

Ground source heat pump systems in Christchurch: history, issues and opportunities

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Abstract

Ground source heat pump (GSHP) technology has expanded in Ōtautahi/Christchurch, largely driven by post-earthquake rebuild and enabling policies. Six years after the earthquakes, there were more than fifteen large GSHP projects under development or completed across the city.

Christchurch's GSHP systems predominantly use bore pairs, typically abstracting water from deeper aquifers, often Aquifer 4 (Wainoni Gravel Formation), and injecting the water back into Aquifer 1 (Riccarton Gravel Formation). The vertical separation of the aquifers means that abstraction and injection bores can be in close proximity without resulting in thermal interference. Due to the proliferation of GSHP systems in the city centre there have been some concerns about interference effects on other users and groundwater mounding in the Riccarton Gravel Formation and the overlying shallow water table, and resource consent applications are treated with increasing rigour.

This paper briefly outlines the GSHP systems that have been installed in Christchurch and describes some of the issues associated with GSHP system installation. Christchurch is showing how, despite some issues, there is an opportunity to use natural

groundwater resources to reduce energy costs and build climate-resilient infrastructure.

Introduction

Ground source heat pump (GSHP) systems utilise the relatively constant temperature of near-surface soils, rocks and groundwater to provide a heat supply (or heat sink) for buildings. The heat transferred from the subsurface is upgraded into useable energy using mechanical compression plant that changes the temperature of the energy supplied. Most systems in Christchurch are 'open loop', abstracting groundwater from one aquifer, extracting the heat or cool from the water, and then re-injecting back into another aquifer, with no net take. These systems are highly effective in using a renewable energy source for heating and cooling larger commercial facilities.

GSHP systems are used extensively in Europe (Weber *et al.*, 2016; Lind, 2011). They were first used in the late 1940s to early 1950s, although they became more common and commercially viable from the 1970s onward. The uptake of this technology in Aotearoa New Zealand has been more recent. The first systems were developed in the 2000s, with notable growth in adoption after 2008. They have not been used as

widely as in Europe, possibly due to high upfront installation costs, a lack of widespread awareness, and a preference for more familiar heating solutions like air-source heat pumps, which dominate the market (Climo *et al.*, 2012; Coyle, 2014). However, larger facilities with greater heating and cooling demand, such as airports, libraries, swimming pools, hospitals, convention centres and arger accommodation facilities (e.g., hotels, lodges, residential care) are now often adopting GSHP technology. The technology is particularly suited to Ōtautahi/Christchurch as discussed in this paper and by Seward *et al.* (2017).

New Zealand's climate is generally temperate, experiencing neither excessive heat nor extreme cold. In the residential home sector this has led to a history of minimal investment in home energy systems, with people generally having lower expectations of indoor comfort than is found in many other nations (Climo *et al.*, 2012). The lower expectations have been suggested as a barrier to the uptake and utilisation of GSHP technology in the private sector (Coyle, 2014), where these types of systems are generally only being installed in 'top-end' residential circumstances (Seward *et al.*, 2017).

The key driver for the uptake of GSHP technology in Christchurch has been the aim to rebuild a greener, more energy-efficient city in the wake of the destructive 2010 and 2011 earthquakes. The earthquakes resulted in the destruction of more than 1,000 commercial buildings in Christchurch's central business district, many of which have been, or are still being, rebuilt. As described by Seward *et al.* (2017), the city is located on a series of unconfined and confined aquifers, ranging in depths from 5 m to greater than 200 m and containing water that is generally consistently between 12 and 13°C, providing a stable, consistent source of heat energy.

This paper summarises the Christchurch experience in terms of GSHP investigations

and outcomes, exploring some of the issues faced in implementing the technology. However, due to a unique combination of geological suitability, forward-thinking policies, and growing demand for sustainable heating and cooling solutions, Christchurch has emerged as a city that has adopted this low-emissions technology, with numerous successful systems.

