A REVIEW OF GEOTHERMAL RESOURCE MANAGEMENT UNDER THE RMA 1991 WITH A VIEW TO THE FUTURE

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ABSTRACT

As one of the world's major geothermal nations, New Zealand is a leader in geothermal resource management through the framework of the Resource Management Act 1991 (RMA) and the Central Government's devolution of geothermal resource management to Regional Councils. In the 30 years since the RMA was enacted, the geothermal policy developed by the Bay of Plenty and Waikato Regional Councils has managed the competing interests of large-scale energy development and the protection of rare and vulnerable geothermal features and landscapes for 90% of the national geothermal resource.

Pending Government reform of the resource management system, we review issues that have arisen in the last 30 years and to what extent the two Councils' broadly similar policies have been successful in managing the resource. We highlight RMA strengths, such as the goal of sustainable management and community participation. We identify challenges, gaps and future opportunities to develop and integrate resource management policy. Emerging issues include advancing technology to better understand geothermal resources, new techniques to access the deeper resource, and the further extraction of minerals from geothermal fluid. Partnerships and shared decision making with Māori will also increase in the management of geothermal taonga for the benefit of their communities.

As we transition to a zero-carbon future, extractive uses of geothermal resources will increase, while the need to protect and preserve our remaining geothermal features and ecosystems, and the need to honour the Crown/Māori relationship, will remain.

1. INTRODUCTION

1.1 Background to geothermal management In New Zealand

Geothermal use and development in New Zealand have been well traversed in literature (Burnell et al. 2016, Dickie and Luketina 2005, Luketina and Parson, 2019). Sustainable use of geothermal by Māori for heating, bathing, cooking and health and wellbeing has existed for generations. This relatively low-impact use continues as part of everyday life. However from the 1950s an increasing demand for energy led the Government to look at alternative sources of energy and a move to develop both hydro dams and geothermal power plants, such as in Kawerau and Wairakei.

This rapid increase in development took place in a vacuum of Central and Local Government regulation and policy around geothermal management (except for the Geothermal Energy Act 1953). The focus was on energy, and environmental effects were not something generally considered. Māori participation was very limited, and in some cases, Māori relationships with, and accecss to,their geothermal taonga were severely undermined by geothermal enterprise (Doorman et all 2020). For example, in 1955, the Ohakuri Hydro Dam was built at Orakeikorako, flooding much of the valley, including two of the world's biggest geysers. By the time the first stage of the Wairakei geothermal power station was commissioned in 1958, the geysers at Geyser Valley and Spa Sights on the Wairakei-Tauhara Geothermal System had disappeared as a result of the development.

By the late 1960s and 70s, demand for energy continued. Despite some changes to the law, the management of geothermal resources focused on energy use rather than the effects of energy use on the wider environment. In Rotorua, for example, the consequences were damage to and loss of surface features, including Waikite, Wairoa and Papakura Geysers. In 1950 there were 130 significant geysers active in New Zealand, but only about a dozen remain today, largely due to the effects of geothermal development.

Even in the late 1980s, under the Water and Soil Conservation Act (1967), the effects of the use of geothermal resources on the environment were not well considered. For example, Ohaaki Power Station was commissioned in 1989. The resulting effects included subsidence and loss of several geothermal springs, including a riverside geyser and the spring that fed a large pool, the Ohaaki Ngawha, which was considered a taonga or treasure by tangata whenua.

There have, of course, been considerable economic and social benefits gained from these developments, including energy security, employment, research and innovation, and successful ventures with by or with Māori. Geothermal development for electricity generation and direct heat use contributes significantly to the Bay of Plenty and Waikato regional economies (Luketina et al., 2017)

In the 1970s and 1980s, the effects of large-scale development (not only in geothermal) united the environmental community and crystallised thoughts around better environmental management. Local Government and resource management reform led to the

enactment of the RMA in 1991 (repealing 78 statutes and regulations) and the creation of regional and district councils. Thirty years on, we are now facing a new era of reform in a context of climate change, de-carbonisation and a biodiversity crisis. The reforms propose the replacement of the RMA with a Natural and Built Environment Act (NBA) and a Spatial Planning Act. A broad framework for the former has been outlined in the NBA Exposure Draft (Minisitry for the Environment, 2021).

