District Council staff. While they were well informed that geoheat is useful for pool facilities, they were less informed about other geoheat uses and international trends. The construction of the new Tauranga City Council building has commenced without a geoheat system and it is unclear whether the available geoheat at site was considered as an energy option in the design phase.

This is symptomatic of a general lack of awareness of low temperature geothermal uses in New Zealand. There is clearly a need for increased communication on the geoheat opportunities not just in the western Bay of Plenty but across New Zealand.

6. RESOURCE MANAGEMENT

6.1 Regional policy statement

New Zealand's geothermal systems are currently managed under the Resource Management Act of 1991 (RMA), which has the overall purpose of sustainable management of natural and physical resources.

The Bay of Plenty Regional Policy Statement (RPS) provides the overall policy framework for management of geothermal, including sustainable and integrated management of geothermal

The RPS classifies all geothermal systems in the region, where the TGS is classified as a low temperature system. The RPS provides for extractive use of the geothermal system, where the adverse effects of the activity can be avoided, remedied or mitigated. Discharge of geothermal fluid must be managed to avoid significant adverse effects on surface water and stormwater.

The RPS also requires the protection of significant surface features and includes criteria to determine whether a feature is significant.

A system management plan is also required for the integrated management of the system. This is currently under development.

6.2 Resource consenting

Generally regional rules relate to drilling, take and use of geothermal or non-geothermal water, taking of heat and energy, and discharges. Where more than one type of resource consent is required, these will be dealt with as one application where possible.

While less likely, any disturbance of land or disturbance of contaminated land has potential to need consent for earthworks and would need to be confirmed on a case-by-case basis. Where structures are placed on the beds of water, consents may also be needed for structures in water bodies.

Consenting requirements will be site and system specific but they are a necessary requirement. They are the main tool available to regional councils to manage the effects of the use of the resource, and appropriately manage it for the future. It is the BOPRC's legal requirement to manage the TGS as set out in the RMA.

Feedback from stakeholder interviews conducted for this report was that due to the uncertainty of outcome, unknown costs, and unknown time frames, consents are a perceived and/or real barrier.

Reconsenting of geothermal wells is required every 10 years by the BOPRC. One consent holder interviewed for this project described that approaching reconsenting was "daunting", and others found the process very difficult with "hoops to jump through." All had gone through the reconsenting process within the last two years and had employed consultants to assist. For each site, the fee for reconsenting that included their consultants, council employed consultants, and the council reconsenting fees, totalled \$15k and \$16k. A third site spent \$25k in total for their home heating and orchard irrigation reconsenting application, the majority of that total was also on consultant fees after their attempt to complete the application themselves was rejected. Unfortunately, reconsenting costs of this magnitude dilute the economic gains from having geoheat, especially for smaller installations.

In some cases, applicants must engage local iwi or hapū to assess the cultural effects of their application. This was something interviewees said they didn't know how to appropriately undertake without specialist assistance. Although employing external consultants is not a requirement, these parties were driven to this decision by fear of being bogged down in a red tape process and losing time by making mistakes.

One interviewee expressed that, in his opinion, the rigour required of the current reconsenting process seemed more appropriate for the initial application only. As metering of the well is now required and because BOPRC send someone to inspect the well annually, he said as long as those checks were OK, the reconsenting process should be streamlined and more like "rubber stamp process."

If local government wants to support a geoheat strategy for the region, an evaluation of the current consenting and reconsenting process that engages a larger sample, would identify inefficiencies and opportunities to streamline the process.

6.3 Sustainable management

The importance of robust geothermal management became most evident in the 1970s when resource failures in Rotorua, caused by uncontrolled extraction, highlighted the need for careful oversight. Culturally significant geysers like Waikite and Papakura stopped erupting, prompting a protection and recovery plan in the 1980s. Practices in other geothermal systems, such as Wairakei and Ohaaki also resulted in the loss of features, and in some cases unsustainable use of the energy resource. More careful management under the RMA, and industry best practice, have resulted in greater consideration of environmental impacts of geothermal use.