Geological and hydrological setting

Christchurch overlies a multi-layered aquifer system, with aquifers separated by aquitards (Fig. 1). Artesian pressure exists across much of the city and increases with depth. This hydrogeological setting means that abstraction and injection for GSHPs can be from closely located bores penetrating different aquifers, thus avoiding the risk of thermal interference where re-injected warmer or cooler water is then abstracted by another GSHP system, negatively impacting on its performance. In all the GSHP systems in Christchurch that return groundwater back into ground, the take is from a deeper aquifer than the injection aquifer. Because deeper groundwater beneath Christchurch is generally at a higher pressure than shallower groundwater, abstracting from deeper wells minimises energy requirements. In some cases, abstraction wells can be allowed to free flow. In shallower aquifers, injection pressures may be relatively low, requiring minimal energy expenditure in terms of both abstracting the water from the ground and discharging it back.

The majority of abstraction is from the Wainoni Gravel Formation (Aquifer 4, henceforth referred to as the Wainoni Gravel) and injection is usually into the Riccarton Gravel Formation (Aquifer 1, Riccarton Gravel), these being generally the most permeable formations (Table 1). Other system configurations have been considered, including abstraction from shallow formations and injection into deeper ones;

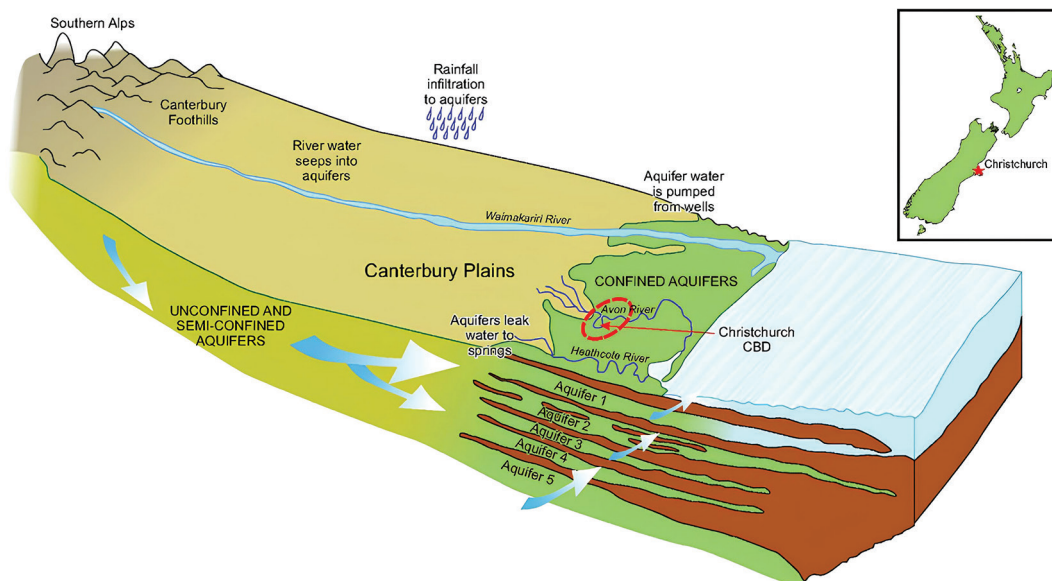


Figure 1 – Conceptual diagram showing the groundwater flow from the foothills of the Southern Alps to the confined aquifers under Christchurch. Image redrawn from Weeber (2008).

while this would avoid interference effects on groundwater levels in deeper aquifers, to date it has not been considered to be an acceptable option due to concerns about adverse effects on groundwater quality of the deeper aquifers.

Rutter (2015) summarised all available aquifer test data for the Christchurch aquifers and found aquifer transmissivities vary between <40 and $20,000 \text{ m}^2/\text{d}$ with the individual aquifer ‘averages’ being between $\sim 1,200$ and $4,360 \text{ m}^2/\text{d}$ (Table 1). Water temperatures are generally between 11°C

and 13°C , with water originating in the Port Hills (south of the city) generally being a few degrees warmer. In the south of Christchurch, particularly in the Hillsborough Valley, geothermal springs have been identified, which could be a contributing factor to the area’s warmer groundwater temperatures.

Regulatory framework

To take and discharge groundwater generally requires a resource consent from the relevant regional council, in this case, Environment Canterbury. Although the Christchurch-

Table 1 – Summary of aquifer depths and transmissivities for the six main aquifers used for groundwater abstraction beneath Christchurch. Aquifer parameters based on Rutter (2015).