The reforms create both opportunity and risk for geothermal. We move towards this change with 70 years of experience in geothermal development, a connected geothermal community, improved knowledge of the deep geothermal resources, technological advances in modelling and in engineering solutions, and long-term monitoring data on the effects of use on sensitive features and individual geothermal systems. There is greater expectation of genuine partnerships with Māori. In this paper, we explore the changes seen in geothermal management under the RMA over the last 30 years and whether our existing tools are fit for purpose for the next 30 years.

2. OPPORTUNITIES AND LIMITATIONS OF THE RMA

2.1 Geothermal Management under the Resource Management Act 1991

The RMA is underpinned by the concept of sustainable and integrated management of resources, which allows for resource development subject to adverse effects being avoided, remedied or mitigated. It is effects-based, evidence-based, and requires consideration of alternatives and public participation in policy development and consenting processes. Part II of the Act provides the overall framework for the management of geothermal resources.

Geothermal water and energy are managed by regional councils, with 21 geothermal systems and nearly 90% of the resource managed by Bay of Plenty and Waikato Regional Councils. Ngawha in Northland is the only high-temperature geothermal system outside of those two Regions, and Northland accordingly does not have a detailed geothermal resource use policy framework.

There has been little national direction provided to regional councils regarding their geothermal functions. There are no national policy statements directly about geothermal, although there are some that have some influence on geothermal management, including the National Policy Statements on Renewable Electricity Generation, Electricity Transmission, Freshwater Management. The draft National Policy Statement on Indigenous Biodiversity will also have important implications for geothermal development.

The Regional Policy Statements (RPS) of Waikato and Bay of Plenty Regions set the overall direction for geothermal management through high-level objectives and policies, while detailed policies and rules for use and development are contained in their regional plans. The two Councils have developed policy frameworks that are very similar in nature and effect (Bay of Plenty Regional Council 2015, Waikato Regional Council 2016). Both RPS contain policies that direct sustainable and integrated management of the resource, and protection of significant geothermal features, using system classification to achieve this. However, Waikato regional policy focuses on sustainable management of the regional geothermal resource as a whole rather than on the sustainable use of individual geothermal systems used for large-scale development, and references to precaution are limited. Bay of Plenty policy, on the other hand, specifically requires sustainable use of large-scale extraction with a precautionary approach, and describes sustainable use criteria in detail. These, and other, divergencies should be considered in better integrating cross-boundary geothermal policy and in creating future national-level geothermal policy to support de-carbonisation (Parson, 2022).

At times inconsistency in regional geothermal policy is cited as an obstacle to development. However, the policies utilise broadly similar approaches to achieve sustainable management, particularly system classification and the use of System Management Plans (SMPs). The industry appears to be broadly supportive of this approach. There are some differences, e.g. the specific criteria that are used to identify significant geothermal features, but this appropriately reflects that communities of interest and geothermal values are not homogenous across the Taupō Volcanic Zone (TVZ). That is not to say that consistency is not desirable, and to address this the Waikato and Bay of Plenty Regional Councils have an MoU for geothermal management to reduce duplication, seek opportunities to collaborate on projects, and sometimes share staff resources and expertise. There is also some integration between the councils regarding economic development portfolios (which include activities relating to energy), although this could be improved.

While a National Planning Framework (as referred to in the NBA Exposure Draft) might create an opportunity for further streamlining of regional policies, this may be unnecessarily bureaucratic given most geothermal resources are managed by only three regional councils. This could also detract from regional self-determination. Also, some of the failings attributed to the RMA and regional policies arise during their implementation, particularly as most consents are discretionary and require the weighing up of complex information and competing interests. More work can be done operationally to create greater certainty for consent holders (e.g. through Standard Operating Procedures and guidelines), greater transparency in decision making (especially for and with Māori), consistent monitoring , and whole system reporting. We also think that further streamlining of consenting processes, without losing rigour, transparency, or appropriate community participation is a positive step.

3 SUSTAINABLE AND INTEGRATED MANAGEMENT TOOLS

3.1 System Classification

A key strategy to help achieve sustainable management of regional geothermal resources is system classification. Figure 1 shows the systems within the TVZ and their classification under the Bay of Plenty and Waikato RPS (Bay of Plenty Regional Council 2015, Waikato Regional Council 2016). This approach reflects the values, opportunities and limitations to use within different geothermal systems, using information about the presence of surface features and existing development. The aim is to consider sustainability within a TVZ context and take a balanced approach to use and protection. The approach enables development where appropriate

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while ensuring representative examples of significant geothermal features are protected for future generations. It also provides for a more careful assessment of effects in Conditional Development Systems, where there is an absence of robust evidence about the potential effects of development. This gives developers confidence that they can invest in effective and efficient generation of fluid for electricity generation, for example, provided they do this within clearly defined boundaries and constraints.

