

May 11, 2010

Environmental Mitigation Aspects of Water Resources in Geothermal Development: Using a Comparative Approach in Building a Law and Policy Framework for More Sustainable Water Management Practices in Canada

Kamaal Zaidi

Environmental Mitigation Aspects of Water Resources in Geothermal Development: Using a Comparative Approach in Building a Law and Policy Framework for More Sustainable Water Management Practices in Canada

By

Kamaal R. Zaidi

Abstract

Canada is embarking upon new renewable energy sectors such as geothermal energy. But with this new development comes environmental impacts upon its natural resources, particularly water resources. This paper explores geothermal energy development in the context of environmental mitigation measures for more sustainable water resources by comparing geothermal energy law and policy between the United States and New Zealand with the intent of establishing similar mitigation measures in Canada. These common law jurisdictions are chosen to discuss more mature legal regimes from the perspective of sustainable water resource management through environmental mitigation. The paper first describes geothermal energy development from exploration and drilling to power plant energy applications, and then explores the legal aspects of geothermal development. The paper examines the latest developments in geothermal law and policy in the context of sustainable water environmental mitigation in the U.S. and New Zealand, and comparisons are made with British Columbia, Canada's most active geothermal jurisdiction.

TABLE OF CONTENTS

1. Introduction	3
a. Research Question and Methodology	4
2. Geothermal Energy Development in the U.S. and New Zealand.....	5
3. The Impacts of Geothermal Energy on Water Resources and Environmental Mitigation Measures	9
4. Environmental Impact Assessment for Geothermal Water Resources	14
5. Legal Issues in Geothermal Energy Development in the U.S.	17
a. Best Management Practices	20
6. U.S. Federal and State Legislation for Geothermal Energy Development	21
a. <i>Rivers and Harbors Act (1899)</i>	<i>22</i>
b. <i>Geothermal Steam Act (1970)</i>	<i>24</i>
c. <i>Clean Water Act (1972)</i>	<i>26</i>
d. <i>Safe Drinking Water Act (1976)</i>	<i>26</i>
e. <i>National Environmental Policy Act (2005)</i>	<i>29</i>
f. Utah	31
g. California	33
i. The Geysers and Municipal Wastewater Injection.....	35
7. New Zealand	36
i. <i>Resource Management Act (1991)</i>	<i>36</i>
ii. <i>Contact Energy Ltd. v. The Waikato Regional Council and The Taupo District Council</i>	<i>41</i>
iii. Wairakei Geothermal Power Station	44
8. Proposing a Canadian Regulatory Framework of Mitigation-Based Sustainable Geothermal Water Management Practices	48
a. <i>Canadian Environmental Assessment Act</i>	<i>48</i>
b. British Columbia	50
i. <i>Geothermal Resources Act</i>	<i>51</i>
ii. <i>Environmental Assessment Act</i>	<i>53</i>
iii. <i>Water Act</i>	<i>56</i>
iv. South Meager Geothermal Project	58
c. Proposed Environmental Mitigation Measures for Sustainable Water Management Practices in Canada’s Geothermal Sector	59
9. Conclusion	59

INTRODUCTION

Geothermal energy is becoming a more popular form of renewable energy to meet the increasing demands for electricity to reduce carbon dioxide emissions. Due to its natural abundance below the earth's surface, geothermal energy is being harnessed by a growing number of nations through regulatory policy and legislative frameworks. Despite the renewable nature of geothermal development as a cleaner source of energy compared to fossil fuels, some environmental concerns exist with potential impacts on water resources surrounding the geothermal site. Although Canada is becoming interested in geothermal development, it lacks any comprehensive federal or provincial legislative and policy framework that provides for environmental mitigation measures to help manage the use of geothermal-produced water in a sustainable fashion.

A frequently cited definition of sustainability is “development that meets the needs of the present without compromising the ability of future generations to meet their own needs”.¹ In the context of geothermal water management, sustainability means maintaining water quality (which affects the consumption of water) and water allocation (which is the efficient use of the amount of water in geothermal areas).² The benefit of sustainability is that it allows water resources to be used over a long period, prevents over-exploitation when there are poor monitoring measures, and maintains the commercial viability of geothermal wells.³ Because water contamination from industrial development affects human and animal populations around the geothermal site, adequate environmental mitigation measures are necessary to balance geothermal development with environmental safeguards against its harmful effects on water resources. Hence, a legal and

¹ United Nations General Assembly, Report of the World Commission on Environment & Development 42/187, Brundtland Report (1987), online: <<http://www.un.org/documents/ga/res/42/ares42-187.htm>>.

² Stephen J. Hoffmann, *Planet Water – Investing in the World's Most Valuable Resource* (John Wiley & Sons, Inc., 2009), at 243 [Hoffmann].

³ Lloyd Burton & Chris Cocklin, “Water Resource Management and Environmental Policy Reform in New Zealand: Regionalism, Allocation, and Indigenous Relations” (1996) 7 *Colo. J. Int'l Env. L. & Pol'y* 75.

policy framework is necessary for sustainable water management in Canada's emerging geothermal industry.

a. Research Question and Methodology

In this paper, the research question is what specific environmental mitigation measures can be used to contribute to sustainable water management practices in Canada's geothermal sector. In addressing this question, the factual background includes a comparative analysis of the environmental assessment processes and geothermal legislation and policies in common law jurisdictions with more mature and comprehensive legal and policy frameworks such as the United States and New Zealand. In the United States, geothermal energy has been used since 1956, while in New Zealand there has been geothermal energy development since 1950.⁴ The aim of this paper is to identify environmental mitigation measures that lead to sustainable water management practices in order to further the use of geothermal development in Canada.

This is why a comparative legal analysis is done - to improve Canada's legal system by drawing upon functional equivalents from other jurisdictions that achieve similar policy goals, and which may reveal ideas for domestic law reform.⁵ The author argues that Canada can draw from the environmental mitigation experiences in the U.S. and New Zealand to create similar water management approaches to improve sustainable water quality and use. These recommendations will help provincial and federal regulators and geothermal developers to facilitate sustainable geothermal energy development using sustainable water management practices considered in the environmental assessment process.

⁴ John W. Brooks, "Legal Problems of the Geothermal Industry" (1966) 6 Nat. Resources J. 511 at 512.

⁵ John C. Reitz, "How to do Comparative Law" (1998) 46 Am. J. Comp. L. 617, at 620. Reitz considers good comparative analysis to include an overview of the similarities and differences among various legal systems, and which includes "functional equivalence". This is an explicit comparison made between legal systems for a well-defined issue. A good comparative analysis also requires the comparator to study the degree to which there are or are not functional equivalents, which prompts the question of how one legal system could help another legal system achieve the same result by appreciating the interrelationship between different areas of law, particularly between substantive and procedural law. Ultimately, one compares each country's legal system to understand how that nation achieves an ideal. Transplanting foreign law into one's own legal system for the purpose of domestic law reform may not be absolute, as it must be done in a way that is acceptable within the limits of a domestic legal system.

Section 1 explores geothermal energy development by explaining the science and technology that leads to its various uses. Section 2 describes the various environmental impacts of geothermal development, with a particular focus on water resources. Section 3 covers the legal issues associated with water rights and its link with geothermal development and environmental mitigation. Sections 4 and 5 conduct a legal and policy comparative analysis of environmental mitigation measures of geothermal water resources in the U.S. and New Zealand. The relevant literature (including federal and state legislation, case law, law review articles, and government reports) will be surveyed to discuss how environmental mitigation measures lead to sustainable water management practices. Two examples of sustainable water management practices will be discussed - the Geysers in California and the Wairakei Geothermal Power Station in New Zealand. Section 6 then explores the environmental assessment process in Canada and British Columbia, and uses comparative analysis to build environmental mitigation measures that can lead to sustainable water management practices in Canada's geothermal sector.

1 - GEOTHERMAL ENERGY DEVELOPMENT IN THE U.S. AND NEW ZEALAND

Geothermal energy is defined as natural heat from the earth's core that can be recovered from geothermal activity in and near volcanoes, hot springs, geysers, and boiling mud.⁶ Geothermal resources produce both water and steam (known as geothermal fluids) from high and low temperatures areas, in regions known as geothermal fields.⁷ Low-temperature water (less than 150°C) is used for heating, while high-temperature water is designated for electricity generation.⁸ The water and steam is separated in a pressure vessel known as the separator, and is

⁶ European Renewable Energy Council, *Renewable Energy in Europe* (James & James Science Publishers, 2004), at 32. High geothermal temperatures range between 30°C - 350°C. The ultimate source of the earth's heat comes from radioactive decay. See Owen Olpin, A. Dan Tarlock, and Car F. Austin, "Geothermal Development and Western Water Law" (1979) 2 Utah L. Rev. 778.

⁷ *Ibid.*

⁸ *Ibid.* at 33. The most common high-temperature technologies for power generation are: (1) flash steam power plant; (2) binary cycle power plant; and (3) combined flash and binary cycle plants. Flash steam power plants are the most common type of geothermal power plant, and operate normally between 5 - 100 megawatts of electrical power (MWe). Binary cycle power plants operate between 100 - 200°C.

piped to a power station to drive turbine engines that produce electric power.⁹ The separated water (known as brine) is either used in a power station, or re-injected back into a geothermal reservoir.¹⁰

Near the geothermal power station, water from underground sources of rivers, lakes, and streams is extracted as geothermal heat using a geothermal pump to transfer heat to the earth's surface.¹¹ Excess geothermal fluids produced at a well-site (particularly during well testing) can be evaporated in a reserve pit, or possibly re-injected into the underground geothermal reservoir.¹² Geothermal fluids are unevenly distributed in the earth's crust, and may be found at depths too great to be extracted through industrial means such as exploration and drilling. However, many countries are found in regions where magma (hot molten rock) is pushed up through faults and cracks near the earth's surface, creating "hot spots" within 2 - 3 kilometres of the earth's surface.¹³

Due to technological and economic constraints, extracting geothermal resources is limited to within the upper few kilometres of the earth's crust, depending upon the location of development.¹⁴ A survey of temperatures, reservoir volumes, permeability (flow) of hot water and steam at various depths, is necessary to plan any geothermal drilling activity. Generally, there are a number of exploration techniques to locate geothermal areas and recover geothermal

⁹ *Ibid.* at 35.

¹⁰ *Ibid.*

¹¹ *Ibid.*

¹² *Ibid.*

¹³ G.N. Tiwari & M.K. Ghosal, *Fundamentals of Renewable Energy Sources* (Oxford: Alpha Science International Ltd., 2007) at 399. Geothermal fields are found where oceanic plates converge with continental plates in the following regions: (1) Japan (between the Pacific plate and the Eurasian plate); (2) Indonesia (Indian-Australian and Eurasian plates); (3) New Zealand (Pacific and Indian-Australian plates); and (4) Chile and Central America (Nazca and South American plates). Countries that lie along boundaries of tectonic plates with volcanic activity have natural geothermal reservoirs (such as hot springs and geysers) from which to harness energy, as these areas produce heat, pressure, and steam. Those nations in unstable regions along the Pacific "ring of fire" area are best known for their geothermal potential, but geothermal energy can be tapped anywhere with the proper technology and financial resources. At present, geothermal energy is used in approximately fifty-eight countries around the world, and is growing in popularity since it produces lower carbon dioxide emissions relative to fossil fuels.

¹⁴ *Ibid.* at 401. This is because the deeper one drills, the more costly is the drilling operation since more equipment is required. On average, geothermal wells are drilled to less than five kilometres from the earth's surface.

energy: (1) inventory and survey of land surfaces; (2) geological and hydro-geological surveys; (3) geophysical and geochemical surveys; and (4) exploratory wells (for core drilling or drilling for seismic studies).¹⁵

The inventory and survey of land surfaces allows scientists to study surface thermal phenomena of hot springs, steam vents, and geysers, as well as the chemical properties of the underlying soil and bedrock.¹⁶ Geological surveys use field data to locate geothermal reservoirs, while hydro-geological surveys provide information on the distribution and movement of groundwater in the soil and rocks of the underlying earth's crust.¹⁷ Geochemical surveys involve water sample collection from hot springs, fumaroles, and hot pools for chemical analysis.¹⁸ The goal of geothermal developers is to use these exploration techniques to connect geothermal wells with fluid-filled fractures in order to collect essential geothermal fluids for both direct and indirect energy uses for consumers and industry. Direct use of geothermal energy refers to the immediate use of heat or cold energy in residential and commercial buildings, while indirect use refers to the generation of electricity from the earth's heat from geothermal power plants.¹⁹ Under these conditions, geothermal fluids are extracted using a continuous supply from the earth's core for geothermal power plants to produce energy without burning fossil fuels, thereby producing lower carbon dioxide emissions.²⁰

In the U.S. and New Zealand, direct uses of geothermal water resources provide for:

- district heating and cooling in residential homes and commercial/industrial buildings;
- swimming, bathing, and balneology (tourist hot springs and medical therapy);
- agriculture (e.g. greenhouse heating); and
- aquaculture (fish, prawn, and alligator farming)

¹⁵ *Ibid.* at 428.

¹⁶ *Ibid.* at 424.

¹⁷ *Ibid.* Hydro-geological surveys thus reveal temperatures and salinity of geothermal fluids. This information will help developers decide whether or not to develop a drilling plan for such an area.

¹⁸ *Ibid.* at 425.

¹⁹ *Ibid.* at 430.

²⁰ Oregon Department of Geology and Mineral Industries, Oregon's Geothermal Energy Potential in Spotlight, online: DOGAMI <<http://www.oregongeology.org/sub/news&events/archives/OreognGeothermal.pdf>>.

District heating and cooling starts from a central location and supplies water or steam through a network of pipes to homes or buildings.²¹ In this way, the heat can be used by residential homeowners in winter, while providing cool air in the summer months by re-injecting heat into underlying pipelines.²² District heating systems also reduce electricity costs for homeowners and businesses, and in the U.S. residential homeowners save 30-50 percent on their natural gas heating bills.²³ Geothermal energy is used to heat public swimming pools and bathing facilities for tourists at resorts. Alternative medical therapy spas use naturally heated water to treat diseases, a practice known as balneology.²⁴ Geothermal energy is also useful for agricultural purposes, including: (1) greenhouse heating; (2) animal husbandry; and (3) soil warming.²⁵ Greenhouse heating improves the climate for growing crops indoors (particularly in cold climates), while also helping raise livestock (such as fish, prawns, and alligators) in aquaculture operations, as the temperature of ponds is better controlled through continuous underground heat than through conventional means.²⁶ Soil warming helps cultivate field crops for longer periods during the year to increase the yield that would not occur in colder climates.²⁷ Farmers in California rely on re-used, nutrient-filled geothermal wastewater from streams flowing from dual water systems (potable and wastewater) to grow crops and for aquaculture.²⁸

There are various types of geothermal power plants which use water, including: (1) dry steam power plants; (2) flash steam power plants; (3) binary cycle power plants; and (4) fossil

²¹ *Ibid.* at 431.