Formation (Aquifer)	Average well depth (m)	Average transmissivity (based on (x) number of aquifer tests)
Springston Formation (Aquifer 0)	9	3,250 (4)
Riccarton Gravel (Aquifer 1)	25	4,124 (53)
Linwood Gravel (Aquifer 2)	60	1,204 (34)
Burwood Gravel (Aquifer 3)	75	1,883 (8)
Wainoni Gravel (Aquifer 4)	140	3,618 (18)
Number 5 Gravel	180	4,360 (5)

West Melton groundwater allocation zone, as defined in the Canterbury Land and Water Regional Plan (operative 2015), is considered to be fully allocated, the aquifer system is managed in plan view: consents to take water from one aquifer and discharge into another aquifer are considered to be non-consumptive and thus are not affected by the allocation status of the groundwater allocation zone. In addition, a fast-tracked planning process implemented following the 2010/11 earthquakes made the take and discharge of water for GSHPs a permitted activity under certain circumstances. However, most of the recently completed or planned commercial aquifer energy installations in the central Christchurch city area have opted to obtain consents for their facilities even though the permitted activity rule has been in place since 2015. The regulatory aspects will not be explored in any detail here but are covered in more detail in Seward *et al.* (2017).

GSHP installations

Pre-earthquake installations

Before the earthquakes, a few GSHP systems were in place across Christchurch, including at the Town Hall (utilised mains water), the University of Canterbury (commenced in 1997), and Christchurch Airport (from 1973). Whilst the Town Hall suffered serious damage and the heating/cooling system was decommissioned, systems at the university and airport continued (and still continue) to be used. These systems generally did not involve injection but instead discharged to surface water networks or shallow infiltration basins, although the University of Canterbury did install a system in 2003 taking Aquifer 5 water and injecting into the Linwood Gravel (Aquifer 2). Further details of the pre-2016 systems are given in Seward *et al.* (2017).

Post-earthquake installations

The Christchurch rebuild-driven installation of GSHP systems has been unmatched

elsewhere in New Zealand with over 20 commercial systems installed in the years following the earthquakes. The current (or attempted) systems are shown in Table 2 and Figure 2. (Two notable examples of systems that were investigated but failed to

Table 2 – Commercial GSHP systems in Christchurch.

Facility	Year of completion
University of Canterbury (UC)	1997 +
UC Science Lecture Theatres	2003
St Andrews College	2009
Christchurch International Airport	2011
CCL	2012
TAIT Technology Centre	2015
Bus Interchange	2015
Environment Canterbury main building	2016
Art Centre	2016-19
St Georges Hospital	2016-19
Justice Precinct	2017
The Terrace	2017
King Edward Barracks	2017
UC New Education Building	2017
Hornby High School	2017
Town Hall	2018
Tūranga (Central Library)	2018
UC Student Union Building	2018
UC School of Biological Sciences	2019
Blum	2019
New Brighton Hot Pools	2019
Te Pae (Convention Centre)	Failed
Taiwhanga Rehia	Failed
Metro Sports Facility)	
UC Tupuānuku (Garden Halls)	2021
Hillmorton Hospital	2024
UC Building Group 4	2024
University of Otago	2024