All geothermal systems are distinctly unique and have different management requirements. It is noted that the Tauranga SMP will be addressing sustainable management practices for the system, including reinjection requirements and discharges to surface etc. Implementing these measures helps to maintain the thermal capacity of the aquifer and ensure reliable and efficient operation of the geothermal systems.

All technologies listed in this document can be used sustainably, so long as they are used and managed appropriately. A few simple points that assist with best practice and to minimise impact of the environment include net zero discharge systems such that all water extracted is returned to the aquifer, i.e. no discharge to stormwater / Tauranga Harbour; closed loops to be fully grouted to prevent mixing of aquifers and surface water infiltration; and thermal modelling of any system design to ensure sustainability of long-term operational performance as well as environmental protection.

7. ENABLING THE FUTURE OF GEOHEAT

7.1 Data

The temperature maps and assessment about open and closed loop potential made for this paper are based on data collected from 2029 wells made available from existing consents. In some areas, like Matua, the number of data points available in a contained geographic area increases the map accuracy there and reduces risk for future investments. However, in other areas and for certain depths, data availability is limited.

There is risk that a well, once drilled, may not perform as modelled in a detailed design or there is a temperature anomaly. Such risks are the reality of geoheat projects worldwide and this risk can be an obstacle to investment. To reduce risk and improve design accuracy, more collected data and updated maps should be made publicly available.

It is not the role of, nor expected that, publicly available data be of sufficient quality to completely derisk and design a specific application at a given location. However, enhancing the availability and quality of publicly available data can go a long way to encouraging investment into geoheat systems. A preliminary derisking process using publicly available data at a minimum provides a level of certainty to any investor that there is at least a known geoheat resource available and whether it may be suitable to their application. For example, even a simple understanding of what temperatures are available at what depth enables a project proponent to understand whether geoheat may be suitable and thus worth further site-specific investigation.

Better data will also improve understanding of the TGS from an extraction and management perspective. Thus, minimum data collection requirements during installation should be a requirement moving forward. System monitoring is critical to understanding resource variations and their impact on management and operational performance.

7.2 Environmental best practice

Adopting best practice principles is critical for balancing increased uptake of geoheat systems within the TGS with its long-term sustainable management.

The UK Environment Agency (2016) has developed an 'Environmental good practice guide for ground source heating and cooling' that could serve as a useful tool for BOPRC in its ongoing management of the TGS with respect to enhanced uptake of geoheat systems. The Tauranga System Management Plan, under development, will include best practice principles.

7.3 Regional geoheat strategy

The majority of international examples of district energy schemes involve the public sector to some degree, whether it is with planning strategies, incentivising development, or in many cases, the public sector has partial or full ownership of the project (UN Energy Programme, 2016).

It is likely that in order to ignite a geoheat future for the western Bay of Plenty and Tauranga City, where multiple residential and industrial district schemes could operate, it will need significant support and leadership from local councils and central government. For example, the development of a regional geoheat strategy and a commitment to geoheat project support initiatives like streamlined consenting, central government grants or even council led geoheat project tenders. It is also likely that projects will initially follow a public and private sector investment partnership model. However, as the concept matures, private investment could be expected to be more common.

These initiatives are well suited to ESG investors like New Zealand Green Investment Finance and also superannuation funds. If local private sector investment is slow to get involved, there are multiple overseas investors that specialise in financing, developing, constructing, and operating large-scale geothermal heating plants for district heating companies. Therefore, it is not unforeseeable that international finance would take an interest in a geoheat strategy for the western Bay of Plenty.

7. CONCLUSION

The TGS is a readily accessible source of sustainable thermal energy that could provide significant energy, economic, environmental and health benefits to the region. However, it is relatively unknown as a resource and further research will improve resource management and inform the potential benefits it may provide.

All efforts to use the TGS to the region's strategic advantage can and must be done sustainably. Adopting best practice principles is critical for balancing increased uptake of geoheat systems within the TGS with its long-term sustainable management. This report has outlined how important it is to ensure good system design, appropriate technology selection, and ensuring compliance of installation techniques.