²² *Ibid.*

²³ U.S. Department of Energy (DOE), Energy Efficiency and Renewable Energy, Geothermal Technologies Program, Direct Use of Geothermal Energy, online: DOE <<http://www1.eere.energy.gov/geothermal/directuse.html>>.

²⁴ John W. Lund, "Spas and Balneology in the United States", online: Geo-Heat Center <<http://geoheat.oit.edu/pdf/bulletin/bi034.pdf>>.

²⁵ *Ibid.*

²⁶ *Ibid.* At present, thirty-eight greenhouses using geothermal energy for heat and light to raise vegetables, flowers, and tree seedlings in eight western states in the U.S., while there are twenty-eight aquaculture operations in ten states.

²⁷ Mouldi Ben Mohamed, "Multiple Integrated use of Geothermal Resources in the Kebili region, southern Tunisia" (Paper presented at the International Geothermal Conference, Reykjavik, Iceland, September 2003).

²⁸ United Nations, *World Water Development Report 3 - Water in a Changing World* (UNESCO, 2009), at 142.

hybrid power plants.²⁹ Dry steam power plants extract geothermal fluids from the geothermal reservoir through a well, directing the water and steam toward a turbine engine, which produces electricity.³⁰ Flash steam power plants (which are the most common type of plant) use hot water (around 182° C, or 360° F) that is pumped under high pressure to the generation equipment at the surface.³¹ Binary cycle power plants use hot water or steam by passing it through a heat exchanger in a closed-loop system, using a secondary fluid (isobutene) which vaporizes to turn the turbine engine.³² Given these uses of water in geothermal development, it is important to discuss some of the environmental impacts of geothermal energy on water resources, which lead to environmental mitigation measures that can help preserve this valuable resource.

2- THE IMPACTS OF GEOTHERMAL DEVELOPMENT ON WATER RESOURCES AND ENVIRONMENTAL MITIGATION MEASURES

The following section discusses the environmental impacts produced by geothermal development on water resources that are common in the U.S. and New Zealand, and explores the mitigation measures used to reduce the harmful effects of geothermal activities on the surrounding water resources.

For geothermal development, water is an essential resource that is used during four stages - reconnaissance, exploration, drilling, and resource production.³³ Initially, water helps compact the soil during construction of the geothermal well.³⁴ Exploration and drilling of geothermal fluids then requires the removal of a large amount of water from underground geothermal reservoirs, a process which may lower water tables in the immediate area, while causing land

²⁹ *Ibid.*

³⁰ U.S. Department of Energy (DOE), Energy Efficiency and Renewable Energy, Hydrothermal Power Systems, online: DOE <<http://www1.eere.energy.gov/geothermal/powerplants.html>>.

³¹ *Ibid.*

³² U.S. Department of Energy, Geothermal Technologies Program, online: DOE <<http://www1.eere.energy.gov/geothermal/powerplants.html>>.

³³ Deloitte, Department of Energy – Office of Energy Efficiency and Renewable Energy Geothermal Program, Geothermal Risk Mitigation Strategies Report (15 February 2008), online: Deloitte <http://www1.eere.energy.gov/geothermal/pdfs/geothermal_risk_mitigation.pdf>.

³⁴ Mary H. Dickson & Mario Fanelli, *Geothermal Energy: Utilization and Technology* (Earthscan Publications, 2005), at 160 [Dickson & Fanelli Geothermal].

surfaces to subside (known as land subsidence).³⁵ Geothermal development has several negative impacts on water resources. First, water contamination of rivers, lakes, and streams may occur due to effluent flowing from the geothermal power plant. Both surface waters and groundwater sources can be affected by the fluid discharges containing toxic chemicals (such as arsenic, mercury, and lead), that can collect within water reservoirs.³⁶ During geothermal energy activities that separate water and steam, the disposal of wastewater into the ground may contaminate groundwater sources, or the storage of this wastewater may be held in holding ponds or sumps (from which it can leak into surface waters).³⁷ Second, when water is discharged as bore water or condensate from a geothermal field into a local river or stream, it alters the water chemistry of surface and groundwater sources, thus affecting aquatic ecosystems and territorial communities that consume these resources.³⁸

Discharged waste can affect water quality. In *United States v. Republic Steel Corp.*, the U.S. Supreme Court held that solid waste material discharged into the Calumet River (which flows into the larger Mississippi River) by industrial companies is forbidden under section 10 of the *Rivers and Harbors Act* because it obstructs the navigable waters.³⁹ This case demonstrates how the courts have prevented industrial companies from dumping waste materials into river systems that would adversely affect other waterways, thereby creating significant environmental impacts in other communities and ecosystems. This decision prompted a permitting process that provides an effective monitoring mechanism for developers whose activities directly affect water resources. Essentially, industrial development affecting water resources that connect with other waterways would no longer go unchecked.

³⁵ *Ibid.* at 524. This problem can be remedied by re-injecting geothermal fluids back into the ground through rock pores. A geothermal developer may also dig very deep into the ground to cause slumping or landslides.

³⁶ Dickson & Fanelli Geothermal, *supra* note 34 at 162.

³⁷ *Ibid.*

³⁸ *Ibid.* Contamination of water sources with heavy metals goes beyond drinking supplies, as it affects food quality (where metals such as cadmium can be found in rice grains). See United Nations, *World Water Report 3 – Water in a Changing World* (UNESCO, 2009), at 139.

³⁹ *United States v. Republic Steel Corp.*, 362 U.S. 482 (1960).

Third, surface water bodies may be contaminated from: (1) surface discharges (where coolant water contains concentrated salts and metals from geothermal plants); (2) spills of geothermal fluids that contain arsenic; or (3) underground contamination of hot springs that feed a surface water body and penetrate other lands through underground aquifers or precipitate on surfaces⁴⁰ The coolant water may also contain metals from corroding pipes or chemical additives used to inhibit corrosion or microbial growth in the system.⁴¹ These activities may affect riparian and wetland habitats, where changes in hydrology due to the accidental spill of geothermal fluids can affect vegetation, which ultimately affects fish and wildlife species consuming this vegetation.⁴² When liquid effluent is discharged, arsenic contamination can pose a public health risk.⁴³

High concentrations of arsenic in water can lead to chronic or acute poisoning in humans who drink from local water supplies, in animals who graze on farms, and in aquatic plant species growing in the river itself.⁴⁴ In regard to the Waikato river system in New Zealand, one commentator studied the impact of geothermal activities at the Waikareki Geothermal Power Station on local water resources, and found that the geothermal plants in this region contributed 40% of arsenic contamination in the river system.⁴⁵ Fourth, the enormous amounts of water needed for geothermal production may deplete water resources in that area. This leads to a loss

⁴⁰ Final Programmatic Environmental Impact Statement for Geothermal Leasing in the Western United States (October 2008), online: <http://www.blm.gov/pgdata/etc/medialib/blm/wo/MINERALS__REALTY__AND_RESOURCE_PROTECTION_/energy/geothermal_eis/final_programmatic.Par.95063.File.dat/Geothermal_PEIS_final.pdf> [Final Programmatic EIS].

⁴¹ *Ibid.*

⁴² *Ibid.* at 4-65.

⁴³ Alper Baba, "Environmental Impact of the Utilization of a Geothermal Area" (2004) *J. of Istanbul Kultur University* 35. See also A.J. Ellis, "Environmental Impact of Geothermal Development" (1978), Report prepared for the United Nations Environmental Programme UNEP.

⁴⁴ Jenny G. Webster-Brown & Vincent Lane, "The Environmental Fate of Geothermal Arsenic in a Major River System" (Paper presented to the International Geothermal Association at the Proceedings of the World Geothermal Congress at Antalya, Turkey, 24 April 2005) [Arsenic Contamination].

⁴⁵ *Ibid.*

of the natural underground thermal properties such as geysers or hot springs, areas that may serve as tourist attractions.

Based on the negative impacts, environmental mitigation measures were introduced to avoid, reduce, remedy or compensate for any significant adverse environmental impacts.⁴⁶ During the environmental assessment process, specific environmental mitigation measures are considered by regulating authorities to create more sustainable water management practices by maintaining water quality and water allocation. To facilitate these mitigation measures, environmental impact assessments are conducted by administrative agencies to evaluate the overall effects of industrial development on surrounding ecosystems and human populations. From a geothermal perspective, the purpose of environmental mitigation is to balance resource development with environmental conservation and protection, but it also encourages the recycling of water itself. For instance, when geothermal fluids are re-injected into the geothermal reservoirs, external water sources are not required to replenish water for further energy production.

To safeguard against adverse environmental impacts on water resources produced by geothermal development, the following environmental mitigation measures are used in the U.S. and New Zealand as provided under legislation and regulations:

- storage and drainage of wastewater in holding ponds;
- water extraction and discharge practices (e.g. coolant replacement);
- well-casing at drilling sites;
- re-injection of geothermal fluids into geothermal reservoirs;
- aquifer testing;
- regular monitoring of chemical and physical properties of surface and groundwater

Storage and drainage of wastewater in holding ponds serves many benefits. First, it helps contain large quantities of water that evaporates in holding ponds or lagoons, and thereby prevents flooding into surrounding areas. Second, to preserve the quantity of water that is used

⁴⁶ John Glasson, Riki Therivel & Andrew Chadwick, *Introduction to Environmental Impact Assessment*, 3rd ed. (Routledge, 2005), at 5 [Glasson, Therivel & Chadwick].

during the four stages of geothermal development, water is stored in holding ponds lined to prevent infiltration of discharged contaminated water into other groundwater sources.⁴⁷ Storage and drainage of water also includes storm water management plans, which are employed in both the U.S. and New Zealand to preserve water quality and restore waterways.⁴⁸ Water extraction and discharge also allows for a controlled method of drawing water from groundwater sources, while releasing specific amounts of water as a discharge to be transported to other locations.⁴⁹ Coolant water containing salts and metals is discharged from geothermal plants, and must be replaced periodically to lower its impacts on surface and groundwater sources.⁵⁰

Well-casing is a mitigation measure that involves specialized pipe surrounded by cement to prevent cross-contamination of water as the geothermal fluid is injected back into the ground.⁵¹ The casing creates a permanent seal around the borehole so as to avoid having the extracted geothermal fluids from leaking into adjacent underground sources.⁵² Well-casing is normally used upon well completion, which ultimately separates geothermal fluids from any shallower aquifers that a borehole may pass through.⁵³ Re-injection is a mitigation measure that transfers discharged water from geothermal plants, and injects it through re-injection wells to underground geothermal reservoirs to preserve the quantity of this resource within a given area. Re-injection preserves water by recycling it from the surface to underground sources to the underground geothermal reservoir. Re-injection prevents wastewater from contaminating surface water systems, and affecting the quality of water in adjoining rivers, streams, and lakes.⁵⁴ By

⁴⁷ Final Programmatic EIS, *supra* note 40 at 4-45.

⁴⁸ United States Environmental Protection Agency, online: U.S. EPA <<http://www.epa.gov/greeningepa/stormwater/index.htm>>.

⁴⁹ *Ibid.*

⁵⁰ *Ibid.*

⁵¹ Alyssa Kagel, Diana Bates & Karl Gawell, A Guide to Geothermal Energy and the Environment, online: <<http://www.geo-energy.org/reports/Environmental%20Guide.pdf>>.

⁵² *Ibid.*

⁵³ *Ibid.*

⁵⁴ *Ibid.*

preserving water resources through re-injection, all waterways will be continually replenished, and can be used as potable drinking water for nearby cities or towns.

Aquifer testing is a mitigation measure that provides information about sub-surface hydrological properties to improve groundwater flow, identify contaminants, and maintain adequate levels of water in a given area.⁵⁵ This prevents a reduction in the water table in surrounding waterways that connect with other streams or springs.⁵⁶ Without aquifer testing, discharges of water are not accurately monitored, and geothermal wells become pathways for geothermal fluids to migrate to other aquifers, and can affect groundwater quality in an area.⁵⁷ This is why regular monitoring of chemical and physical properties helps protect water resources from the impacts of geothermal development. Relevant data collected from aquifer pumping tests will aid geothermal developers to complete a subsurface geophysical investigation to analyze local hydrological conditions.⁵⁸ Once this information is gathered, the developer will forward same to a regulatory agency, and, thereafter, a monitoring program will be formally established to prevent adverse impacts of geothermal activities through mitigation measures.

3 - ENVIRONMENTAL IMPACT ASSESSMENTS FOR GEOTHERMAL WATER RESOURCES

This section discusses the role of environmental impact assessments in the context of geothermal development and water management in the United States. Although environmental assessments involve several factors, this section focuses only on water resources affected by geothermal development.

⁵⁵ The California Environmental Protection Agency (EPA), *Aquifer Testing for Hydrogeologic Characterization – Guidance Manual for Ground Water Investigations* (July 1995), online: California EPA <www.dtsc.ca.gov/sitecleanup/upload/SMP_Aquifer_Testing.pdf>. Aquifers are defined as a geologic formation that contains permeable material sufficient to yield significant quantities of water to wells and springs. See Michael Rasenow, *Aquifer Tests Data: Analysis and Evaluation* (Water Resource Publications, 2006).

⁵⁶ *Ibid.*

⁵⁷ *Ibid.* at 4-46.

⁵⁸ *Ibid.*

Due to the varying environmental impacts on human and natural environments, Environmental Impact Assessments (EIA) are routinely conducted by regulating authorities in the U.S.A. to provide countermeasures that would balance development with protection or conservation.⁵⁹ An EIA is an administrative process (defined by legislation) that evaluates a broad spectrum of potential environmental, socio-economic and health effects of a proposed development project on human and natural environments.⁶⁰ For geothermal development, the EIA submitted by a developer allows the regulating authority to decide whether or not to approve of the project. This evaluation process is subject to a public consultation where technical information gathered by prospective developers is assessed by all interested parties as to the impacts of their proposed activities on the local air, soil, and water sources.⁶¹

Generally, legislation dealing with an EIA includes three elements: (1) impact assessments prior to development; (2) consent/permit applications; and (3) regular monitoring of pollutant discharges.⁶² Many decisions made by public officials during an EIA depend on balancing the economic benefits flowing from the geothermal project (e.g. production of energy) against the potential harm produced on the local environment from these activities.⁶³ These decisions are based on local issues (e.g. impacts on the local drinking water supply) or national issues (e.g. preservation of a unique geothermal feature in a national park).⁶⁴ Once an EIA is completed, public officials may do three things: (1) impose monitoring programs that require developers to detect the actual effects of development; (2) develop environmental mitigation measures prior to development; or (3) reject the project. In the context of evaluating the impacts of geothermal development on water resources, an EIA is to evaluate the water quality by quantifying the

⁵⁹ M.J. Heath, Environmental Aspects of Geothermal Energy Resources Utilization, IAH Congress on Groundwater and Human Development (October 2002), online: <<http://pages.constructionplus.net/mjheath/geothermal.htm>>.

⁶⁰ Final Programmatic EIS, *supra* note 40 at 4-45.

⁶¹ *Ibid.*

⁶² Dickson & Fanelli Geothermal, *supra* note 34, at 168.