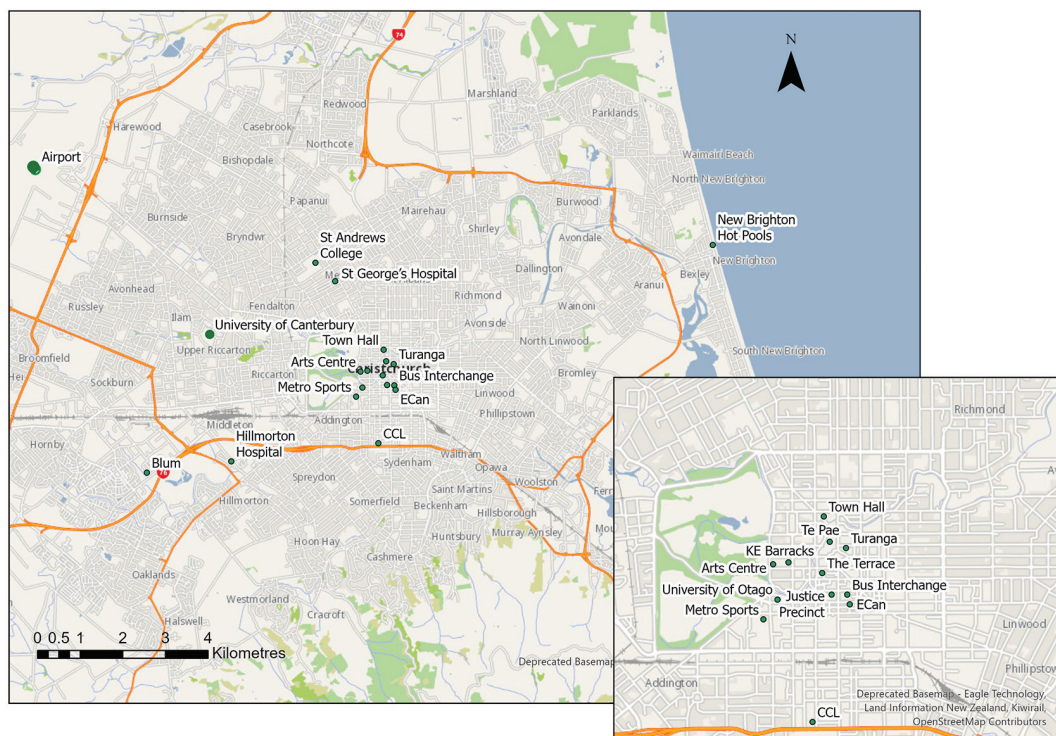


Figure 2 – Locations of GSHPs in Christchurch. The inset map shows the extent of the ‘Four Avenues’, within which GSHP abstraction and discharge are a permitted activity.

be implemented due to issues with injecting water were Taiwhanga Rehia (the Metro Sports Facility) and Te Pae (the Convention Centre)). Appendix 1 provides detail of the bores utilised in the current systems.

Issues and opportunities for GSHPs in Christchurch

The many systems that have now been installed in Christchurch have provided valuable insights into the hydrogeological, environmental and consenting issues associated with GSHP systems. There have been many operational learnings as well, although these are not explored in this paper. The vast majority of systems within Christchurch have been successfully designed, consented and operated. There are still many opportunities for GSHP systems to

be installed and consented in the city and elsewhere in New Zealand. Understanding some of the issues that have been encountered in Christchurch should provide learning opportunities, imparting greater confidence in designing and commissioning future systems. Some of the potential issues with GSHP systems are outlined below. The main areas of concern have included groundwater level drawdown effects on other users as a result of abstraction and thermal interference, shallow groundwater mounding and potential stream augmentation from injection.

Planning framework and stream augmentation effects

Injecting water into the upper aquifers (Riccarton Gravel (Aquifer 1) or Springston Formation (Aquifer 0)) has the potential to result in stream augmentation. This is

not an issue, generally, from a stream flow perspective; however, it can be a problem from a planning point of view and it is useful to understand a peculiarity in the policy framework regarding GSHPs. The Christchurch-West Melton Groundwater Allocation Zone is considered to have no further allocation available. However, because a GSHP system returns all groundwater to the ground, albeit into a separate aquifer, under the current Canterbury Land and Water Regional Plan (LWRP) GSHP systems are considered to be non-consumptive. Therefore, injection water must (under the LWRP framework) stay in the gravels: upward vertical migration of water (leakage) and stream augmentation represent a loss of water from the aquifer system and hence would contravene the policies and rules of the LWRP. Thus, establishing the degree of stream augmentation effects becomes a focus when preparing and assessing resource consent applications associated with GSHP discharges.

Impacts on water resources and other users

Groundwater abstraction for a GSHP system must be assessed to ensure it will not have an adverse impact on other groundwater users. The process for this assessment is to drill and test bores and determine water level interference effects in nearby bores, using Environment Canterbury's WQN10 tool¹. Using this information, the abstraction depth may be targeted to minimise any adverse effects on other users.

The focus of consenting is on local interference effects rather than any cumulative effects on the overall aquifer system (as the abstracted water is returned to the ground and the activities are considered non-consumptive in terms of overall allocation). It is possible that with future plan changes

there could be a different approach taken to consenting GSHP systems, for example if separate allocation blocks were given to each individual aquifer. This would be complex to put in place and may not be feasible in practice.