This approach has been especially useful in Development Geothermal Systems (DGSs), where effects on geothermal surface features do not need to be avoided but must be remedied or mitigated. This enables the deep high-temperature zone in a DGS to be explored and exploited provided the effects on other natural and physical resources are minimised, and any effects on the overlying land are avoided, remedied, or mitigated. Controlled depletion of the geothermal system is expected to occur in Development Geothermal Systems that support large-scale uses, with the rate and extent of system depletion carefully monitored under resource consents.

This regulatory structure allows energy takes to be optimised in Development Geothermal Systems. The SMP, a mandatory requirement in Waikato and Bay of Plenty policy, encourages a developer to carefully think through the resource capabilities and explore and develop them over time. It gives the developer with land access and resources consents the right to uncontested development over the lifetime of the consents. Once the fluid has been taken, a developer can maximise its use by stripping out heat and minerals through their choice of technology or via arrangements with secondary parties before returning the fluid to a receiving environment where the discharge composition and volume has minimal impact (usually reinjection).

The geothermal system classification approach described above is an example of how Regional Spatial Strategies under a Strategic Planning Act could be applied to geothermal management (see below). There are, however, some concerns about the expectation of certainty in establishing 'hard' boundaries when classifying systems, and the two regional councils use a different approach, where Waikato has delineated boundaries while Bay of Plenty uses indicative boundaries only. Using a precautionary approach, 'buffer' zones could be applied where there is a lack of information to define boundaries. It is noted, however, that where system boundaries are embedded in plans, any change is required to follow a Schedule 1 RMA process. This can be quite onerous and reduces operational flexibility for resource users until the process is complete.

Another boundary challenge is the three-dimensional boundary definition, in particular the boundary at depth. Most planning tools refer to a two-dimensional boundary, but this does not lend itself well to different planning frameworks reflecting different risk profiles. For example, the rules around deep exploration could be quite different to those for shallow abstraction. Boundaries could also evolve to include volumetric boundaries.

Another limitation of the system classification approach has been that some landowners, often Māori, are disadvantaged. Historical degradation of many systems, such as Wairakei, has emphasised the need for the protection of some remaining geothermal landscapes. Some of these landscapes are now within Protected Systems, or Conditional Development Systems, and are often within Maori Ahu Whenua (land trust) blocks. This raises ongoing equity issues, only partly resolved through Treaty of Waitangi Settlements.

3.2 Protection of Significant Geothermal Features - Success or room for improvement under a new Act?

As described under section 2.1 above, the RMA has created a sustainable management framework, given effect to through RPS and regional plans. The development of policy requires an evaluation of costs and benefits, efficiency and effectiveness and is subject to a submission and appeal processes. The policy is evidence-based, drawing on years of monitoring and research and informed by expert input. System classification for example, and policies on the protection of significant geothermal features, have resulted in most of our remaining unmodified systems e.g. Waiotapu and Waimangu being identified as Protected Systems. However planning processes are lengthy and costly, and Local Government and RM reform will significantly reduce the number of planning documents.

Equally, the resource consent process is robust (some say it is too costly, litigious and unnecessarily precautionary), and consents require a comprehensive assessment of environmental effects (AEE), and many monitoring conditions that ensure sustainable management of the geothermal system and management of surface effects. In this respect, we are giving effect to Part II of the Act, especially sections 6 and 7, which require us to recognise and provide for outstanding landscapes and features, significant indigenous vegetation and habitat of indigenous fauna, and the relationship of Māori with their taonga (among other things).