⁶³ *Ibid.*

⁶⁴ *Ibid.*

concentration of contaminants in ground and surface waters, the dispersion of discharged wastewater to surrounding areas, and hydrological properties of geysers and hot springs. In the U.S., once a proposed project triggers the *National Environmental Policy Act (NEPA)*, state regulations direct regulating agencies to decide whether such a proposal is one which “normally requires an environmental impact statement”.⁶⁵

If so, an EIA must be prepared, otherwise an Environmental Assessment (EA) is prepared.⁶⁶ An EA leads to one of two decisions: (1) that the proposed action will not result in significant impacts to human and natural environments (in which a Finding of No Significant Impact, or FONSI will be issued); or (2) that the proposed action will result in significant impacts to the human environment, in which case an EIS is prepared.⁶⁷ This is important because most decisions for proposed actions ending in a FONSI have environmental mitigation measures recommended as a means to avoid significant impacts. These mitigation measures may not be required as a matter of law, but are required if an EIS is to be avoided.⁶⁸ Actions that require leases, permits, pipelines, and rights-of-way for major reservoirs require an EIS.⁶⁹

NEPA requires that detailed environmental data be available to regulators and citizens before any decision is made or action is taken for a proposed industrial project.⁷⁰ Typically, the scope of an EIA in the U.S. includes a detailed description of the physical characteristics of the surrounding landscape, expected residues and emissions, and an outline of reasonable alternatives for the project to be carried out by the developer.⁷¹ EIAs are useful because they identify and mitigate foreseeable environmental effects on natural and human populations from

⁶⁵ Joan E. Drake, “The NEPA Process: What Do We Need To Do and When?” (Paper presented for the Rocky Mountain Mineral Law Foundation at the Special Institute on NEPA and Federal Land Development, Denver, Colorado, 2-3 February 2006) [Drake].

⁶⁶ *Ibid* at 3-8.

⁶⁷ *Ibid*.

⁶⁸ *Ibid*.

⁶⁹ *Ibid*.

⁷⁰ Sue Goff, “The Effective Use of EIA for Geothermal Development Projects” (Paper presented to the International Geothermal Association at the Proceedings of the World Geothermal Congress at Kyushu, Japan, 28 May 2000).

⁷¹ *Ibid*.

the activities on a geothermal site. In considering these environmental impact assessments, it would be helpful to discuss some specific legal issues affecting geothermal water rights.

a. Legal Issues Affecting Water Resources in Geothermal Development

This section will briefly discuss the law affecting geothermal development in the context of water rights in the United States. As sustainable water management relates to water availability, surface water rights (including riparianism and prior appropriation), groundwater rights, and federal water rights will be explored along with water mitigation measures. This discussion will acquaint the reader with the legal system of water rights allocation, and how federal law influences state law in this realm.

Water rights affect both surface water (e.g. running streams, lakes, ponds) and groundwater (found in aquifers, saturated soils, and not free-flowing bodies of subsurface water) independently.⁷² The law allocates water for uses as both “consumptive” and “non-consumptive”, where the former refers to the permanent removal of water from its source, while the latter refers to the removal of water from its source, but is recycled back.⁷³ There are two surface water rights – riparianism and prior appropriation.⁷⁴ Riparianism refers to the right to use a stream that borders upon a parcel of land owned by someone.⁷⁵ Water can be taken out of the stream for use on the riparian land, and this water right is secured by land ownership.⁷⁶ In contrast, prior appropriation refers to control over water rights using a “first in time, first in right” approach, where water belongs to the first person who puts it to beneficial use.⁷⁷ Used primarily in the western states where water is scarce, a party has senior rights to exact quantities

⁷² Eric Pearson, *Environmental and Natural Resources Law*, 3rd ed. (Matthew Bender & Company, Inc., 2008), at 117. Groundwater is defined as water which “occurs or moves, seeps, filters, or percolates through the ground under the surface of the land.” See *Metropolitan Utilities District v. Merritt Beach Co.*, 140 N.W.2d 626 (Neb. 1966) [Pearson].

⁷³ *Ibid.*

⁷⁴ *Ibid.* at 296.

⁷⁵ *Ibid.* at 297.

⁷⁶ *Ibid.* Under the “natural flow doctrine” of riparianism, one must justify the use of the water as long as it does not affect the natural flow of a stream, but this doctrine no longer applies.

⁷⁷ *Ibid.*

of water as long as it puts the water to beneficial use during a specified period.⁷⁸ Once an owner discontinues using that water, the right extinguishes.⁷⁹ Unlike the riparian system (which is based on the common law), prior appropriation rights are governed by state regulatory agencies. Geothermal resources that are considered to be groundwater, treat ownership rights under the doctrine of prior appropriation, while resources that are considered to be minerals, treat ownership rights under correlative rights.⁸⁰ In contrast, correlative rights refers to when adjoining landowners must limit their use of a common underground resource to a reasonable and proportionate share based on the extent of their surface ownership.⁸¹

Applying the doctrine of prior appropriation to water management in geothermal resources, seniority rights govern competing interests between developers over water resources by encouraging them to adopt efficient extraction methods. If a landowner fails to make beneficial use of a geothermal resource, the party may lose the right to extract geothermal resources in that area. But, a geothermal developer owns the water resource as a mere right of use if it uses water during a specified period, such as during a lease or permit.⁸² This is because in most U.S. jurisdictions, water (as a geothermal resource) is owned by the public, or is held in trust under federal or state law for the public.⁸³

Groundwater rights may be determined by land ownership (where the owner of the overlying land has the rights to extract a reasonable amount of water for use on that land), or by a prior appropriation system where rights are associated with a quantified and beneficial use.⁸⁴ Federal water rights are generally acquiesced to state law, but interstate water projects that

⁷⁸ *Ibid.*

⁷⁹ Stoel Rives, Lava Law – Legal Issues in Geothermal Energy Development, online: Stoel Rives <<http://www.stoel.com/webfiles/LawofLava.pdf>> [Stoel Rives Lava Law].

⁸⁰ *Ibid.*

⁸¹ *Ibid.*

⁸² *Ibid.*

⁸³ *Ibid.*

⁸⁴ *Ibid.* at 302.

connect to “navigable waters of the United States” trigger the federal Commerce Clause.⁸⁵

Interstate allocation of water rights occurs in three ways: (1) equitable apportionment (where a court can allocate waters flowing interstate equally among states having different allocation systems such as riparian and prior appropriation); (2) interstate compact agreements between states for waters in an interstate stream; and (3) federal water legislation (where Congress has the power to allocate water among states).⁸⁶

These legal principles are important because they describe how water rights are justified and regulated based on its use either within a state or across states. To use water resources in a geothermal area, geothermal permits or licenses are granted by federal or state regulatory agencies to prospective developers for proposed geothermal projects. In the U.S., ownership of geothermal resources below federal lands is retained in the federal mineral estate, but it may convey a right to a private party to develop the resource.⁸⁷ This means that the federal agency known as the Bureau of Land Management (BLM) grants access to geothermal lands through competitive leases for prospective developers, where the highest bidder is awarded the rights.⁸⁸

Both the BLM and the United States Forest Service (FS) require comprehensive mitigation measures to protect water resources for industrial development projects such as geothermal. The mitigation measures are couched under broad sustainable water management procedures known as Best Management Practices (BMPs).⁸⁹ The BMPs are used by developers on a site-specific basis to minimize the adverse environmental impacts produced by industrial activities, including

⁸⁵ *Ibid.*

⁸⁶ *Ibid.*

⁸⁷ Stoel Rives Lava Law, *supra* note 79.

⁸⁸ *Ibid.* As a rule, geothermal leases may not be issued in national parks, wildlife refuges or wilderness study areas, national recreation areas, and Indian reservations, mainly because Congress seeks to protect unique sites meant for public use. This is because any lease that is contrary to the public interest or hinders the performance of federal functions is not permitted. See generally Raymond J. Werner, “Geothermal Leases” (1975) 54 Or. L. Rev. at 627.

⁸⁹ Final Programmatic EIS, *supra* note 40 at 4-47.

geothermal energy.⁹⁰ When enforcing the BMPs, state BLM offices work with geothermal lessees early in the development process.⁹¹ Two BMPs are presently employed in the U.S. geothermal sector: (1) no surface occupancy on water bodies, riparian areas, and wetlands; and (2) controlled surface use within 500 feet of riparian or wetland vegetation to protect these areas.⁹² These two measures reduce the impacts of geothermal activities near water bodies (such as lakes), riparian areas (rivers used for fishing by local residents), and wetlands (wildlife and vegetation).

The BMPs prompt developers to understand the local hydrology to avoid creating hydrologic conduits between aquifers to avoid spreading contaminated water between underground sources of water.⁹³ Moreover, developers must develop a Storm Water Management Plan at the site to comply with local regulations.⁹⁴ BMPs contribute to sustainable water resource management because of the application of water preservation measures that prevent developers from creating more underground conduits between aquifers. The storm water management practices will restore the health of affected waterways, and protect water quality by preventing contamination with other groundwater sources. Through the BMPs and storm water management practices, geothermal developers can therefore reduce impacts in areas of surface and groundwater discharges.

4 - U.S. FEDERAL AND STATE LEGISLATION FOR ENVIRONMENTAL MITIGATION OF WATER RESOURCES

This section highlights the relevant federal and state legislation that create mitigation measures for sustainable water use in the United States. Key environmental statutes, policies, and

⁹⁰ *Ibid.*

⁹¹ *Ibid.* at Appendix D.

⁹² *Ibid.*

⁹³ *Ibid.*

⁹⁴ *Ibid.*

case law will be explored in the context of environmental assessment and geothermal development, which will lead to a discussion of state approaches.

In the U.S., geothermal energy is embodied in section 1501 of Title 30 of the *United States Code*: “The Congress finds that: (1) domestic geothermal reserves can be developed into regionally significant energy sources promoting the economic health and national security of the Nation; and (2) there are institutional and economic barriers to the commercialization of geothermal technology.”⁹⁵ Geothermal resources may be located on federal, state, local, or Indian lands, and are tailored for various purposes such as direct and indirect uses. With respect to water resources, water policy is shared between federal, state and local governments.⁹⁶ Over the years, Congress has enacted several forms of legislation relevant to the governance of sustainable water management resources for geothermal development, including the:

- *Rivers and Harbors Act*⁹⁷ (1899);
- *Geothermal Steam Act*⁹⁸ (1970);
- *Clean Water Act*⁹⁹ (1972);
- *Geothermal Energy Research, Development and Demonstration Act*¹⁰⁰ (1974);
- *Safe Drinking Water Act*¹⁰¹ (1976); and
- *National Environmental Policy Act*¹⁰² (2005)

In the U.S., the first meaningful statute governing water pollution control was the 1899 *Rivers and Harbors Act*, which set up a regulatory permitting process to bar developers from dumping refuse matter and dredge in “navigable waters of the United States” to foster interstate

⁹⁵ 30 U.S.C. §1501. At present there are seven states with geothermal power plants: (1) Alaska; (2) California; (3) Oregon; (4) Hawaii; (5) Utah; (6) Idaho; and (7) Nevada. *See generally* Colin F. Williams & Brenda S. Pierce, Geothermal Resource Assessment, online: USGS <http://energy.usgs.gov/flash/geothermal_slideshow.swf>. See also Raymond J. Werner, “Geothermal Leases” (1975) 54 Or. L. Rev. at 623.

⁹⁶ Hoffmann, *supra* note 2 at 17.

⁹⁷ *Rivers and Harbors Act*, 33 U.S.C. § 403.

⁹⁸ *Geothermal Steam Act*, 30 U.S.C. § 1001.

⁹⁹ *Clean Water Act*, 33 U.S.C. § 1251.

¹⁰⁰ *Geothermal Energy Research, Development and Demonstration Act*, 24 U.S.C. § 1101.

¹⁰¹ *Safe Drinking Water Act*, 42 U.S.C. § 300.

¹⁰² *National Environmental Policy Act*, 42 U.S.C. §4321.

commerce.¹⁰³ Developers would require a permit issued by the Army Corps of Engineers.¹⁰⁴

This measure derives from *Daniel Ball v. U.S.* (1871), where the U.S. Supreme Court established federal regulatory jurisdiction under a bipartite test against industrial developers which dumped waste into rivers and lakes.¹⁰⁵ This bipartite test included: (1) that the body of water be navigable in fact; and that (2) it must by itself, or with other waters form an interstate commerce highway with other states.¹⁰⁶ Congress thus expressed concern over industrial activities that affected major waterways connected to each other. This case serves as an essential precursor to modern environmental assessments in that federal agencies regulate how local development affects water resources in other locations as to water quality and allocation.¹⁰⁷

In 1970, Congress enacted the *Geothermal Steam Act* as the first piece of legislation designated for geothermal energy development.¹⁰⁸ This legislation serves as the basis for all geothermal laws in the U.S., and establishes the leasing process on federal lands for geothermal development. The primary term of a geothermal lease in the U.S. is ten years, but for leases issued prior to 8 August 2005, if geothermal steam is produced in commercial quantities within the lease term, the geothermal developer (lessee) may extend the primary term for up to forty

¹⁰³ 33 U.S.C. §§ 401-466n. See Philip Weinberg, *Environmental Law*, 3rd ed. (University Press of America, Inc., 2006), at 248. In 1968, the Army Corps of Engineers announced that it would consider factors other than protection of navigation when issuing permits under the Rivers and Harbors Act. Several suits were commenced against industrial dischargers for operating without a permit. See *Zabel v. Tabb*, 430 F.2d 199 (5th Cir. 1970), cert. denied, 401 U.S. 910 (1972). Navigable waters include: (1) all waters currently in use, were in use in the past, or may be susceptible to use in the future; (2) all interstate waters (including wetlands); (3) intrastate lakes, rivers, streams, sloughs, prairie potholes, playa lakes, or natural ponds; (4) tributaries; and (5) territorial seas [Weinberg].

¹⁰⁴ *Ibid.*

¹⁰⁵ *Daniel Ball v. United States*, 77 U.S. 557, 563, 19 L.Ed. 999 (1871). See Weinberg, *supra* note 103 at 258.

¹⁰⁶ *Ibid.*

¹⁰⁷ Other notable pieces of water pollution control legislation include the *Federal Water Pollution Control Act (FWPCA)*, the *Water Quality Act* of 1965, and the *Clean Water Act* of 1972. The FWPCA allowed courts to grant relief from pollution after considering the economic feasibility of abatement practices performed by developers. The *Water Quality Act* provided for the adoption of water quality standards for activities affecting interstate waters. See Mark A. Ryan, *The Clean Water Act Handbook* (American Bar Association, 2003), at 6 [Ryan Clean Water Act].