Impacts of mounding

The potential for mounding (a localised rise in the water table or hydraulic head around the injection point) in both the injection aquifer (usually Riccarton Gravel) and in the overlying shallow water table (Springston Gravel or Christchurch Formation) must be assessed as part of the consent process. In 2017, Environment Canterbury commissioned a modelling report (Rekker, 2017) to investigate the potential for mounding of the water table in shallow sediments. The study found that when GSHP systems discharge to the Riccarton Gravel it has the potential effect of raising the water table in the overlying shallow water table (acknowledging that there were significant uncertainties in the modelling approach). As a result of the study, the consenting process started to require a much more detailed level of investigation (than had previously been required) into the potential effects of mounding on underground structures, liquefaction potential and the potential for springs to emerge.

Thermal interference

The risk of thermal and water level interference has been reported in areas of intense abstraction for GSHPs elsewhere, such as in London where there are many installations within 250-500 metres of each other (Fry, 2009). To ascertain the potential for thermal interference from GSHP systems in Christchurch, modelling has been carried out using the groundwater flow model

¹ <https://wqn10.ecan.govt.nz/>

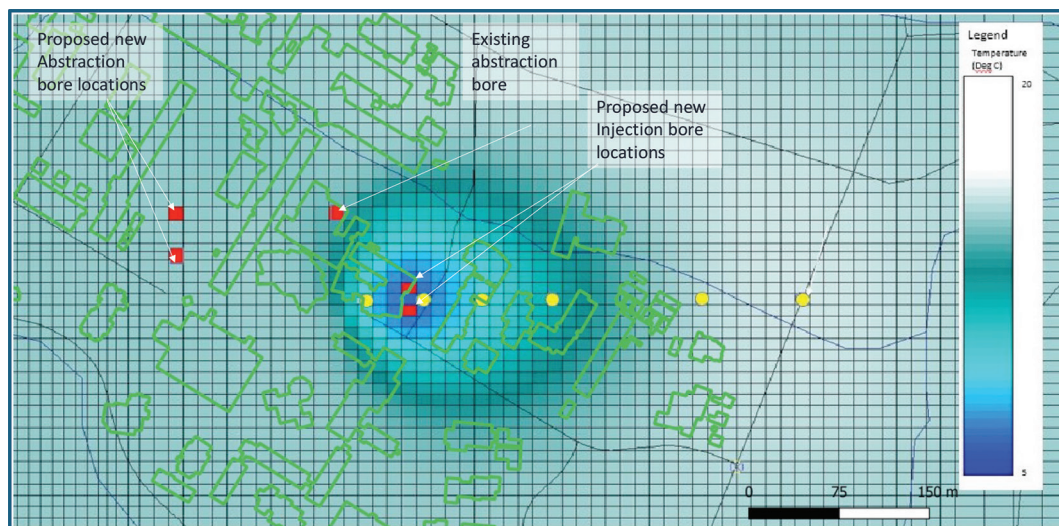


Figure 3 – Modelled temperature effects from injection of cool water into the Linwood Gravel at University of Canterbury (Hector, 2024).

MODFLOW, with heat transfer modelled using MT3D (Hector, 2024). In most cases, due to the use of the Riccarton Gravel as the receiving groundwater system, there are unlikely to be problems with thermal interference: there are very few bores, apart from at the University of Canterbury, where abstraction for GSHP systems is from the Riccarton Gravel.

However, there are a few bores that re-inject water into the Linwood Gravel (Aquifer 2). For example, at Tūranga (the new central library) injection is into the Linwood Gravel and there are two down-gradient GSHP systems that abstract from the same aquifer: the Bus Interchange and the Environment Canterbury building. The likely impacts were assessed and it was not considered that injection at the Tūranga site posed a threat to the existing down-gradient GSHP systems (Rutter, 2018). Another thermal interference risk area is the University of Canterbury, where there are several abstraction and injection bores in different aquifers. One new scheme (Building Group 4; Hector, 2024)

was designed in an area close to another GSHP system with abstraction bores in the Riccarton Gravel. The presence of these thermally sensitive bores prevented use of the upper aquifer for injection, and it was necessary to inject into the Linwood Gravel instead. Example output from modelling to assess the likely thermal migration in the injection aquifer is shown in Figure 3.

As with the Tūranga modelling, the results suggest that the effects from the thermal plume resulting from the injection of water into the Linwood Gravel in this location would not propagate a great distance from the injection bore locations. This was a simple modelling approach with no assessment of uncertainty: the fact that there were no thermally sensitive bores in the injection aquifer precluded the need for a more detailed investigation.