However, the implementation of the RMA has been inadequate in achieving much of its intended purposes, and the continued loss of geothermal values, and potential ongoing risks to those values, demonstrates this. Often these effects are the result of small-scale cumulative impacts that are difficult to measure and hard to attribute to any single use. Other effects are more direct, such as the effects of earthworks, diversion, structures, rubbish dumping and contaminant discharges. For example, regional council monitoring shows continued decline in the extent and quality of significant geothermally influenced vegetation. In the Bay of Plenty Region, over 7 ha of geothermal vegetation and habitat was lost between 2003 and 2016, despite being mapped and identified as significant under section 6(c) of the RMA. In Taupō significant geothermal vegetation was recently fragmented by roading developments. This is despite being identified as unique and nationally and internationally rare. In Development Systems, the regional policy framework is specifically designed to provide for mitigation and remediation of significant adverse effects on significant geothermal surface features, so a decline of surface features is anticipated. However, there may be more opportunities for offset, building on positive examples such as the funds provided by large-scale geothermal electricity providers for third parties to undertake restoration and maintenance such as fencing and pest management in geothermal areas elsewhere.

In Rotorua, management under the RMA has seen long-term surface feature maintenance and continued recovery, although some features have yet to recover and may never do so. The relationship of Māori with those resources has also been eroded for multiple reasons. For example, there has been a loss of access to the resource because of the RMA 'first in first served' regulatory framework,

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resulting in 75% of the geothermal take in Rotorua being used for commercial enterprises rather than for traditional or community/communal uses. There has also been inadequate engagement of Māori in planning processes, with 'mainstream science' often held up as the absolute truth in our understanding of the state of resources and effects of development. This has meant there is poor recognition of Mātauranga Māori (Māori knowledge) in identifying values, attributes, and the mauri (similar to life force) of geothermal. An example of this is in Rotorua, where the regional council has monitored heat flow, temperature, and chemistry for 30 years, with no reference to Mātauranga Māori. This is changing, and legislative reform will accelerate this shift.

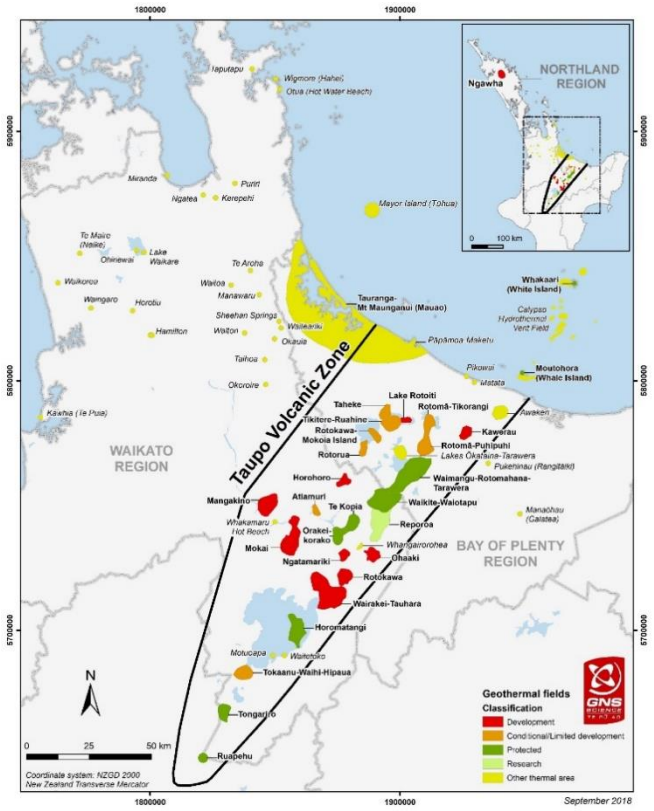

Figure 1: Geothermal systems in the TVZ, spanning the Bay of Plenty and Waikato regions and their category within the Geothermal System Classification (Image courtesy of New Zealand Geothermal Association and GNS Science, 2018).

There are, however, excellent examples of where an effort has been made to recognise cultural attributes in geothermal management, with cultural indicators, and we need to find more opportunities. In some cases, development has led to an increase in geothermal vegetation such as at Craters of the Moon at Wairakei in the Waikato Region, but this is an ephemeral effect and in no way compensates for the loss of the much rarer geysers and sinter-depositing springs that were rendered extinct by the development.

Given the intent of the RMA and RPS policies, what is the cause for the ongoing decline in many geothermal values and what changes are needed? Geothermal is inherently complex - lack of information and a lack of certainty presents issues for regulatory bodies and resources users alike. Lack of certainty, especially in systems that are Conditional Development, potentially leads to resistance to investment and resistance by landowners and the community that are cautious about potential effects. This lack of certainty is often translated in policy to the precautionary approach, an approach that is well justified in sensitive systems. For example, in Rotorua the effects of deep drilling or large heat takes are not well known, but the consequences of getting things wrong are dire and irreversible. For this reason, a precautionary approach is well justified. Adaptive management solutions are also used, enabling decision makers to respond to improved understanding of the resource (e.g. new data through drilling, surface feature trends, modelling). There is also a case for a less precautionary approach in Development Systems, and for exploration drilling, where risks can be managed.