¹⁰⁸ *Geothermal Steam Act*, 30 U.S.C. §1001-1025 (1970). During the eighty-eighth Congress in 1964, Senator Bible of Nevada introduced a bill to allow the disposition of geothermal resources by amending the Mineral Lands Leasing Act of 1920. See Jan D. Sokol, "Geothermal Leasing in Wilderness Areas" (1976) 6 *Env't'l L. The Lewis & Clark Law School – Northwestern School of Law* at 496. Prior to 1970, no statutory authority allowed developers to extract geothermal resources on U.S. public lands. To remedy this situation, Congress passed a bill in 1966 allowing geothermal leasing on public lands through a system of privately-held leases, which later became the *Geothermal Steam Act*. See Raymond J. Werner, "Geothermal Leasing" (1975) 54 *Or. L. Rev.* at 623.

years.¹⁰⁹ The lead agency which authorizes geothermal leases to prospective developers in twelve states is the federal Bureau of Land Management (BLM), and mostly in the west.¹¹⁰ The BLM first issues an exploration permit known as the Notice of Intent to Conduct Geothermal Resource Exploration Operations.¹¹¹ The regulator then issues a Construction Permit for the construction and maintenance of geothermal well field operations, and also a Commercial Use Permit for extracting geothermal resources for the purpose of producing electricity or district heating.¹¹²

Other BLM regulatory requirements, such as the BLM Geothermal Resources Operational Order No. 2, oblige all developers to explore and drill with minimal damage to the environment and the geothermal reservoir.¹¹³ Building on this leasing system, the *Geothermal Energy Research, Development and Demonstration Act* (1974) requires a geothermal developer to submit a detailed plan of environmental mitigation measures to the United States Geological Survey (USGS)¹¹⁴ to prevent fires, soil erosion, surface and groundwater pollution, damage to fish and wildlife, air and noise pollution, and any other hazards affecting public health and safety.¹¹⁵ For geothermal development, two mitigation measures include water extraction and discharge practices, and re-injection, both of which reduce the amount of water being used

¹⁰⁹ Stoel Rives Lava Law, *supra* note 79.

¹¹⁰ Bureau of Land Management (BLM), Energy, Geothermal Energy, online: BLM <<http://www.blm.gov/wo/st/en/prog/energy/geothermal.html>>. The BLM currently handles 530 geothermal leases in the United States.

¹¹¹ Blaydes & Associates, California Geothermal Energy Collaborative: Expanding California's Confirmed Geothermal Resources Base – Geothermal Permitting Guide (April 2007), online: Blaydes & Associates <<http://www.geopower.ca/California%20Geothermal%20Permitting%20Guide/PermittingGuide.pdf>> [Blaydes & Associates].

¹¹² Tiffany Grant, “California Geothermal Law and its Impacts on Thermophile Biodiversity”, *Engage* (Vol. 6, Issue 2) [Grant].

¹¹³ Blaydes & Associates, *supra* note 111.

¹¹⁴ U.S. Geological Survey (USGS), About USGS Home, online: USGS <<http://www.usgs.gov/aboutusgs/>>. The USGS helps developers and lead agencies to analyze scientific information relating to resource development activities. The USGS has geothermal programs relating to water, including the: (1) Cooperative Water Program; and (2) Groundwater Resources Program. See generally USGS, Science Areas, online: USGS <<http://www.usgs.gov/programs.asp>>.

¹¹⁵ *Geothermal Energy Research, Development and Demonstration Act*, 42 U.S.C. §5905 (1974).

during geothermal activities, and to recycle the water into the geothermal reservoir to replenish and maintain the life of a field.

The *Clean Water Act (CWA)* of 1972, is a pollution control statute that uses mitigation measures to protect water quality by delegating authority to the Environmental Protection Agency (EPA) to issue permits to developers for any development-based discharge of pollutants into surface waters.¹¹⁶ Water quality standards are established as a treatment control, where its purpose is to protect the propagation of fish and wildlife, and provides for recreation in and on the water.¹¹⁷ The *CWA* regulates “point source” and “nonpoint sources” of water pollution, where the former refers to pipes, outfalls and other confined channels that physically discharge pollutants, while the latter refers to all other discharges from no particular source.¹¹⁸ A point source is defined in sections 507 and 1362(14) of the *CWA*, and commented upon in *Natural Resources Defense Council, Inc. v. Costle* as “any discernible, confined and discrete conveyance” such as a pipe, ditch, channel, conduit, well, or tunnel “from which pollutants are or may be discharged.”, and from which each developer using a point source of water (either new or existing) requires a permit to discharge such pollutants.¹¹⁹

An important water mitigation provision under the *CWA* is section 1342, which provides for administration of the National Pollutant Discharge Elimination System (NPDES).¹²⁰ The NPDES requires any discharger to obtain permits from the EPA that restrict the type and quantity of pollutants released into navigable waters.¹²¹ Section 401 of the *CWA* regulates discharges that can affect water quality, while section 404 gives the Army Corps of Engineers

¹¹⁶ Pearson, *supra* note 72 at 379. The precursor to the *Clean Water Act* is the *Federal Water Pollution Control Act (FWPCA)* of 1948, where the federal government funded states to manage water pollution controls and coordinate interstate pollution abatement efforts. The stated objective of the *Clean Water Act* is “to restore and maintain the chemical, physical, and biological integrity of the Nation’s waters.” See 33 U.S.C. §1251.

¹¹⁷ Ryan Clean Water Act, *supra* note 107 at 26.

¹¹⁸ *Ibid.* at 381.

¹¹⁹ *Ibid.*

¹²⁰ *Ibid.* at 383. The NPDES permit process was established under the *Federal Water Pollution Control Act (FWPCA)*.

¹²¹ *Ibid.* at 384.

(via the EPA) the authority to issue permits for discharges of “dredged or filled materials” affecting the navigable waters of the United States.¹²² Although the EPA is granted authority to manage water resources that affect interstate commerce, a state agency may assume control over the water permitting process if the EPA approves of such regulatory actions.

Another water mitigation provision is found in section 303(d) of the *CWA*, which establishes a Total Maximum Daily Load (TMDL) program.¹²³ This program regulates industrial activities where developers fail to meet water quality standards despite meeting effluent limitations and other state pollution control requirements. TMDL is a calculation of the maximum quantity of a pollutant that is added to a water body from all sources (including natural background sources) without exceeding the water quality standards for that pollutant.¹²⁴ Each state must create TMDLs for all pollutants that prevent waters from reaching water quality goals, and the TMDL helps regulators identify and quantify the source of pollution.¹²⁵ Despite dischargers fully complying with existing state water quality standards, section 303(d) requires states to quantify water use within their boundaries based on the severity of the pollution and the type and use of the waterway.¹²⁶

For geothermal development, this means that developers must comply with more stringent water quality standards by identifying and calculating the amount of pollutants (such as arsenic) that would be found in discharged water. This added measure helps protect water resources through regulations to strengthen water quality standards by controlling the discharge of harmful contaminants, particularly into local drinking water supplies. Supplementing this legislation is

¹²² “Dredged material” refer to those materials that “is excavated or dredged from waters of the United States.” See 33 U.S.C. § 323.2(c). On the other hand, “filled materials” refer to materials from a broad range of activities ranging from the placement of fill necessary for the construction of any structure in waters of the United States to the creation of artificial reefs. See 33 U.S.C. § 323.2(f).

¹²³ Ryan Clean Water Act, *supra* note 107 at 205.

¹²⁴ *Ibid.* See 33 U.S.C. §1313(d)(1)(C).

¹²⁵ *Ibid.* Each state must submit this TMDL for each pollutant to the EPA, which has thirty days to approve or reject the TMDL. If the EPA rejects the TMDL, it must produce its own TMDL list for the state within thirty days. Thereafter, the state must incorporate the EPA’s TMDL list into its own water management plans.

¹²⁶ *Ibid.* at 207.

the *Safe Drinking Water Act (SDWA)* of 1976, which creates drinking water regulations that reduce adverse public health effects from exposure to contaminants.¹²⁷ The *SDWA* promotes a federal water protection program known as the Underground Injection of Fluids (UIF), which allows states to regulate the pumping of water to underground sources to recycle water resources within a given area.¹²⁸

The *National Environmental Policy Act (NEPA)* of 1969 represents the first U.S. federal legislation to emphasize environmental impact assessments.¹²⁹ The principles of environmental impact assessment were first considered in *Calvert Cliffs' Coordinating Committee v. U.S. Atomic Energy Commission*.¹³⁰ Here, the U.S. Court of Appeal stressed the need for federal agencies (like the Atomic Energy Commission) to follow the legislative intent of Congress in advancing environmental preservation using specific environmental assessment measures that would protect the environment, while allowing for industrial development.¹³¹ The court focused on section 102(2)(C) of *NEPA* by stating that: “responsible officials of all agencies prepare a detailed statement covering the impact of particular actions on the environment, the environmental costs which might be avoided, and alternative measures . . . to aid in the agencies’ own decision-making process . . .”¹³² This decision laid the foundation for modern environmental mitigation measures that provide alternative measures.

Later amended in 2005, *NEPA* is triggered when a development proposal is submitted to a regulating authority, and it is determined that a major federal action would be “significantly affecting the quality of the human environment.”¹³³ A major federal action refers to projects

¹²⁷ 42 U.S.C.A. §§300(f)-(j). See also Hoffman, *supra* note 2 at 243.

¹²⁸ Ryan Clean Water Act, *supra* note 107 at 206.

¹²⁹ Glasson, Therivel & Chadwick, *supra* note 46, at 28.

¹³⁰ *Calvert Cliffs' Coordinating Committee v. U.S. Atomic Energy Commission*, 449 F.2d 1109, cert. Denied, 404 U.S. 942. See also Weinberg, *supra* note 98 at 366.

¹³¹ *Ibid.*

¹³² Weinberg, *supra* note 103 at 367.

¹³³ Drake, *supra* note 65 at 103. See also Pearson, *supra* note 72 at 117.

(either existing or new) that produce significant environmental effects, and may be subject to federal control.¹³⁴ If there is a question of whether an action has a significant effect on the environment, then the agency must prepare an Environmental Impact Statement (EIS).¹³⁵ The term “significantly affecting” determines how society will be affected by the severity of the proposed project (through both beneficial and adverse impacts) by considering public health and safety, uniqueness of the geographic area, cumulative effects, and uncertain effects on the human environment.¹³⁶ The most common federal actions that trigger *NEPA* are construction projects that require federal permits (such as geothermal projects), particularly those that impact “navigable waters of the United States” under section 404 of the *Clean Water Act*.¹³⁷

As mentioned *supra*, to determine if any development action may significantly affect the environment, an agency may prepare an Environmental Assessment (EA), a Finding of No Significant Impact (FONSI), or an EIS.¹³⁸ From a geothermal mitigation perspective, *NEPA* requires the BLM and the U.S. Forest Service (FS) to draft a Geothermal Resources Leasing Programmatic Environmental Impact Statement (Geothermal PEIS).¹³⁹ The Geothermal PEIS requires developers to obtain permits during each stage of geothermal development (reconnaissance, exploration, drilling, and resource production), and avoid or mitigate adverse environmental effects of geothermal activities.¹⁴⁰ Without this information, interested parties such as a regulating agency or affected communities may not properly evaluate the severity of

¹³⁴ *Ibid.*

¹³⁵ See e.g. *Blue Mts. Biodiversity Project v. Blackwood*, 161 F.3d 1208, 1212 (9th Cir. 1998).

¹³⁶ Drake, *supra* note 65. See also 40 C.F.R. §§1508.27(b)(2), (4), (5), and (7).

¹³⁷ *Ibid.* The “human environment” is a broad term that encompasses the natural and physical environment, and the relationship of the people with that environment.

¹³⁸ Blaydes & Associates, *supra* note 111 at 8.

¹³⁹ U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, National Geothermal Action Plan (Draft), Geothermal Technologies Program, online: DOE <<http://www1.eere.energy.gov/geothermal/pdfs/ngap.pdf>>.

¹⁴⁰ Pearson, *supra* note 72 at 134.

the adverse effects, or recommend adequate mitigation measures to address water quality and allocation issues for the proposed site.¹⁴¹

Although the U.S. Supreme Court ruled in *Robertson v. Methow Valley Citizens Council*¹⁴² that *NEPA* does not impose a duty on agencies to mitigate adverse environmental effects or a duty to include a fully developed mitigation plan in an EIS, it is reasonable to assume that geothermal development projects significantly affect the quality of the environment, and that a detailed mitigation plan would be necessary. This is because geothermal fluids extracted from underground sources, or discharged onto surface lands can impact an area due to flow of contaminants through the interconnectedness waterways within an ecosystem. The detailed mitigation plan would include a geothermal developer's version of their own best water management practices, or recommendations made by a regulating agency (with public input) based on available scientific data and environmental impact assessments that help identify pollutants.

Given the integrated nature of water resources, water quality and allocation will affect water consumption in surrounding areas. Also, jurisdictions with scarce water resources rely heavily on the amount of water needed for direct and indirect uses. Any reduction in the availability and quality of water could produce deleterious effects on communities and natural habitats. Considering the importance of safeguarding the environmental effects of geothermal activities on water resources, it is useful to examine two states that apply sustainable water management practices through mitigation measures: (1) Utah, and (2) California. Each western state is chosen because water resources are scarce. This discussion will form the basis for sustainable water management practices recommended in the Canadian geothermal sector.

¹⁴¹ *Ibid.*

¹⁴² *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 109 S. Ct. 1835 (1989). See *ibid*, at 129.

UTAH

Under the *Utah Code*, geothermal resources are codified under Chapter 22 of the *Utah Geothermal Resource Conservation Act (UGRCA)*.¹⁴³ Utah's Department of Natural Resources, Division of Water Rights (DWR) issues permits to geothermal developers for water use, after the State Engineer reviews a developer's plan of development (with complete and accurate production records) to determine if a Certificate of Appropriation can be provided to proceed with development.¹⁴⁴ The DWR requires all geothermal wells to be drilled, operated, and maintained with a view to protect water resources under a water pollution prevention program which affects surface and groundwater sources, administered by the Division of Water Quality (DWQ) (along with the Division of Oil, Gas, and Mining) under Utah's Underground Injection Control (UIC) Program.¹⁴⁵ The UIC, under which geothermal fluids are re-injected into the ground, prevents the flow of geothermal fluid contaminants into surrounding rivers, lakes, reservoirs, springs, and ground water wells by requiring developers to install mitigation –based equipment, such as well-casing, surface seals, and well caps at the geothermal well site.¹⁴⁶

The UIC Program, which is meant to achieve water quality standards, is part of the federal *Safe Drinking Water Act (SDWA)*, under which the DWQ issues a Utah Pollution Discharge

¹⁴³ *Utah Geothermal Resource Conservation Act*, 73 *Utah Code Ann.* §8 (2009), online: Utah State Legislature <http://le.utah.gov/~code/TITLE73/73_22.htm>. There are four known geothermal resource areas (KGRAs) in Utah: (1) Cove Fort – Sulphurdale; (2) Crater Hot Springs; (3) Roosevelt Hot Springs; and (4) Thermo Hot Springs. Most geothermal development in Utah occurs on federal lands located at Cove Fort and Roosevelt Hot Springs. See generally Daniel J. Fleischmann, *Geothermal Development Needs in Utah* (26 June 2006), online: <<http://www.geo-energy.org/publications/reports/Utah%20Final%20Pre-Publication%20Report%20%20June%2026.pdf>>.