Hydrogeological and bore performance issues

Constructing successful abstraction and injection bores in the Canterbury alluvial deposits is not without challenge. The inherent heterogeneity of the formations

and moderately high above-ground pressures requires a considered and often flexible approach to system design. The variability of the sediments is illustrated by the fact that bores at the same depth that are located sometimes only a few tens of metres away from each other can show totally different yields. While desktop assessments can be carried out to identify target drilling depths the advent of sonic drilling to install pilot holes has been a major improvement in terms of providing evidence to identify target depths for injection and abstraction horizons.

Sonic drilling is an advanced form of drilling that employs high frequency vibration to resonate and advance a core barrel or casing into subsurface formations (Harris *et al.*, 2023). The introduction of

this technology now enables drillers to obtain effectively ‘intact’ samples of sediments for particle size analysis (Fig. 4). The resulting, more reliable, lithological log enhances the accuracy with which drillers can target specific productive horizons. Sonic drilling results may also help in understanding the likely success of development, and, in some cases, this has helped decisions to continue drilling bore, rather than abandon the bore when results were not initially promising.

Since the earthquakes, anecdotally, it seems that there are increased issues with sand migration when developing production bores (I. Haycock, pers. comm., 2012). This may be due to seismic activity causing re-sorting of the sediments, with fine-grained material being transported into the open framework

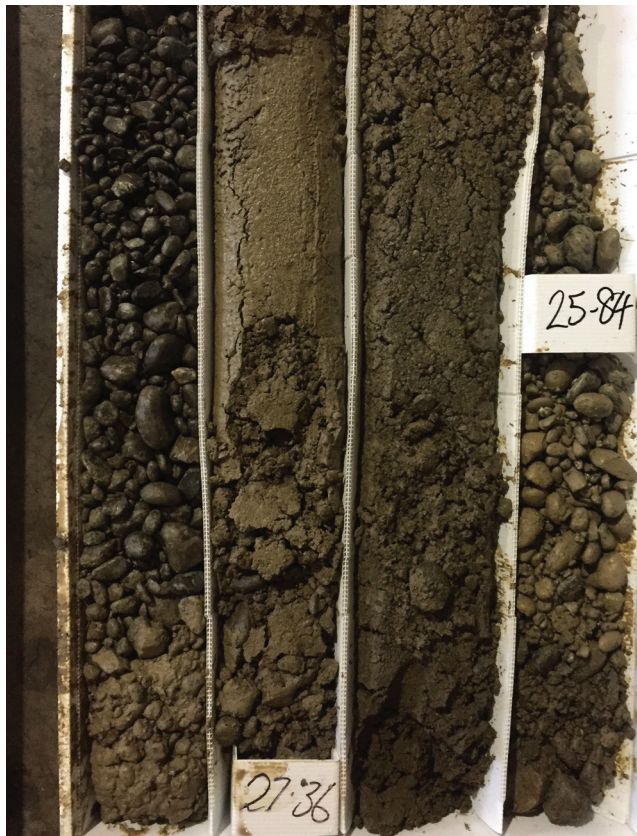


Figure 4 – Example of sediments retrieved from sonic drilling.

gravels through which the majority of flow occurs (as suggested by Rutter *et al.*, 2016). The sand migration can result in prolonged development time for abstraction bores and difficulties in achieving satisfactory performance without sand ingress being an issue: in some cases, maximum bore yield and/or operational limits are required to mitigate sand ingress. In a few isolated cases, it has also resulted in abandoning bores due to sand ingress that was unable to be controlled and re-drilling of bores at a different depth. Is it notable that the issues can be quite localised. For example, at Tupuānuku (Garden Halls, University of Canterbury), the first (eastern) abstraction bore, BX24/2727, was successfully completed at 199 m depth, albeit with some sand ingress. On the western side of the building, a second abstraction bore was drilled to a similar depth but failed due to major sand ingress that could not be resolved through development of the bore. Re-drilling eventually resulted in a successful bore at 65199 m depth.