Limits to use are another common tool under the RMA that could be used more effectively. While limits are generally not prescribed or required, some regional plans specify limits to use and qualitative objectives (e.g. in Rotorua there is a limit to net take). These limits are usually set through modelling and because of community participation in planning processes. Environmental limits are envisaged as part of the NBA, as outlined in the Exposure Draft. These are the lower boundaries of a safe operating space but ideally should not equate to a bottom line (where significant and potentially irreversible harm to the environment occurs). Reliance on limits alone would not be ideal as this would create a race to the bottom where the use of all available resources above the limit is acceptable.

Setting very specific limits for geothermal would be complex, but it is possible and involves identifying attributes to be protected, modelling fluid and heat at depth, and limits to the extent and quality of sensitive and vulnerable surface features. The NBA exposure draft acknowledged that limits should or can be both qualitative and quantitative limits. For example, limits could specify net abstraction of fluid or heat or limits that reflect Mātauranga Māori and a Te Ao Māori perspective on the mauri of the resource. It is

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noted that the current purpose of environmental limits in the Exposure Draft specifies that limits relate to either or both ecological integrity of the natural environment and/or human health. We think it will be important to also recognise the biophysical matters such as pressure, temperature, flow and chemistry that is not ecologically related.

3.3 Partnerships with Māori

Perhaps the biggest change in the way geothermal has been managed in the last 30 years is the evolving Treaty landscape. There is not scope in this paper to properly traverse the impacts of colonisation on Māori rights and interests in geothermal, and Māori are best placed to comment on this. We make some broad observations only.

The RMA and the Local Government Act 2002 make quite explicit reference to Māori interests in resource management. RMA Section 6(e) requires that councils recognise and provide for the relationship of Māori and their culture and traditions with their ancestral lands, water, sites, wāhi tapu and other taonga and section 7 refers to their role as kaitiaki. Section 8 of the Act requires that councils consider the principles of the Treaty of Waitangi, which include, for example, the duty to consult and to act in partnership. To fully give effect to the RMA, there is therefore a high test on Council to work in close partnership with Māori in policy development, operationally and in decision making. Regulatory agencies and consent holders have a poor record of meaningful engagement, and the lack of capacity of Māori also creates a barrier to participation. However, best practice has evolved considerably, through legislative changes and improved capacity of Māori because of Treaty Settlement processes.

Several RMA tools assist this. There are 43 Iwi Management Plans (IMPs) in the Bay of Plenty and a similar number in the Waikato Region, and many of these make explicit reference to geothermal. The policies often seek the protection of taonga and management of adverse effects, but also that Māori are enabled to realise economic and social wellbeing through development of their resources. Protection of customary or traditional uses that remain part of everyday life are also advocated and are required by law under RMA s14(3)(c) of the. Unfortunately, these IMPs have not always been 'had regard to'. Early versions of IMPs were perhaps not directive or specific enough. A move as a result of reforms from 'have regard to' to give effect to under the NBA, as signalled in the exposure draft, will see a marked difference in the way these documents are written and also how statutory agencies give effect to them.

Treaty Settlements have also specifically addressed geothermal resources, however, the Waitangi Tribunal has not yet reported conclusively on Māori ownership rights in geothermal resources (Waitangi Tribunal Report Wai. 2358). Many individual Iwi have had their interest in and relationship with geothermal formally recognised by the Crown. There are multiple examples of Statutory Acknowledgements of geothermal resources (e.g. Ngati Tuwharetoa (Bay of Plenty), Affiliate Te Arawa iwi and hapu, Ngati Rangiteaorere). These Statutory Acknowledgements ensure iwi with a relationship with geothermal resources are properly engaged through planning and consent processes. However, they have had limitations in that they do not explicitly create a right or interest in geothermal, and Māori may feel that they do not give enough weight to their participation in decision making over those resources.