¹⁴⁴ *Ibid.* at §73-22-8(1). Dr. R. Gordon Bloomquist, *Utah Geothermal* (20 January 2004), online: <http://awwww.geology.utah.gov/emp/geothermal/ugwg/.../ut_geothermal0104.ppt>. These records must be kept on file by the geothermal developer for five years, and the DWR has the right to examine such records at all reasonable times.

¹⁴⁵ *Ibid.* at 73-22-6(1)(f). See also Craig D. Galli, *Utah Environmental Handbook* (Government Institutes, 2003) at 37 [Galli].

¹⁴⁶ *Ibid.* The Underground Injection Control (UIC) Program is regulated under Utah's Rule R317-7. See generally U.S. Environmental Protection Agency, *Understanding the Safe Drinking Water Act*, online: <http://www.epa.gov/safewater/sdwa/pdfs/fs_30ann_sdwa_web.pdf>.

Elimination System (UPDES) permit.¹⁴⁷ The UPDES permit is issued for a fixed term not exceeding five years, and where necessary, may require a developer to comply with water quality standards under Utah's *Water Quality Act*.¹⁴⁸ Aside from the UPDES permit, two other types of discharge permits are issued to geothermal developers in Utah – general and individual.¹⁴⁹ A general permit covers a category of discharges within a geographic area, while an individual permit refers to discharges that are considered to be a significant pollutant, and where the developer's technology changes the nature of discharge.¹⁵⁰ Any person proposing a new discharge (as from a new geothermal site) shall submit an application to the DWQ at least 180 days before the date on which the discharge is to commence.¹⁵¹ For this new proposal, the applicant must submit detailed information regarding the nature, character, and extent of the discharge, including maps of the affected area.¹⁵² Similarly, Utah's Ground Water Quality Protection Regulations require an applicant for a new geothermal facility that “discharges or would probably result in a discharge of pollutants that may move directly or indirectly into ground water” to apply for a groundwater permit prior to the installation of the geothermal facility.¹⁵³

For an existing geothermal facility, a discharge permit requires “treatment and discharge minimization technology commensurate with plant process design capability . . .” These mitigation measures protect both surface water and groundwater from being contaminated by the effluent produced by the geothermal well pipes. As the metals contained in the geothermal fluids

¹⁴⁷ Utah Department of Environmental Quality, Utah Underground Injection Control (UIC) Program, online: <<http://www.waterquality.utah.gov/UIC/index.htm>>. To explore the federal *Safe Water Drinking Act (SDWA)*, see U.S. Environmental Protection Agency, online: *Safe Drinking Water Act* <<http://www.epa.gov/safewater/sdwa/index.html>>. The *SDWA* was enacted in 1974, and was amended in 1986 and 1996. The *SDWA* introduced federal drinking water standards as a public health measure for resource development located near human populations. The Division of Water Quality, Utah's state agency, received rulemaking authority under section 1422 of the *SDWA*. See also Galli, *supra* note 145.

¹⁴⁸ Utah Code Ann. §19-5-108(2).

¹⁴⁹ Galli, *supra* note 145 at 45.

¹⁵⁰ *Ibid.*

¹⁵¹ Utah Code Ann. R317-8-3.1(4).

¹⁵² Utah Code Ann. R317-8-3.5.

¹⁵³ Utah Code Ann. R317-6-6.1A.

flow out of the well to be either discharged on the surface, or re-injected into the ground, they are contained in a sealed environment or closed loop circuit of pipes.¹⁵⁴ Utah’s approach therefore applies several mitigation measures that: (1) replenish sufficient quantities of water in geothermal reservoirs through an underground re-injection program (thereby controlling the rate of extraction and processing which prolongs future geothermal development); (2) maintain water quality by preventing cross-contamination of surface and groundwater sources (thereby allowing for adequate water consumption); and (3) protect adjoining waterways that connect to a geothermal site. In supporting these sustainable measures, the State Engineer represents the enforcement arm in Utah’s geothermal regulatory framework.

CALIFORNIA

California is one of the oldest producers of geothermal energy because of its location on the Pacific “ring of fire” region.¹⁵⁵ In 1956, California developed the largest group of geothermal power plants and steam fields in the world at the Geysers, located north of San Francisco.¹⁵⁶ Today, the Geysers geothermal field produces more than 1000 megawatts (MW) of electricity for district heating in surrounding communities. In California, permitting and licensing for the development of geothermal wells clearly emphasizes sustainable water management practices:

prevent, as far as possible, damage to life, health, property, and natural resources; prevent loss of geothermal reservoir energy, prevent damage and waste of *underground and surface waters for irrigation or domestic use*; prevent other surface environmental damage,

¹⁵⁴ *Ibid.*

¹⁵⁵ Blaydes & Associates, *supra* note 111.

¹⁵⁶ California later enacted its own *Geothermal Resources Act* on 1 January 1967 to regulate three stages of geothermal development – exploration, resource development, and production. See John Sass & Sue Priest, U.S. Geothermal Development, Geothermal California, online: <<http://www.geothermal.org/articles/California.pdf>>. For a history of The Geysers see CALPINE, The Geysers, online: <<http://www.geysers.com/history.htm>>. See generally Leslie Blodgett & Kara Slack, Geothermal 101: Basics of Geothermal Energy Production and Use, online: <http://www.geothermal.org/publications/reports/Geo101_Final_Feb_15.pdf> [Sass & Priest].

including subsidence; and encourage the wise development of geothermal resources through good conservation and engineering practices.¹⁵⁷

This language reflects the best management practices policy espoused under the federal *Clean Water Act*, where wastewater management will promote irrigation and domestic activities (including the growth of crops, aquaculture, and recreation). The regulation of geothermal development is provided for under Title 14 of California's *Public Resources Code (Natural Resources)*, where federal and state coordinating agencies comment on potential environmental impacts of proposed geothermal projects, and environmental mitigation measures.¹⁵⁸ Some environmental considerations pertain to the issuance of water geothermal permits.¹⁵⁹ Water permits known as the General Construction Activity Storm Water Permit are required under California's *Clean Water Act*, and are issued by the State Water Resources Control Board (SWRCB).¹⁶⁰ This permit requires developers to prepare and apply a Storm Water Pollution Prevention Plan (SWPPP) if the geothermal project will disturb more than one acre around the geothermal site.¹⁶¹ This measure is intended to preserve the volume of water in a geothermal field, while reducing groundwater contamination during the construction phase of geothermal development.

Apart from Title 14, the broadest regulation of environmental mitigation measures for industrial development in California occurs under the *California Environmental Quality Act (CEQA)*.¹⁶² The environmental assessment process on state lands triggers *CEQA* during the

¹⁵⁷ Title 14, Nat. Res., Div. 2, Ch.4. The Division of Oil, Gas, and Geothermal Resources (DOGGR) is California's lead agency that manages the geothermal development process on state and private lands, including: (1) surveying of geothermal fields; (2) exploration; (3) application for a geothermal project; (4) permitting/licensing; (5) public consultations; (6) resource/well field development; (7) production/end-use; (8) abandonment and closure of geothermal wells; and (9) site restoration.

¹⁵⁸ Blaydes & Associates, *supra* note 111.

¹⁵⁹ *Ibid.*

¹⁶⁰ *Ibid.*

¹⁶¹ *Ibid.* Any geothermal discharge that affects surface bodies of water will also automatically trigger the National Pollution Discharge Elimination System Permit (NPDES).

¹⁶² *California Environmental Quality Act*, Pub. Resources Code §§21000-21177.

geothermal lease process.¹⁶³ For geothermal projects on private lands, the submission of an exploration permit would trigger the *CEQA* process.¹⁶⁴ Regional Water Quality Control Boards (nine of which operate under the SWRCB) ensure water allocation by requiring geothermal developers, during exploration and drilling, to designate a place for the temporary holding of geothermal fluids in portable storage tanks or reserve pits (sumps), which are located adjacent to the well pad.¹⁶⁵ The water control boards ensure water quality by allowing licensed haulers to remove the storage tank (containing the geothermal fluids) for the testing of naturally-occurring hazardous substances (such as arsenic and mercury), a process which, depending on the level of contamination, allows regulators to determine where the geothermal fluids can be disposed of.

The Geysers and Municipal Wastewater Injection

The Geysers represents the world's largest geothermal field, and serves as an excellent example of sustainable water management practices for geothermal development, where wastewater is recycled for water allocation purposes.¹⁶⁶ This municipal wastewater injection program is known as the Santa Rosa Geysers Recharge Project, which started in November 2003.¹⁶⁷ This program transfers approximately 11 million gallons of treated wastewater from the City of Santa Rosa's Subregional Wastewater Treatment Plant through a 40-mile pipeline to the southern edges of the Geysers geothermal reservoir.¹⁶⁸ The recycled water flowing from the municipality of Santa Rosa to the Geysers geothermal field allows for water to be re-injected into

¹⁶³ Blaydes & Associates, *supra* note 111 at 8.

¹⁶⁴ *Ibid.* Some geothermal projects may qualify for a *CEQA* exemption, such as when a developer converts an existing swimming pool to use geothermal water where the well can be drilled in an existing parking lot. This measure helps the developer use water from an available source without the need to radically alter this setting, while creating an attractive destination for local swimmers for recreational purposes.

¹⁶⁵ *Ibid.*

¹⁶⁶ Sass & Priest, *supra* note 156. The Geysers has twenty-one power plants that are operated by Calpine Corporation and the Northern California Power Agency.

¹⁶⁷ Sass & Priest, *supra* note 156.

¹⁶⁸ City of Santa Rosa, Incremental Recycled Water Program, August 2007 Addendum to Program EIR and Geysers Expansion Project *CEQA* Checklist (27 July 2007). See also City of Santa Rosa, Geysers Project, online: City of Santa Rosa <<http://ci.santa-rosa.ca.us/departments/utilities/irwp/geysers/Pages/default.aspx>>.

geothermal reservoirs to provide a continuous supply of geothermal water for the pump stations within the Geysers region.¹⁶⁹

The legal basis for this program lies within California's *CEQA*, in which sections 21002 and 21002.1 provide that public agencies may not approve proposed projects unless "feasible alternatives" or "mitigation measures" are advanced, and that each public agency shall mitigate or avoid the significant effects on the environment.¹⁷⁰ Section 21081.6 of *CEQA* further requires public agencies to establish a monitoring program for any changes made to the project in order to mitigate effects on the environment.¹⁷¹ In following these measures, Santa Rosa designates a coordinator to enforce the water mitigation measures in a timely manner by establishing a schedule for monitoring activities, conducting routine inspections for ongoing projects, and enforcing corrective actions that apply mitigation measures.¹⁷² The application of this coordinator-led program is done in two stages. The first stage involves the completion and collection of verification reports, which define each mitigation measure applied to a project.¹⁷³ For instance, any project including pipeline construction through a stream requires the completion of daily verification reports.¹⁷⁴ The second stage involves the completion of a "Mitigation Monitoring Checklist", that provides a summary of the status of the adopted mitigation measures, which is updated by the coordinator four times a year.¹⁷⁵

With respect to geothermal sustainable water resource management, Santa Rosa's program requires re-injection of recycled water from two sources - the Geysers geothermal field and Santa Rosa's wastewater plant – a process that helps the municipality avoid dumping wastewater into

¹⁶⁹ Winzler & Kelly, Technical Memorandum No. 7, Santa Rosa Incremental Recycled Water Program – Geysers, online: <http://www.downtownsr.org/doclib/Documents/ut_irwp_PEIR_TM-07_Geysers.pdf>.

¹⁷⁰ *Ibid.*

¹⁷¹ *Ibid.*

¹⁷² *Ibid.*

¹⁷³ *Ibid.*

¹⁷⁴ *Ibid.*

¹⁷⁵ *Ibid.* at 42.

surrounding lakes, rivers, and streams, while replenishing water resources in the geothermal reservoirs of the Geysers field to be used ultimately for electricity generation. With adequate amounts of water, farmers may also grow crops since the discharged water contains nutrients. Thus, California's mitigation measures produce the following benefits: (1) improve water quality by preventing surface and groundwater contamination using well-casing; (2) preserve discharged effluent that is re-injected into the geothermal reservoir, which allows power plants to generate electricity; (3) supply enough water for agricultural purposes; and (4) enforce regular monitoring of chemical and physical properties of water resources. Indeed, mitigation-based water management creates direct and indirect uses, something that another common law jurisdiction, New Zealand, is pursuing through an integrated approach.

5- NEW ZEALAND

The following discussion reviews the New Zealand government's approach to sustainable water management practices in its geothermal sector using mitigation-based measures under the "resource consent" process. Case law will be discussed in the context of environmental liability relating to common law remedies to avoid, remedy, or mitigate adverse environmental effects. In highlighting such measures, the Wairekei Geothermal Power Station will be explored to illustrate water sustainability using mitigation measures.

Being situated in the Pacific "ring of fire", New Zealand has abundant sources of geothermal energy which has led to the enactment of a series of geothermal-related laws. In 1953, New Zealand's *Geothermal Energy Act* governed the regulation of geothermal energy development.¹⁷⁶ In 1961, the *Geothermal Energy Regulations* supplemented the *Geothermal Energy Act* by requiring government inspections of activities pursued by developers using

¹⁷⁶ *Geothermal Energy Act* 1953 (N.Z.), 1953/100. New Zealand's first major geothermal project began in 1950 in Wairakei on the North Island. See John W. Brooks, "Legal Problems of the Geothermal Industry" (1966) 6 Nat. Resources J. 511 at 512.

geothermal-produced water, while creating a formal application process for geothermal development along these lines.¹⁷⁷ In 1968, the *Water and Soil Conservation Act* came into effect, and dealt with water quality and water allocation, including “water or steam or vapour heated by geothermal energy”.¹⁷⁸ This statute nationalized all water rights, and abolished riparian rights, which transferred control of resource management in regional water groups, whose task was to classify water and adjudicate on water rights applications.¹⁷⁹ This statute provided few guiding principles for water resource management, but it allowed the courts to develop the concept of water sustainability in New Zealand, which would later influence case law under the *Resource Management Act*.¹⁸⁰

Resource Management Act

Sustainable environmental management of natural and physical resources became a national law and policy in New Zealand with the enactment of the *Resource Management Act (RMA)* on 1 October 1991.¹⁸¹ The *RMA* integrates the planning and management of land, air, and water resources (including geothermal) into a single statute, under which the Environmental

¹⁷⁷ Government of New Zealand, Legislation: Regulations, *Geothermal Energy Regulations 1961*, online: New Zealand <<http://www.legislation.govt.nz/regulation/public/1961/0124/latest/DLM15785.html>>.

¹⁷⁸ Derek Nolan, *Environmental and Resource Management Law* (LexisNexis NZ Ltd, 2005), at 460. The *Water and Soil Conservation Act* promoted a national policy for the conservation, allocation, use, and quality of natural water, and to promote soil conservation, and prevent damage by floods, and promoting multiple uses of water, the drainage of land, and protecting local water supplies, fisheries, wildlife habitats, and all recreational uses of natural water. Under section 2(1) of this statute, “natural water” is defined as “all forms of water, including freshwater, groundwater, artesian water, sea water, water vapour, ice, snow, and water or steam or vapour heated by geothermal energy, whatever its temperature . . .” [Nolan Resource Management].