Another related, albeit infrequent, issue has been failure to obtain successful injection capacity (e.g., due to low permeability sediments) or there has been a problem with water emerging at the ground surface (i.e. springs developing). Again, this seems to be a localised issue and difficult to predict. Injection testing at Te Pae (the Convention Centre) and the nearby Tūranga (the new central library) found, unusually, that the Riccarton Gravel in this area exhibits low permeability. Tūranga experienced high injection pressures due to the low permeability of the sediments, and ultimately injection was split between the Riccarton Gravel and Linwood Gravel. Te Pae experienced similarly high injection pressures; however, at this site springs emerged at the ground surface. The seepages were believed to be related to ground disturbance, possibly as a result of site investigations or in-ground structures from the previous building at the site but may also

have been related to relatively deep excavation at the site possibly reducing the thickness of the confining layer. Ultimately, the scheme at Te Pae was abandoned and alternative energy sources were identified.

The problem at Taiwhanga Rehia (the Metro Sports Facility) was slightly different. Here the injection bores were high performing (i.e., accepting large flows with minimal mounding). However, this site had several active springs, and networks of clay tiles/shallow drainage had been installed over the past 100-plus years to manage the issue. The drainage networks were removed during post-earthquake demolition and prior to any GSHP investigation water was already draining off site. During injection testing, despite the relatively low pressures, the incremental increase in shallow aquifer water level augmented the spring flows. To complicate the matter, several historic bores were also known to be onsite, but not all were found/identified and these abandoned bores contributed to the flows. The GSHP approach was abandoned and alternative energy sources identified.

Summary

Ground source heating and cooling technology in Christchurch utilises the abundant renewable energy aquifer resource that underlies the city. There has been significant growth in GSHP installations in Christchurch following the 2010/11 earthquakes.

However, the technology is not without risks and ongoing projects have identified various issues, most of which are surmountable but may result in additional installation costs. The future of GSHP development across Christchurch may become limited by water level interference effects between abstraction bores, thermal interference between injection and abstraction bores, and/or resource management plan changes that

limit the cumulative take from individual aquifers. In some cases, under current Canterbury Land and Water Regional Plan rules, the potential for stream augmentation (caused by leakage from the shallow aquifer receiving the injection discharge, resulting in a 'consumptive' groundwater take) could potentially limit certain schemes.

The risk of thermal interference and water level interference has been reported in areas of intense abstraction and injection, such as in London where many GSHP installations are within 250-500 metres of each other (Fry, 2009). However, in the London example, the GSHP systems utilise the Chalk aquifer, which has no clear aquitards. In Christchurch's case, thermal interference is generally not considered to be a major issue due to the presence of aquitards and the fact that there is limited abstraction from aquifers that are also used for injection.

Poor bore performance and sand ingress issues have been encountered in some bores, for example Riccarton Gravel (Aquifer 1) bores at Tūrangā and Number 5 Gravel bore at Tupuānuku. The use of sonic drilling to target specific depths may help to overcome some of the early issues and reduce risks associated with this.

Christchurch is demonstrating that, despite the challenges, GSHPs provide an opportunity to leverage natural groundwater resources to reduce energy costs and build climate-resilient infrastructure. The lessons learnt should be considered and built on if GSHP systems are installed elsewhere in New Zealand.

Acknowledgements

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Appendix 1: Christchurch's existing GSHP schemes

Scheme	Well Number(s)	Well type: abstraction (A) or injection (I)	Well Depth (m)	Rate of take (L/s)	Resource Consent(s)	Year drilled
University of Canterbury (UC)	M35/2244	A	9.1	5.6	CRC194229	1966
	BX24/1724	A	26.2	35.6		2018
	M35/2476	A	45.7	53.3		1963
	M35/3083	A	9.1	18.3		
	M35/3084	A	11.27	9.1		1973
	M35/3085	A	12.2	6.1		1973
	Discharge to surface water		–		CRC194230	
	M35/7082	A	31.3	30	CRC941244	1998
	Discharge to Okeover Stream				CRC941245	
Christchurch International Airport	M35/1468	A	20	210	CRC074115.1	1973
	M35/1382	A	30.5			1966
	M35/1371	A	16.4			1964
	M35/17762	A	37.5			2008
	M35/17763	A	40.4			2009
	M35/17973	A	35			No Date
	No injection bore (discharge to soak pit)				CRC074116.1	
Christchurch International Airport	M35/7595	A	35.8	175	CRC970754.1	1997
	M35/7597	A	30.3			1997
	M35/7598	A	33.3			1997
	M35/7599	A	35.7			1997
	M35/11037	A	34.65			2006
		A				
	No injection bore (discharge to oak pit)				CRC970755.1	
UC Science Lecture Theatres	M35/9322					2003
	M35/9323					
	M35/9324					