The RMA makes specific reference in section 14(3)(c) to customary rights in geothermal and regional plans give effect to this through specific provisions. This has typically been interpreted to mean low impact uses, such as taking water from surface features for bathing, steam for cooking, and use of features, healing etc. While regional plans reinforce this, the Act does not prioritise these uses from other uses, and as such, they are not always specifically protected through allocation limits that provide for customary uses first and as a priority. The RMA 'first in first served' philosophy does not lend itself well to providing for an ongoing interest of Māori in geothermal uses, especially where the resource may have constraints and are already 'over-allocated', in systems such as Rotorua.

The RM reforms have signaled a much greater expectation of the Government for partnership with Māori, including in policy and decision making (e.g. joint panels), co-management or go-governance agreements, future use of Mātauranga Māori in management and monitoring. For geothermal, this could mean co-design of geothermal policy frameworks such as SMPs, a Te Ao Māori perspective on the wellbeing of the resource and the interconnectedness of geothermal resources with community wellbeing. There will also be greater use Mātauranga Māori indicators in monitoring programs, and the use of Mātauranga Māori models.

3.4 System Management Plans – a tool for integrated and sustainable management

System management plans are a commonly used tool under regional policy statements and as required by regional plans. They encourage and document, among other things, the thinking, discussion, and agreement about the expected state of the geothermal system and the path to this state. They present an integrated approach to geothermal management, as anticipated by the RMA and in many ways are consistent with Te Ao Māori.

Geothermal SMPs were first contemplated during the development of regional policy statements and regional plans. They were considered in detail by the Environment Court in 2005 when various parties appealed changes to the Waikato RPS and the Proposed Waikato Regional Plan (Environment Court, 2006). The Environment Court endorsed the use of an SMP and a peer review panel for Development Geothermal Systems. The SMP was to be prepared by applicants during the consent process, setting out how the system was going to be developed and managed, e.g., identifying development stages, reinjection sites, future sources of energy and managing adverse effects. The peer review panel is to be established by the Regional Council and the panel charged with overseeing the implementation of the SMP and providing expert advice and recommendations to the Regional Council regarding system management. The SMP was specifically to include processes for preparation, amendment, and review, and providing for operational flexibility and adaptive management, so that a formal 'change' of resource consent conditions was not required. The SMP also requires reservoir and subsidence modelling, reinjection/injection and a discharge strategy, and research, monitoring and reporting provisions.

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In 2010 a Board of Inquiry (BOI) was established to explore a National Policy Statement for Renewable Electricity Generation. The BOI considered the WRC policy and planning provisions for allocating and managing geothermal and found that they provide certainty for those applying them and have a robust policy foundation (BOI 2010). Therefore, the Board endeavoured to use the WRC approach to establish a policy platform for the allocation and management of known geothermal resources under the RMA to promote their allocation and use for electricity generation throughout New Zealand (BOI 2010). However, when Cabinet considered the BOI recommendations in 2011, the proposed geothermal provisions were removed as Cabinet considered that the high temperature geothermal was concentrated in three areas of the country, and there was ongoing collaboration between the relevant local authorities resulting in a nationwide best practice approach.

The current Waikato RPS in clause "9.3.1 Large-scale takes and use" prescribes the contents of the required SMP, and the required Discharge Strategy (Waikato Regional Council 2016). (The Bay of Plenty RPS contains similar provisions.)

In the Bay of Plenty, SMPs are also used for other systems where there are multiple users and a high level of take. System management plans are also currently being developed for Rotorua and Tauranga Systems. For these systems, there is a strong case for close collaboration and even co-design with Māori, given the strong relationship, Māori have with geothermal. System management plans are likely to endure under new legislation and are also likely to evolve, to move away from being entirely technical documents designed to support consenting, to documents that reflect a Te Ao Māori view, and an integrated approach to management.

3.5 Resource use approaches in Development Geothermal Systems

As interest in geothermal development continued to grow in New Zealand, predominantly within the Taupō Volcanic Zone, issues emerged as the geothermal system classifications prevent new development from being undertaken in Protected Systems. In responding to the classifications, the primary approach of the geothermal industry is to increase resource use efficiency and maximising outputs of Development Geothermal Systems and identifying the opportunities beyond power generation.