¹⁷⁹ R.P. Boast, “Geothermal Resources in New Zealand: A Legal History” (1995) 6 *Canterbury L.R.* 20 [Boast Geothermal].

¹⁸⁰ *Resource Management Act (N.Z.) 1991*. For example, multiple use of water resources was developed in *Keam v. Minister of Works and Development* [1982] 1 *N.Z.L.R.* 319, 9 *N.Z.T.P.A.* 240, where the New Zealand Court of Appeal held that applicants seeking to develop a geothermal field need two approvals: (1) a licence under the *Geothermal Energy Act*, and (2) a water right from a regional water board under the *Water and Soil Act* [RMA].

¹⁸¹ *Resource Management Act (N.Z.) 1991*, Legislation: Acts, online: Government of New Zealand <<http://www.legislation.govt.nz/act/public/1991/0069/latest/DLM230265.html>>. The legislative history of the *RMA* is such that following consultations, public hearings, and working papers, largely based on the Brundtland Report, the New Zealand government issued a report in December 1988 to propose resource management law reform, which later became the *Resource Management Bill* of 1989. *Ibid.* at 85. The *RMA* effectively replaces the *Geothermal Energy Act* of 1953. See also Chris Bromley, “Practical Methods of Minimizing or Mitigating Environmental Effects from Integrated Geothermal Developments: Recent Examples from New Zealand” (Paper presented at the International Geothermal Conference at Reykjavik, Iceland, September 2003).

Protection Authority (EPA) administers the *RMA* in close association with the Ministry for the Environment.¹⁸² Section 5 states the purpose of the Act:

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

A careful analysis of this section reveals some important concepts about water sustainability in New Zealand. First, sustainability follows the Brundtland Report's definition, where the needs of future generations must be considered. This implies preservation of water resources through water allocation, where the amount of water must be used efficiently to allow for longer periods of water use. Second, there is a concern for "health and safety", where water quality standards are needed to avoid contamination of surface and groundwater sources that affect drinking water supplies and natural habitats. Third, "social, economic, and cultural" issues are to be addressed to protect recreational activities, promote tourism, and preserve cultural water practices for the indigenous Maori people.

In accomplishing these objectives, mitigation measures are to balance economic development with the protection of water, air and land resources using an integrated approach. This approach was stressed by Justice Baragwanath in *Ports of Auckland Ltd. v. Auckland City Council and Ors*: "It is the duty of the Court and other bodies with responsibility for construing the *RMA* to recognize that planning decisions are a form of delegated legislation which must be internally consistent in order to promote sustainable management as Parliament has directed. .

¹⁸² Ministry for the Environment, Resource Management Act, Administration of the *RMA*, online: Government of New Zealand <<http://www.mfe.govt.nz/rma/central/administration.html>>. The *RMA* strengthens the riparian rights to the Crown and limits the common law rights of water users.

”¹⁸³ With sustainable development as its focus, the *RMA* directs resource management planning through a “resource consent”¹⁸⁴ process whereby local authorities act as enforcement bodies, and are divided into Regional Councils and District/City Councils.¹⁸⁵ Regional Councils manage soil conservation and establish rules for the maintenance and enhancement of water quality and allocation in water bodies by preparing Regional Policy Statements.¹⁸⁶

New Zealand’s sustainability policy stresses how regional councils must assess the impacts of geothermal development: “When making decisions over geothermal water levels or flows, or allocating geothermal water, the regional council will consider the following matters: (a) the natural availability of the water resource; (b) the existing and reasonably foreseeable future demands on water resources; and (c) conservation of water and its efficient allocation”.¹⁸⁷ In contrast, District/City Councils manage physical resources by way of land use and subdivisions.¹⁸⁸ Therefore, water resource management is governed by general provisions of the

¹⁸³ *Ports of Auckland Ltd. v. Auckland City Council and Ors* [1998] N.Z.H.C. 481. This New Zealand High Court nuisance case related to noise from the Ports of Auckland and its potential effect on future residential development on the former Railway Precinct.

¹⁸⁴ A resource consent is a permit with conditions attached that grants to their holder a personal right to use water. Section 122 of the *RMA* states that resource consents are neither real or personal property, and therefore not tradable in New Zealand. In *Aoraki Water Trust v. Meridian Energy Ltd.*, [2005] 11 E.L.R.N.Z. 207, the issue was whether further resource consents could be issued to a number of parties for irrigation purposes at Lake Tekapo, when it was allocated to a power company (Meridian Energy Ltd.) for electricity generation. The Supreme Court of New Zealand decided that granting further consents would reduce the amount of water available to the original holder of the resource consent. This ruling meant that the right granted by a resource consent to take and use a resource amounts to an allocation of that resources. See David McGregor & Bell Gully, *Water Allocation and Trading – A New Zealand Perspective*, online: Bell Gully <http://www.bellgully.com/resources/pdfs/water_allocation.pdf>.

¹⁸⁵ For a discussion on sustainable development and management, see Nolan Resource Management, *supra* note 173 at 93. The New Zealand Ministry for the Environment defines “sustainable development” as two things: (1) recognizing the environmental costs of activities to protect natural and physical resources, and (2) conserving the resources for future generations. Investment New Zealand, *A Guide to Resource Consents under the New Zealand Resource Management Act*, online:

<http://www.investmentnz.govt.nz/common/files/RMA%20Document_Nov05_Client%20Copy.pdf>. There are sixteen Regional Councils that manage water, land, and air resources, while there are seventy-four District and City Councils that provide networks and community services such as water supplies and sewage. See J. Wallace, Patricia Wouters & S. Pazvakavambwa, *Hydrology and Water Law: Bridging the Gap*, (IWA Publishing, 2006), at 299.

¹⁸⁶ David Grinlinton, “New Zealand Planning Law” in Anker, Olsen & Ronne, *Legal Systems and Wind Energy Law – A Comparative Perspective* (DJOF Publishing, 2008), at 145.

¹⁸⁷ *Ibid.*

¹⁸⁸ *RMA*, *supra* note 180 at s. 30(1)(c)(i)-(v). More specifically, a regional council prepares policies for the integrated management of resources and on the effects of the use, development or protection of water resources, geothermal energy, and the discharge of contaminants into water. They have responsibilities to establish rules to

RMA, and policy instruments administered by local and central agencies. Resource consent applications from developers are received by regional councils, and a decision is made at public hearings as to whether the geothermal project will commence or be renewed.¹⁸⁹

Under the *RMA*, resource consents are granted by Regional or District/City Councils when a proposed geothermal activity is not ordinarily permitted in a District or Regional Plan, but an Assessment of Environmental Effects (AEE) is required.¹⁹⁰ The statutory basis for the management of geothermal water resources is found under sections 14 and 17 of the *RMA*. Section 14 prohibits a person to take, use, dam, or divert “any water, heat, or energy of geothermal water”, unless it is permitted by a resource consent, or in a regional plan drafted by a developer undertaking to operate a geothermal plant.¹⁹¹ Section 17 of the *RMA* regulates the discharge of contaminants into water bodies, where a producer has a duty to avoid, remedy, or mitigate any adverse effects on the environment.¹⁹² However, this duty is not enforceable unless an abatement notice or enforcement order is issued to pursue mitigation measures to avoid adverse effects on the environment.¹⁹³ Wastewater treatment is also encouraged under the *RMA*, where pollutants can be removed from waste flows from urban areas, commercial and industrial wastes.¹⁹⁴ Since wastewater is a discharged contaminant, a consent authority may issue a discharge permit on the condition that the developer adopt the “best practicable option” under

allocate the taking or use of water, heat, and energy from water. See Nolan Resource Management, *supra* note 173 at 98.

¹⁸⁹ Chris J. Bromley, “Advances in Environmental Management of Geothermal Development” (Paper presented to the International Geothermal Association at the Proceedings of the World Geothermal Congress at Antalya, Turkey, 24 April 2005). Moreover, the Federal Minister of Conservation may direct a Regional Council to supply a detailed geothermal development plan, modify or vary this plan, or to review a regional project in operation. Local governing bodies like the regional council are given authority by the *Local Government Act* (1974) to manage key water management programs such as storm water management plans.

¹⁹⁰ *Ibid.* There are five types of resource consents under section 87 of the *RMA*: (1) land use; (2) subdivision; (3) coastal; (4) water, and (5) discharge.

¹⁹¹ Two exceptions to this rule are found under sections 14(3)(b) and 14(3)(c) of the *RMA*, where the former allows a person the right to use water for “domestic needs”, while the latter allows a person to take and use geothermal water in accordance with the “tangata whenua” Maori customary values and traditions. See Nolan Resource Management, *supra* note 173 at 471-73.

¹⁹² *RMA*, *supra* note 180, s. 17.

¹⁹³ Nolan Resource Management, *supra* note 178 at 150.

¹⁹⁴ *Ibid.* at 453.

section 108(2)(e) of the *RMA*, a measure similar to Best Management Practices (BMP) in the U.S. geothermal sector.¹⁹⁵

Considering the broad impacts of geothermal development on water resources, various legal remedies relevant to avoid, remedy, or mitigate adverse environmental effects are available as nuisance, negligence and strict liability. Nuisance, which can be public or private, is defined as the unlawful interference with a person's use or enjoyment of land, or some right in connection with it, and several noteworthy cases have arisen relating to environmental liability.¹⁹⁶ Ordinarily, a developer complying with environmental standards under a district or regional plan has no right to cause a nuisance.¹⁹⁷ Moreover, the grant of resource consents to a developer does not provide a statutory defence capable of defeating a private nuisance claim against them.¹⁹⁸ Negligence arises from a failure to exercise the duty of care demanded by the circumstances where a plaintiff suffers an injury.¹⁹⁹ The basis for this action is not the occupation of property, but that a duty of care was breached by the defendant to the plaintiff, where it was foreseeable that injury could result from the act or omission of the defendant.²⁰⁰

Aside from nuisance, the strict liability rule emerged in the United Kingdom in *Rylands v. Fletcher*.²⁰¹ The defendant (Rylands) hired independent contractors to build a reservoir on his land to power a mill. The contractors discovered an old mine whose shaft and passages connected with another mine on neighbouring land owned by the plaintiff Rylands, but did not inform Fletcher of this underground connection.²⁰² When the reservoir was filled with water, the water seeped through the subsurface and flooded the adjacent mine used by the plaintiff

¹⁹⁵ *Ibid.* at 496.

¹⁹⁶ Trevor Daya-Winterbottom, Toxic Torts – Common Law Remedies and Environmental Liability, Resource Management News, online: Resource Management News <<http://www.qualityplanning.org.nz/pubs/3552.pdf>> [Daya-Winterbottom Toxic Torts].

¹⁹⁷ *Ibid.*

¹⁹⁸ *Ibid.*

¹⁹⁹ *Ibid.*

²⁰⁰ *Ibid.*

²⁰¹ *Rylands v. Fletcher* [1868] L.R. 3 H.L. 330.

²⁰² *Ibid.*

Fletcher.²⁰³ The issue was whether a landowner would be liable for damage caused by lawfully building something on his land, which escaped and naturally caused damage to the surrounding lands.²⁰⁴ The House of Lords held the landowner strictly liable for damage caused by something non-natural brought onto the land and used in its ordinary manner, although there was no negligence.²⁰⁵ Therefore, in *Rylands v. Fletcher* the common law principle emerged that a person who brings or maintains something “non-natural” on his or her lands (such as a water reservoir), and substances escape naturally from that site to cause harm on adjacent lands, must be answerable for all the damage which flows naturally from it.²⁰⁶

This rule was applied in another U.K. water case, *Cambridge Water Company Ltd. v. Eastern Counties Leather plc*²⁰⁷, where the defendant Eastern Counties Leather used an organic solvent (perchloroethene) to carry out operations at a tannery.²⁰⁸ After degreasing animal skins, the tannery discharged water containing the solvent into the local aquifer, that contaminated groundwater sources supplying drinking water for 250,000 local inhabitants.²⁰⁹ Although initial water tests confirmed the presence of organic contaminants, a borehole at Sawston Mill was purchased by the plaintiff Cambridge Water Company to supply drinking water to this community.²¹⁰ The plaintiff brought an action for injunctive relief and damages against the defendant in nuisance, negligence, and the rule under *Rylands v. Fletcher*.²¹¹ The issue was whether the foreseeability of the environmental damage suffered by the plaintiff was relevant to a claim under the rule in *Rylands v. Fletcher*.²¹² The House of Lords held that the defendant was not liable for water contamination since a reasonable supervisor employed by the defendant

²⁰³ *Ibid.*

²⁰⁴ *Ibid.*

²⁰⁵ *Ibid.*

²⁰⁶ *Ibid.*

²⁰⁷ *Cambridge Water Co. Ltd. v. Eastern Counties Leather plc* [1994] 2 WLR 53.

²⁰⁸ Daya-Winterbottom Toxic Torts, *supra* note 196.

²⁰⁹ David Wilkinson, “Cambridge Water Company v. Eastern Counties Leather plc (1994) 57 Mod. L. Rev. 799.

²¹⁰ *Ibid.*

²¹¹ Sue Elworthy & Jane Holder, *Environmental Protection* (Reed Elsevier UK Ltd., 1997).

²¹² Daya-Winterbottom Toxic Torts, *supra* note 196.

would not have foreseen that the solvent would leak from the tannery floors to contaminate local groundwater sources, and that it would evaporate.²¹³ The High Court also held that the storage of chemical solvents was a natural use of the land since the borehole was located in an industrial village that benefited from employment in that sector.²¹⁴

Applying the rulings in *Rylands* and *Cambridge Water Company*, the following arguments can be made when evaluating geothermal development impacts on water resources. First, it could be argued by affected landowners that the non-natural emission of discharged wastewater from a geothermal power plant could be a nuisance for nearby lands and waterways because of the presence of contaminants, such as arsenic. These contaminants would reduce the water quality in the local drinking water supply, and damage surrounding natural habitats and major waterways such as rivers, lakes, and streams, adverse effects that would impact wildlife, recreational and tourist activities. Second, geothermal extraction of water may lead to significant depletion of water levels, thereby creating land subsidence and reduced water availability for lakes and rivers, where fishing and boating are prevalent.

In response, a geothermal developer could argue that if the discharged wastewater is subjected to proper mitigation measures (such as re-injection, well-casing, storing water in holding ponds, and storm management plans), the geothermal fluids would not escape naturally in great quantities, and the adverse effects upon local water resources would be significantly reduced. Baseline studies would provide information about local hydrological properties of surface and groundwater sources, and regular sampling and testing of the chemicals found in discharged geothermal fluids would monitor any release of contaminants. Considering that foreseeability of damage was considered in *Cambridge Water Company* to be a pre-requisite for liability in nuisance, negligence, and the rule under *Rylands v. Fletcher*, it follows that a

²¹³ *Ibid.*

²¹⁴ *Ibid.*

geothermal developer can use the baseline studies and water testing results to conduct more thorough environmental assessments that would reveal as many adverse effects as possible. Mitigation measures may not completely prevent the escape of contaminants, nor would they ensure preservation of water quantities, but to “avoid, reduce, or mitigate” such effects will likely have less impact on public health and natural habitats. It would also preserve water quantities in a given area by recycling discharged water between a power plant and geothermal reservoirs or municipalities.