ACKNOWLEDGEMENTS

Many thanks to the Bay of Plenty Regional Council for commissioning an investigation into the geoheat potential of the TGS. We also wish to thank Brian Carey from GNS Science who assisted in guiding the development of the original scope and reviewed various drafts. The findings of that comprehensive public report have been used to create this summary paper.

REFERENCES

BOPRC (2023): Tauranga Geothermal System Science summary report, Environmental Summary Report December 2023.

Briggs, R. M., Lowe, D. J., Esler, W. R., Smith, R. T., Henry, M. A. C., Wehrmann, H., Manning, D. A. (2006): Geology of the Maketū Area, Bay of Plenty, North Island, New Zealand. Sheet V14 1:50 000 (Occasional Report). Department of Earth and Ocean Sciences, University of Waikato in collaboration with Bay of Plenty Regional Council, Whakatane.

Carey B. S., Carden Y., Alcaraz S. A., Moore G., Wells C. (2024): Energy Transition Accelerator – Bay of Plenty – Geothermal Energy Assessment, GNS Science Report 2024/02.

Davis, R.A., Healy, T.R. (1993): Holocene coastal depositional sequences on a tectonically active setting: Southeastern Tauranga Harbour, New Zealand: Sedimentary Geology, v. 84, p. 57-69.

EECA. (2024) Regional Energy Transition Accelerator: Bay of Plenty. Available at: https://www.eeca.govt.nz/assets/EECA-

Resources/Co-funding/RETA-Bay-of-Plenty-Phase-One Report.pdf (Accessed: 31 May 2024).

Farquharson N. et al. (2016) Geothermal Energy in Munich (and Beyond) A Geothermal City Case Study, ERDWERK GmbH, Munich, Germany.

IEA (2024), Renewables 2023, IEA, Paris https://www.iea.org/reports/renewables-2023.

Janku-Capova, L., Zarrouk, S. J., Zuquim, M. (2022). Tauranga Geothermal System: Temperature Distribution, Conference: 44th New Zealand Geothermal Workshop.

Leonard GS, Begg JG, Wilson CJN. (2010): Geology of the Rotorua area, Lower Hutt (NZ): GNS Science. 1 folded map +102 p., scale 1:250,000, Institute of Geological and Nuclear Sciences 1:250,000 geological map.

Liu, X., Ho, J., Winick, J., Porse, S., Lian, J., Wang, J., (2023). Grid Cost and Total Emissions Reductions Through Mass Deployment of Geothermal Heat Pumps for Building Heating and Cooling Electrification in the United States. US Department of Energy.

Pearson-Grant, S.C., Burnell, J.G. (2018): Update of the Tauranga Basin geothermal reservoir model. GNS Science Consultancy Report 2018/102.

SmartGrowth (2024). SMARTGROWTH STRATEGY 2023-2073, 306 Cameron Road, Tauranga.

TCC (2024) Long-term Plan 2024-34 - Tauranga City Council, Available https://www.tauranga.govt.nz/Portals/0/data/council/long_term_plans/2024-34/files/01 introduction.pdf (Accessed: 31 May 2024).

Tschritter, C.; Westerhoff, R.S.; Rawlinson, Z.J.; White, P.A. (2017) Aquifer classification and mapping at the national scale - phase 1: identification of hydrogeological units. Lower Hutt, N.Z.: GNS Science. GNS Science report 2016/51. 52 p.; doi: 10.21420/G2101S.

United Kingdom Environment Agency (2017). Environmental good practise guide for ground source heating cooling. V3. Report ID: GEHO0311BTPA-E-E.https://mail.gshp.org.uk/pdf/EA_GSHC_Good_Practice_Guide.pdf on 7 June 2024.

United Nations Environment Programme. (2016) Business Models for District Energy: A Continuum from Public to Private.

White B. (2009): An updated assessment of geothermal direct heat use in New Zealand, New Zealand Geothermal Association. 36 p.

ISSN 2703-4275