One option prompted was further staged exploration and development of different zones within one geothermal system. The approach may be to explore and develop separate geothermal fields within a geothermal system or targeting deeper zones and commissioning multiple power stations. A single developer is ideal for a given geothermal system in order to reduce competing interests and to avoid the resource being completely exhausted (although Kawerau is an example of a successful 'multi tapper' system) Current applications of this strategy are observable in systems such as Wairakei-Tauhara, where five power stations have been installed and there is still pending current development of the Tauhara II Power Station, and Rotokawa, where two power stations exist. A staged development approach accommodates future opportunities in geothermal development with the advancement of science and technological capabilities, such as plans to research and explore deeper supercritical resources that have recently gained interest and support through Geothermal: The Next Generation (Chambefort et al., 2019).

Geothermal resource use exists beyond water take for power generation, with direct use opportunities providing an alternative. The process involves directly utilising geothermal fluid or taking heat through a heat exchanger. Tourism and direct use activities related to bathing and commercial and personal uses have long been practiced, with examples being the use of WK1 for Wairakei Resort Hotel (Carey et al., 2018) and the instalment of domestic geothermal bores for hot water use and space heating in Taupo and Rotorua (Curtis, 1988; Lebe, 2020; Morris, 1995). Industiral scale direct heat use has also been enabled in some Development Systems (e.g. wood processing, tissue products, milk processing etc at Kawerau). Some direct use activities involve secondary users utilising geothermal fluids from nearby power stations, with examples including but not limited to:

- Wairakei-Tauhara: relatively cooler injection line waters (180 °C) used for aquaculture, bathing pools, timber drying, wood pellet fuel manufacturing, hospital space heating (Carey et al., 2018; Climo et al., 2020).
- Kawerau: utilising geothermal process steam for timber drying, co-generation, chemical plant, tissue mill, milk processing, greenhouse, and swimming pool (Bloomer, 2015, Climo et al., 2020).
- Mokai: using clean steam from high enthalpy wells for milk powder production and greenhouse (Taylor, 2011).
- Ohaaki: pilot project by Geo40 to extract colloidal silica from separated geothermal fluid (Climo et al., 2020).

Direct use activities, as listed in examples above, are sustainable as they rely on pre-existing fluid takes and may avoid further adverse effects on the deep reservoir conditions and Significant Geothermal Features while creating economic opportunities.. As recorded in the Waikato Regional Plan section for geothermal, this requires coordination between the power generators as the primary resource developers, with other stakeholders within the system. Further evaluation on the potential of direct use applications in other Development Systems where this approach has not been applied, such as in Ngatamariki and Rotokawa, could potentially open up more resource use opportunities for future generations. We do not anticipate that RM reforms will limit these opportunities, but we should ensure technological advances are not constrained.

3.6 Information Management and Peer Review Panels as a tool for effective and efficient management

Upon the RMA coming into effect in 1991, regional councils (Waikato Regional Council, 1992) recognised the importance of having unrestricted access to high-quality data and information to support quality decision-making and policy development for sustainable management of geothermal resources. However, resource developers are reluctant to have their commercially sensitive information (generated under resource consents) in the public domain. The RMA provides only limited protection for commercial or culturally

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sensitive information under s 42 (which applies to information used as part of a proceeding under the Act); otherwise, the Act has a freedom-of-information approach to environmental information (see RMA s 35). Therefore, resource consent holders seeking to protect commercially sensitive information must rely on the Local Government Official Information and Meetings Act 1987 s 7, which is at the regional council's discretion to apply in the protection of information. Historically, this issue has resulted in potential barriers for regional councils accessing full resource consent holder-generated information and data under resource consents, and Bay of Plenty and Waikato Regional Councils take a slightly different approach to this matter. In the Bay of Plenty, this is primarily because multiple resource consent holders utilise the same geothermal system (Kawerau). Both Waikato and Bay of Plenty geothermal policies and plans acknowledge that information challenges create uncertainty in managing the resource (Bay of Plenty Regional Council, 2015; Waikato Region Council, 2016 and 2007).

Another issue was the lack of individuals with technical knowledge of geothermal geoscience and engineering working within regulatory bodies. The solution taken was to form a "Peer Review Panel" (PRP) consisting of independent technical experts to provide recommendations to councils in the administration of resource consents. This PRP model was adopted from the case of the Golden Cross Mine in the Waitekauri Valley (Waikato Regional Council, 1997), where a PRP was formed due to a lack of technical expertise in mining within WRC. Today, Waikato and Bay of Plenty regional policy requires the operation of all resource consents (and their accompanying SMP) on Development Systems to be regularly reviewed by a dedicated PRP. While Northland regional policy does not specifically require PRP for large-scale geothermal use, in practice a PRP assists in managing the Ngawha geothermal system.