It is interesting to note that the *RMA* does not define nuisance or address other civil law remedies, but it does provide for two enforcement procedures to end nuisance actions: (1) abatement notices and (2) enforcement orders. Abatement notices are issued only by local regional or district enforcement officers (upon reasonable grounds) under section 322 of the *RMA*.²¹⁵ The notice prohibits a person to from commencing any activity that is “noxious, dangerous, offensive, or objectionable” to the extent that it causes adverse environmental effects.²¹⁶ This requires the occupier of land carrying out any activity “over a water body” to avoid, remedy, or mitigate such adverse effects. An abatement notice allows an enforcement officer to order a potential defendant to stop a nuisance or refrain from starting one.²¹⁷ Enforcement orders, on the other hand, can be initiated by any potential plaintiff to seek reimbursement of actual or reasonable costs for avoiding, remedying, or mitigating any adverse environmental effects. These orders are issued by the Environment Court under section 319 of the *RMA*, and can require a potential defendant to “remedy or mitigate” any adverse effect on the environment, particularly when he or she fails to comply with an abatement notice.²¹⁸ To further

²¹⁵ *RMA*, *supra* note 180, s. 322.

²¹⁶ *Ibid.*

²¹⁷ *Ibid.*

²¹⁸ *RMA*, *supra* note 180, s. 314(1)(c)-(d). New Zealand’s Environment Court is a national court which was created under the Resource Management Amendment Act of 1996, and sits in Wellington, Auckland, and Christchurch. The court consists of eight Judges, seven alternate Judges, fifteen Commissioners, and five Deputy Commissioners. Most of the court’s work involves issues arising under the *RMA*, such as water permits, discharge permits, applications

illustrate sustainable water management practices using environmental mitigation measures at a New Zealand geothermal power plant, I will explore activities at the Wairakei Geothermal Power Station.

Wairakei Geothermal Power Station

The Wairakei Geothermal Power Station (Wairakei plant) is New Zealand's largest geothermal plant, where two mitigation measures are applied to promote water sustainability for generating electricity and serving tourist areas.²¹⁹ The first mitigation measure involves the re-injection of discharged water from the power plant into local ground surfaces, a process that redistributes water to commercial river tourist attractions within the Waikareii region.²²⁰ The Wairakei plant re-injects 30 - 40% of wastewater into a geothermal reservoir, which forms artificial hot pools and geysers (known as "Wairakei terraces") at the Craters of the Moon tourist location.²²¹ This re-injected discharged wastewater also provides warm water for the hot pools at the Waikareii Resort Hotel.²²²

The second mitigation measure is the requirement for the operator to measure the amount of discharged wastewater flowing from the Wairakei plants to surface waters.²²³ Here, an operator must obtain a resource consent from a regional council, which establishes baseline limits as to how much discharged wastewater can be used during the course of the project.²²⁴

for resource consents, and regional and district policy statements and plans. It also makes rulings on classification of waters, setting water levels for both lakes and rivers, setting minimum water quality standards, and takings of geothermal fluids. See Government of New Zealand, Environment Court, online: New Zealand Department of Justice <<http://www.justice.govt.nz/courts/environment-court>>.

²¹⁹ The Wairakei Geothermal Power Station began operations in 1958, and produces 161 megawatts.

²²⁰ Chris J. Bromley, "Practical Methods of Minimizing or Mitigating Environmental Effects from Integrated Geothermal Developments: Recent Examples from New Zealand" (Paper presented at the International Geothermal Conference at Reykjavik, Iceland, September 2003).

²²¹ *Ibid.*

²²² *Ibid.* The adjacent Te Kiri O Hinekai thermal stream with its famous "Honeymoon Pool" was created by diverting hot water from the main Wairakei drain. The re-injected water also provides the local prawn farm benefits from the direct use of discharged waste hot water, complying with the water quality standards under the Third Schedule of the *RMA*, which allows for fish spawning.

²²³ Arsenic Contamination, *supra* note 44.

²²⁴ *Ibid.*

This mitigation measure serves two purposes: (1) it regulates the amount of discharged flowing water so as to preserve the resource in the Wairakei region; and (2) it limits arsenic water contamination. Using these two mitigation measures, the Wairakei plant can maintain its operations without compromising the water resources in surrounding areas.

A relevant case under the *RMA* involving geothermal development, culture, and mitigation-based sustainable water management practices is *Contact Energy Ltd. v. The Waikato Regional Council and the Taupo District Council*.²²⁵ Contact Energy (Contact) is a geothermal developer that applied for a resource consent in September 1996 for three main purposes: (1) to extract 57,000 tonnes per day of geothermal fluids in the Wairakei and Tauhara geothermal fields (known as the Wairakei-Tauhara geothermal system); (2) to re-inject discharged wastewater underground; and (3) to obtain a land-use consent to generate 50 megawatts of electricity at the Wairakei plant.²²⁶ The resource consent was refused by the Waikato Regional Council and the Taupo District Council in April 1998 on two grounds: (1) that the Tauhara Hapu tribe sought exclusive and undisturbed possession of the geothermal resource because it was valued in the Maori culture; and (2) businesses within the Waikato region would suffer because of the Wairakei plant's geothermal extraction of water resources.²²⁷ Other opponents included the Tauhara Middle Trusts (holding land in trust for the Tauhara hapu tribe), Taupo Hot Springs Limited, and Akinra Holdings Limited (the latter two of which have business interests using geothermal energy from hot springs).²²⁸

After the refusal by the Waikato Regional Council, Contact modified its proposal by reducing the extraction levels of geothermal fluids from 57,000 tonnes to 20,000 tonnes per day,

²²⁵ *Contact Energy Limited v. The Waikato Regional Council and the Taupo District Council*, 2000 Env. Ct. 1523 [Contact Energy].

²²⁶ *Ibid.* Other resource consents were needed for discharge of contaminants, handling of storm water, taking of river water, disturbance of beds of rivers and streams, and maintenance of geothermal wells.

²²⁷ *Ibid.* These two councils worked together on reviewing this resource consent application.

²²⁸ *Ibid.*

which later became the main issue on appeal to the Environment Court.²²⁹ The Court considered the relationship between geothermal development and the Maori culture as a matter of “national importance” under section 6(e) of Part II of the *RMA*, where it states: “The relationship of Maori and their culture and traditions with their ancestral lands, *water*, sites, *waahi tapu*, and other *taonga*.”²³⁰ The Environment Court also recognized section 2(1)(d) of the *RMA* that defines “environment” as “social, economic, aesthetic, and cultural conditions”. In the context of environmental assessment, this meant that the court evaluated not only adverse environmental effects produced by geothermal activities at the Wairakei plant, but also the role of water resources within indigenous cultures being affected by such development.

Section 88 of the *RMA* requires an applicant for a resource consent to include an assessment of adverse environmental effects with enough detail that reflects the scale of development.²³¹ Various environmental effects on water resources were identified at the Wairakei-Tauhara geothermal fields, including land subsidence, hydrothermal eruptions, and the continuity of supply of geothermal fluids for tourist facilities. For instance, the Lanecove Hotel uses geothermal fluids from a borehole for heating spa pools, water supplies, and for space heating, and arguments were presented by Taupo Hot Springs Ltd. and Akinra Holdings Ltd. that the effects of Wairakei’s plant operations would result in a “material decline in the Waipahihi Springs.”²³² As the adverse effects of Contact’s proposed geothermal plan were not subjected to a public consultative process, the nearby Taupo community argued that the quality of scientific information gathered by the geothermal energy developer was insufficient in assessing “actual

²²⁹ *Ibid.* Contact submitted its appeal to the Environment Court in May 1998.

²³⁰ *RMA*, *supra* note 180, s. 6(e). Geothermal development must also be consistent with Tikanga Maori under section 14(3)(c) of the *RMA*.

²³¹ *Ibid.*, s. 88.

²³² EcoLex, Compendium of Judicial Decisions on Matters Related to Environment, National Decisions, Volume II (July 2001), *Contact Energy Limited (Appellant) v. The Waikato Regional Council and the Taupo District Council (Respondents)* – 24 January 2000, online: EcoLex <http://www.unep.org/padeli/publications/Compendium_Vol__II.pdf>. [EcoLex].

and potential” effects on the environment.²³³ This is why the Environment Court reviewed the Waikato regional policy statement, which classified the geothermal activities as either development systems or protection systems, and encouraged the “single-tapper” sustainable development concept that unified management for the optimal use of the geothermal resources. Through expert witness testimony of engineers and geothermal scientists, Contact convinced the Environment Court that its modified geothermal plan would reduce the adverse effects on local communities through a series of mitigation measures such as re-injection of discharged water from the Wairakei plant, and a comprehensive monitoring program.²³⁴ The Environment Court thus granted a resource consent to Contact for the proposed geothermal power station near Taupo.²³⁵

Contact Energy highlights the following salient features of integrated sustainable water resource management in New Zealand: (1) the *RMA* is treated by the courts as a comprehensive statute in regulating water quality and water allocation through evidence-based environmental assessments (e.g. hydrological studies), regional policy statements, and mitigation measures; (2) that the Maori culture has a special relationship with geothermal resources, which influences policy-making and court decisions for water resources; and (3) that regional and district councils regulate how electricity is generated at geothermal power plants, and how water resources are to

²³³ This is because section 104(1) of the *RMA* requires a consent authority to consider “actual and potential” effects on the environment. Counsel for Tauhara Middle Trust, J.S. Auld, argued that a much better understanding of the entire resource was needed from drilling wells which could map the geological strata.

²³⁴ For instance, to mitigate impacts on shallow aquifers or surface features, one expert recommended directly tapping the underlying steam zone with production wells, as well as using a peer-review panel as consultants.

²³⁵ *EcoLex*, *supra* note 232. See also *Contact Energy*, *supra* note 225. On 20 December 2007, the High Court of New Zealand re-considered water resource management in *Contact Energy Ltd. v. Waikato Regional Council* [2007] HC AK CIV 2006-404-007655 N.Z.H.C 1523. The first hearing involved issues such as the effects of re-injection to avoid surface water contamination. Contact appealed after the Environment Court decided against it on 17 November 2006 under a Waikato Regional Council rule that restricted Contact’s ability to discharge not more than 15,000 tonnes per day of geothermal fluids on land and surface waters. The issue then became whether Contact could amend the regional policy statement (relating to discharges of geothermal fluids) from a “non-complying” status to a “discretionary” status to increase its production of geothermal resources. The High Court reviewed Waikato’s regional policy statement (covering re-injection as a preferable mitigation measure to protect against the contamination of nearby waterways), but held that the Environment Court did not err in their initial decision under section 68(3) of the *RMA*.

be used in tourist areas relying on geothermal water resources. As shown, the overall benefit of New Zealand's integrated water resource management is that several layers of geothermal-related mitigation measures ensure that water quality and water allocation are maintained to create direct and indirect uses.

6 - PROPOSING A CANADIAN REGULATORY FRAMEWORK OF MITIGATION-BASED SUSTAINABLE GEOTHERMAL WATER MANAGEMENT PRACTICES

Based on the previous comparative analysis, this section will outline mitigation-based measures that would foster new sustainable water management practices in Canada's emerging geothermal industry. The *Canadian Environmental Assessment Act* will be discussed to show how it can be used to create mitigation measures for geothermal water resources. From this discussion, the environmental assessment process in British Columbia (Canada's most active geothermal development jurisdiction) will be considered to recommend a Canadian-based law and policy framework for specific sustainable water mitigation measures.

Canadian Environmental Assessment Act

The *Canadian Environmental Assessment Act (CEEA)* is a federal statute that governs environmental assessments for some proposed projects in Canada. The *CEEA* applies where the Canadian Environmental Assessment Agency has authority to review any project that may cause significant adverse environmental effects as a means to promote sustainable development.²³⁶ The *CEEA* fosters cooperation between federal and provincial governments on environmental assessments. Like the environmental assessment processes in the U.S. (with the EIA and EIS) and New Zealand (e.g. Assessment of Environmental Effects), Canada's *CEEA* allows for public participation in making final decisions for the approval of projects.

²³⁶ Canadian Environmental Assessment Agency, Legislation and Regulations, online: CEEA <<http://www.ceaa-acee.gc.ca/default.asp?lang=En&n=9EC7CAD2-1>>. The Canadian Environmental Assessment Act (CEEA) came into force on 19 January 1995.

Under the *CEEA*, there are four types of environmental assessments: (1) screening; (2) comprehensive study; (3) mediation; and (4) assessments by review panels.²³⁷ Screening is a process whereby a responsible agency documents the environmental effects of a proposed project and determines methods to eliminate or mitigate harmful effects through modifications to the project plan.²³⁸ Large-scale projects undergo a more intensive assessment known as a comprehensive study, where a Federal Environmental Assessment Coordinator (similar to Santa Rosa's Coordinator) assists federal agencies and their provincial counterparts in conducting screening and a technical review of baseline studies.²³⁹ When the environmental effects of a proposed project are uncertain, and likely to produce significant or adverse effects, input is provided through public consultation, and an assessment is made by a review panel.²⁴⁰ In bolstering mitigation measures, section 62 of the *CEEA* allows for the creation of joint review panels as a bilateral harmonization agreement, where federal and provincial authorities work together to ensure that a project undergoes a single environmental assessment in compliance with all jurisdictions.²⁴¹

The *CEEA* therefore facilitates sustainable water management practices for geothermal development in Canada with its focus on sustainable development. The *CEEA*, requires developers to produce sufficient data, equipment, and materials that will help reduce the impacts of geothermal activities on surrounding water resources. This means that the Federal Environmental Assessment Coordinator can require developers to employ mitigation measures such as re-injection or well-casing. It also means that federal-provincial cooperation (under the

²³⁷ *Ibid.*

²³⁸ *Ibid.*

²³⁹ *Ibid.*

²⁴⁰ *Ibid.* The Canadian Environmental Assessment Registry allows the general public to access records relating to the environmental assessment of a project. The Registry has two components: (1) a website of project information, including a notice of commencement of an environmental assessment; and (2) a file open to the public for each assessment containing all records, reports, or public commentaries. Projects undergoing a comprehensive study or assessment by a review panel must consider alternative means of carrying out a project, and this is where specific environmental measures become significant.

²⁴¹ *Ibid.*, s. 62.

harmonization agreements) will likely produce better water management practices through the combined efforts of joint review panels.