Scheme	Well Number(s)	Well type: abstraction (A) or injection (I)	Well Depth (m)	Rate of take (L/s)	Resource Consent(s)	Year drilled
St Andrew's College	M35/18025 (capped)	A	29		CRC093969 (expired)	2009
	M35/18060	A	69			
	M35/18062	A	50			
Computer Concepts Limited	M35/18611	I	43	60	CRC181690	2011
	M35/18612	A	41.25		CRC181688	2011/12
	M35/18613	A	143.25			
Arts Centre	BX24/0506	A	130.5	80	CRC154729	2013/14
	BX24/0508	A	129			
	BX24/0507	I	34.6		CRC154730	2014/15
	BX24/0509	I	38.09			
Environment Canterbury	BX24/0528	I	34.7	33	CRC146484	2014
	BX24/0527	A	84.8		CRC146483	
Bus Interchange	BX24/1062	I	35.38	12	CRC167904	2014
	BX24/1061	A	84.82		CRC167902	
Tait Electronics	M35/1412?	I	15.2	25	CRC185948	2014
	M35/1497	A	12.2		CRC970547	
King Edward Barracks	BX24/1289	A	128	80	CRC251344 CRC201499	2016
	BX24/1290	I	38.5			
The Terrace	BX24/0736	I	34.2	47	CRC175833	2015
	BX24/0737	I	34.15			
	BX24/0738	A	73.6			
	BX24/0735	A	83.25			
Tūranga (New Central Library)	BX24/1435	I	82.9	45	CRC191543 (Previously CRC181479)	2017
	BX24/1437	I	35.42			
	BX24/1436	A	128.84		CRC191544 (Previously CRC181479)	
	BX24/1438	A	128.16			
Town Hall	BX24/1425	I	36	55	CRC183998	2017
	BX24/1426	A	129.5		CRC183997	
	BX24/1427	A	129			2017

Scheme	Well Number(s)	Well type: abstraction (A) or injection (I)	Well Depth (m)	Rate of take (L/s)	Resource Consent(s)	Year drilled
Hornby High School	BX23/0672	I	34.2	30	CRC185992	2017
	BX23/0671	A	103.15		CRC185991	
Justice Precinct	BX24/0650	I	37	153	CRC190794	2017
	BX24/0651	I	37.12			2017
	BX24/0652	A	128.5		CRC190795	2017
	BX24/0649	A	126.5			
Rehua (UC)	BX24/1402	I	15	30	CRC173511	2017
	BX24/1401	A	40		CRC173510	
St Georges Hospital	BX24/1208	I	34.98	50	CRC185621	2018
	BX24/1209	A	140.01		CRC185620	
Haere-roa/ Student Union (UC)	BX24/1650	I	41	33	CRC193783	2018
	BX24/1649	A	150		CRC193782	2018
Blum	BX24/2728	A	25.66	5	CRC202700	2019
	BX24/2729	I	26.12		CRC202701	2019
New Brighton Hot Pools	BX24/2706	A	153.8	36	CRC235529	2019
	BX24/2707	I	98.4		CRC235533	2019
Garden Halls (UC)	BX24/2727	A	199	40	CRC214765	2021
	BX24/2725	A	65			
	BX24/2726	I	35		CRC214766	2021
	BX24/2724	I	31.1			
University of Otago (in Christchurch)	BX24/2905	A	127	120	CRC242142	2023
	BX24/2976	A	128		CRC242143	2023
	BX24/2882	I	32.3			
	BX24/2974	I	35			
	BX24/2975	I	35.5			
Building Group 4 (UC)	BX24/3030	A	137.4	70	CRC243606	2023/24
	BX24/3032	A	138.3		CRC243607	2023/24
	BX24/3031	I	68.4			
	BX24/3033	I	59.4			

Scheme	Well Number(s)	Well type: abstraction (A) or injection (I)	Well Depth (m)	Rate of take (L/s)	Resource Consent(s)	Year drilled
Hillmorton Hospital	BX24/2799	I	32.8	180		2024
	BX24/2800	I	38.3			
	BX24/2801	I	38.8			
	BX24/2802	A	125.7			
	BX24/2803	A	110			