A typical technical PRP comprises of at least two experts, including a geothermal reservoir engineer and a combination of a geologist, geochemist, geophysicist, and in some cases an Iwi representative. The role of the PRP is to provide technical assessments and scientifically scrutinise all monitored activities, data collection, and methodologies and data results provided by resource consent holders. Commonly assessed data include but are not limited to reservoir data (production enthalpy, pressure, temperature, injection, etc.), reservoir model, daily fluid takes, fluid chemistry, surface feature monitoring, subsidence monitoring, and non-condensable gas discharge. Data are required to be presented to the PRP in a reproducible and easily used format. Monitoring reports are provided by the resource consent holders to the PRP through Regional Council and are commonly presented in a quarterly period. Other data monitored at different time periods may be presented at intervals conditioned on the given resource consent conditions and vary between the systems; an example is the four-yearly subsidence monitoring update conditioned for Wairakei-Tauhara. The reports and assessments are culminated in an annual PRP meeting between the Regional Council, resource consent holder, the PRP, and other interested stakeholders, where all issues raised within the management year are discussed with the objective of improving the resource management of the Development System. In Kawerau, the process has evolved in recent years and the four resource consent holders now collaborate to produce a combined annual report.

As partnerships with Māori become a normal part of doing business, the opportunity to better reflect Te Ao Māori, tikanga Māori and Mātauranga Māori in PRP processes and structures is likely to emerge. PRP's could also potentially take on local flavour and perform a function beyond overseeing consents. Instead, they could provide more oversight of integrated management and wider objectives such as the manner in which geothermal is contributing to social and cultural wellbeing. A model that includes tangata whenua at all levels of oversight is essential, and we expect to see both SMPs and PRPs evolve accordingly.

4 FURTHER COMMENT ON THE NATURAL AND BUILT ENVIRONMENT ACT AND STRATEGIC PLANNING ACT

The NBA Exposure Draft proposes a National Planning Framework (NPF) that will play a strategic role in providing direction on matters of national significance where national or sub-national consistencyis desirable, The NPF will help resolve conflicts across competing outcomes and between different planning instruments, for example between nationally significant infrastructure (e.g. for renewable energy) and sensitive natural environments. This has been an ongoing issues under the RMA and is particualry relevant for increased use of geothermal in the move to de-carbonisation.

The NBA will also require specific environmental limits and a range of outcomes for all aspects of wellbeing and the formulation of NBA plans for a region. A sister act, the Strategic Planning Act (SPA) will require Regional Spatial Strategies (RSS) . We already know that there is an inherent conflict between different outcomes if pursued in the same geothermal system, and that the current geothermal classification system is one way of resolving this issue by identifying systems where development can be enabled, and othere where natural values take precendence. Embedding the existing RPS system classification approach into Spatial Plans would reduce the need for lengthy re-litigation over system categories, and potentially this would also create an opportunity to consider constraints and opportunities for further development having regard to other resources, such as freshwater management, significant regional infrastructure, urban and industrial growth areas and other land uses.

It is also highly likely that other RMA tools such as SMPs, resource consenting for geothermal water and energy takes and discharges, and associated consent conditions, and permitted uses for Maori customary takes, will be inherited by the regional NBA Plans. In addition to NBA plans, SMPs are arguably a logical place to set and identify how environmental limits will be achieved and to propose targets that will progressively move the geothermal system state from the present to the identified desired state.

5. CONCLUSION

Thirty years of geothermal management under the RMA has seen the evolution of policy and best practice, developed through policy frameworks, consent processes and operationally by resource users. The current approach has been developed through trial and error, through community participation and through formal processes, such as appeals to the Environment Court. Tools that are now

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embedded in management include system classifications under RPSs, SMPs and operational approaches such as adaptive management, reservoir modelling and monitoring. Decades of experience in geothermal development has led to a strongly connected geothermal community with diverse skills sets, improved knowledge of the deep geothermal resources, technological advances in modelling and in engineering solutions, and long-term monitoring data on the effects of use on sensitive features. There is also now a greater expectation of genuine partnerships with Māori in all aspects of geothermal. Much of our experience and existing tools will remain fit for purpose as we enter a new era of regulatory reform, but opportunities will emerge to refine and improve our approach and to achieve sustainable management of geothermal resources.

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