This process reinforces sustainable water management practices in areas where geothermal developers comply with the *CEEA*, and provincial environmental assessment statutes, which includes input from public consultation. Using the protective water measures under U.S. interstate water regulations and New Zealand's integrated resource consent process, Canadian interprovincial waterways can be safeguarded from potentially adverse effects of geothermal development in areas where geothermal-produced water is discharged into waters flowing across provincial boundaries. The *CEEA* protects these waterways by having developers submit local hydrology information that enables provincial and federal regulatory agencies to require mitigation measures suitable for the needs of each specific geothermal site.

a. British Columbia

Geothermal energy development is emerging in British Columbia (B.C.) because of its location in the "ring of fire" region. As Professor Sheilah Martin reported, B.C. was the first jurisdiction in Canada to introduce geothermal energy by focusing on supplying heat to consumers and businesses using a comprehensive regulatory approach involving a tenure system, surface needs of the developer, and the regulation of geothermal extraction.²⁴² British Columbia's *Geothermal Resources Act (GRA)* of 1973 is the first type of geothermal legislation in Canada.²⁴³ The Ministry of Energy, Mines and Petroleum Resources ("Ministry") is the lead agency that regulates all geothermal activities under the *GRA*, covering ownership of geothermal

²⁴² Sheilah Martin, "The Geothermal Resources Act: A Case Study in Resource Management" (1985) 19 U.B.C. L. Rev. 1 at 2.

²⁴³ *Geothermal Resources Act*, R.S.B.C. 1996, c. 171. In British Columbia, a "geothermal resource" means the natural heat of the earth and all substances including water, steam, and water vapour, and substances dissolved in the steam, water, or water vapour obtained from a well. This resource does not include hydrocarbons or water having a temperature of less than 80°C.

resources, site assessment, permits and leases, unitization, and environmental mitigation.²⁴⁴

From a water sustainability perspective, this statute is important because the extraction of geothermal resources (such as steam, water and water vapour) requires a geothermal “development plan” complete with mitigation measures, including re-injection wells.²⁴⁵

Sustainable water management practices are guided by the *Environmental Assessment Act (EAA)*, which assesses, *inter alia*, major projects for potentially adverse environmental effects, and what mitigation measures may be applied to reduce such effects.²⁴⁶

The *EEA* covers water management, water diversion, and groundwater extraction, all of which apply to geothermal development because of their wide-ranging environmental impacts.²⁴⁷

Under the *EAA*, prospective geothermal developers may apply for major projects to the Environmental Assessment Office (under B.C.’s Ministry of Environment) to obtain an environmental assessment certificate.²⁴⁸ A geothermal developer must provide information relating to the scope of the project (including what environmental issues will be addressed in the assessment), and baseline studies which assess cumulative impacts of the project.²⁴⁹

As part of this pre-application phase, sections 10 and 11 of the *EEA* require a developer to specify the procedures and methods that will be applied as part of the project review plan prior to receiving an order.²⁵⁰ If the order is issued, a working group (comprised of *CEEA* representatives, other government agencies, First Nations, and local municipal officials) is

²⁴⁴ *Ibid.*

²⁴⁵ *Ibid.*

²⁴⁶ *Environmental Assessment Act*, S.B.C. 2002, c. 43 [B.C. EEA].

²⁴⁷ British Columbia, Environmental Assessment Office, The Environmental Assessment Process, online: British Columbia Environmental Assessment Office <http://www.eao.gov.bc.ca/ea_process.html>.

²⁴⁸ *Ibid.*, s. 2. Such is the case at South Meager’s geothermal plant. See British Columbia Ministry of Environment, Water Stewardship, Ground Water Extraction Projects, online: <http://www.env.gov.bc.ca/wsd/plan_protect_sustain/groundwater/library/envass.html>.

²⁴⁹ B.C. EEA, *supra* note 246, s. 16.

²⁵⁰ *Ibid.*, ss. 10, 11.

formed.²⁵¹ This working group advises the Environmental Assessment Office about issues related to the environmental assessment, and helps determine the adequacy of any proposed mitigation measures.²⁵² Once the environmental assessment process is completed (normally after 180 days), an assessment report and a draft Environmental Assessment certificate is issued with details setting out how the project must be designed and constructed.²⁵³ Two provincial ministers then make the final decision – usually the Minister of Environment and another minister responsible for that category of project.²⁵⁴

Section 27 of the *EEA* allows the B.C. government to form harmonization agreements with the federal government, other provinces and municipalities, and the United States to conduct “any aspect of environmental assessment.”²⁵⁵ This provision allows B.C. authorities to share information with other governments for research and technological development, or consider changing approaches to environmental assessments. One of the harmonization agreements in place since 11 March 2004 is the *Canada-B.C. Environmental Assessment Cooperation Agreement* (Agreement), which allows B.C.’s Environmental Assessment Office and the federal Canadian Environmental Assessment Agency to create a joint working plan with developers, conduct joint staff training, and to incorporate federal *CEEA* assessment standards into B.C.’s legislation.²⁵⁶

For geothermal development, the Agreement is important as it allows Canadian jurisdictions to apply the latest environmental mitigation measures that promote sustainable

²⁵¹ *Ibid.* Under British Columbia’s *EEA*, the public comment period is a minimum of thirty days, and the entire environmental assessment process has a maximum of one-hundred-eighty days.

²⁵² *Ibid.*

²⁵³ *Ibid.*

²⁵⁴ *Ibid.*

²⁵⁵ *Ibid.*, s.27.

²⁵⁶ Operational Procedures to Assist in the Implementation of the Environmental Assessment of Projects Subject to the Canada-British Columbia Agreement for Environmental Assessment Cooperation, online: <http://www.eao.gov.bc.ca/pdf/CEAA_EAO_Agreement.pdf>. Section 3 of the *Agreement* provides a single process for developers to follow, thus minimizing duplication of the enforcement of environmental mitigation measures under both the federal *CEEA* and provincial legislation.

water management practices by way of research and development. It also encourages federal-provincial cooperation to issue “new clauses committing the parties to coordinate their environmental assessment processes” in the event both parties assess projects with different views.²⁵⁷ This means two things: (1) that different federal and provincial environmental assessment standards may be harmonized to strengthen the overall evaluative process of water resources; and (2) that even if existing geothermal regulations under provincial law do not include specific water mitigation measures, this arrangement ensures that geothermal development proceeds with proper mitigation measures which address water quality and water allocation.

Another relevant statute in B.C. is the *Water Act*, which regulates water resource development.²⁵⁸ Under the *Water Act*, a regional comptroller may issue a temporary grant to divert or use water (if the project is less than twelve months)²⁵⁹, particularly when changes are made in and about a stream.²⁶⁰ Similar to New Zealand’s resource consent process, section 51 of the *Water Act* allows a developer to be incorporated into a “water users’ community”, which is a public corporate body that issues water licences.²⁶¹ A Minister may designate an area for a “water management plan”²⁶² to address “risks to water quality”, whereby the terms of reference would reveal both the scope of the water management plan and public consultations, while also establishing either a technical advisory committee²⁶³, or a ground water advisory board.²⁶⁴ For geothermal well drilling, section 79(4)(c) of the *Water Act* provides for a mitigation measure under which an engineer may order a person to “undertake measures . . . to remediate or mitigate

²⁵⁷ *Ibid.*, s. 4(a).

²⁵⁸ *Water Act*, R.S.B.C. 1996, c. 483. Similarly, under B.C.’s *Drinking Water Protection Act*, the Lieutenant Governor in Council may restrict the drilling, alteration, and installation of wells.

²⁵⁹ *Ibid.*, s. 8.

²⁶⁰ *Ibid.*, s. 9.

²⁶¹ *Ibid.*, s. 51.

²⁶² *Ibid.*, s. 62.

²⁶³ *Ibid.*, s. 62(1)(c). This water management plan may also be prepared in conjunction with B.C.’s *Drinking Water Protection Act*.

²⁶⁴ *Ibid.*, s. 82(1).

the effects of the introduction of anything, contaminant, matter or substance introduced into a well.”²⁶⁵

British Columbia’s *GroundWater Protection Regulation (GWPR)*²⁶⁶ further promotes sustainable water management practices by requiring owners of private geothermal wells (also known as geotechnical wells) to install the following protective devices in boreholes, test pits, or closed loop geothermal wells: (1) surface seals; (2) secure well caps; (3) well-casings; (4) well identification plate; and (5) controlled artesian flow.²⁶⁷ These devices prevent groundwater contamination surrounding the geothermal well by sealing pipes carrying geothermal fluids. Any person planning to construct a private geothermal well must hire a qualified well consultant (e.g. professional engineer or geoscientist) registered with B.C.’s Ministry of Environment to ensure that the installation and use of such devices prevent groundwater contamination.²⁶⁸

Consistent with the water mitigation measures in the U.S. and New Zealand, the elements of water protection legislation in B.C. prompt sustainable water management practices by requiring developers to initially prepare baseline studies that help regulators and the public devise appropriate water mitigation measures. Developers must also install certain materials in well-casings (such as cement) to prevent surface and ground water contamination during geothermal operations. Linking the *EEA* and *Water Act* to the *GRA*, the B.C. government

²⁶⁵ *Ibid.*, s. 79(4)(c).

²⁶⁶ B.C. Reg. 91/2009, s. 8.

²⁶⁷ British Columbia Ministry of Environment, Water Stewardship, Water Protection Act Information, online: <http://www.env.gov.bc.ca/wsd/water_rights/water_act_info/index.html>. The *WPA* also prohibits the construction and operation of large-scale projects that divert water (over 190 million gallons a day) from one major watershed to another. A registration system defines and limits the removal of bulk water in a development project undertaken by a developer. See also *Ground Water Protection Regulation*, R.S.B.C. 2005, c.2. See also British Columbia Ministry of Environment, British Columbia’s Ground Water Protection Regulation – What Private Well Owners Should Know, online: Ministry of Environment <http://www.env.gov.bc.ca/wsd/plan_protect_sustain/groundwater/gw_regulation/GWPR_private_well_owners.pdf>. See British Columbia Ministry of Environment, FAQs for the Ground Water Protection Regulation, online: Ministry of Environment <http://www.env.gov.bc.ca/wsd/plan_protect_sustain/groundwater/gw_regulation/faq_geotechnical.pdf>. At the end of its service after five years, the private geothermal well must be deactivated and, after ten years, the well must be closed.

²⁶⁸ *Ibid.*, s. 71.

requires geothermal developers to provide detailed studies that list potential cumulative impacts for a proposed project, and then after public consultation and input from technical or groundwater advisory groups, appropriate water mitigation measures can be adopted.

What is missing from B.C.'s *GRA* is a specific provision for environmental mitigation measures that maintains water quality and allocation, unlike the regulatory frameworks in the U.S. and New Zealand. Although it is understood that the *EEA* will automatically be triggered in assessing the potential environmental effects of any geothermal project (since it involves water extraction), it would be prudent to include a provision for water management practices in the *GRA*. Section 14 of the *GRA* does permit an investigation of the geothermal resource, and for sampling or testing of geothermal fluids to be done by developers and regulators, and includes specific criteria for water mitigation measures that would help developers avoid seeking an application through the *EEA*.²⁶⁹ Section 16(4) allows a regulator to set out remedial measures, but there is no mention of water resources.²⁷⁰

Although B.C. can consider mitigation practices from various U.S. jurisdictions to strengthen its water management regime for geothermal development, perhaps amendments should be made to the *GRA* itself. The only *GRA* provisions that refer to environmental mitigation measures relating to water sustainability are found in section 23, where regulators are permitted to prescribe mitigation measures for adequate well casing, pre-drilling and post-drilling conservation methods for “geothermal resources and water”, and “containing or eliminating spillage”.²⁷¹ These mitigation measures include the installation of cement to bind pipes together to prevent cross-contamination of water sources around the geothermal well.

²⁶⁹ *Ibid.*, s.14.

²⁷⁰ *Ibid.*, s.16(2)(b).

²⁷¹ *Ibid.*, ss.23(1)(h), (j), (t).

British Columbia should include a “Best Management Practices” provision to its geothermal legislation to better protect its water resources.

b. South Meager Geothermal Project

The most recent geothermal project located in southwest B.C. is the South Meager Geothermal Project (South Meager), where electricity generation is being planned for commercial operations around 2012.²⁷² For this project, the B.C. Ministry of Forests is the lead agency in managing a dual-flash turbine power plant, which will connect to a transmission line managed by the B.C. Transmission Corporation.²⁷³ This project will involve the design, installation, and maintenance of production and re-injection wells, and geothermal fluid gathering systems.²⁷⁴ An environmental assessment conducted at South Meager under B.C.’s *EAA* reveals how the applicant, Meager Creek Development Corporation, must apply a series of specific mitigation measures designed to reduce the impacts of the power plant on local water resources, and that will lead to sustainable geothermal water management practices.²⁷⁵

First, the applicant must describe field work associated with the installation of water level recorders downstream from the proposed area of development to monitor the amount of water being withdrawn and used for the geothermal project.²⁷⁶ Second, the applicant must provide hydrological studies to the B.C. Environmental Assessment Office revealing how both surface

²⁷² Western GeoPower Corp., South Meager Geothermal Project, Project Description, online: Western GeoPower Corp. <<http://www.geopower.ca/meagerdescription.htm>>. South Meager is located in the Meager Creek hot springs area, which is a tourist location during the summer months.

²⁷³ *Ibid.*

²⁷⁴ *Ibid.*

²⁷⁵ B.C. Environmental Assessment Office, South Meager Geothermal Project, Terms of Reference for an Environmental Assessment Certificate Application under the *B.C. Environmental Assessment Act* (May 2005), online: B.C. Environmental Assessment Office <http://a100.gov.bc.ca/appsdata/epic/documents/p240/1116955745297_9ef0a5e0ee684d23a89daa3546d68f54.pdf>. The South Meager Geothermal Project is not subject to the *Canadian Environmental Assessment Act (CEEA)*. Should a federal environmental assessment be required, the B.C. Environmental Assessment Office and the Canadian Environmental Assessment Agency will harmonize the review of the project. The applicant, Meager Creek Development Corporation, held public consultation meetings in December 2004 in Birken and Pemberton, B.C.

²⁷⁶ *Ibid.* at 13.

and groundwater sources will be affected by its development.²⁷⁷ The data collected must show how wetlands, community watersheds, and wells used for drinking water will be affected by the project in terms of the impacts of the construction, operation, and decommissioning of the geothermal plant.²⁷⁸ Third, the applicant must identify waterways within the project area using GPS photos, as well as flood levels for existing waterways in accordance with federal *CEEA* guidelines.²⁷⁹ To provide for these mitigation measures, an applicant must submit an Environmental Management Plan (EMP) to the B.C. Environmental Assessment Office during each phase of geothermal development.²⁸⁰

It follows that when the applicant implements these mitigation measures, the water quality of surrounding waterways will be maintained. Moreover, re-injection of geothermal fluids (using modern geothermal fluid gathering systems) should preserve sufficient quantities of discharged water that will flow from the South Meager plant. Perhaps this project can use wastewater from surrounding communities to replenish water resources in areas where extraction occurs. The hydrological studies will outline the characteristics of geothermal reservoirs, that will help planners locate and control where re-injection could occur. Through the EMP, the applicant can mitigate the adverse effects of the power plant during the four stages of geothermal development, while recycling water. Therefore, it is likely that the EMP will better sustain the quality and quantity of water resources over a longer period to help continue generating electricity for local communities. British Columbia thus represents a Canadian jurisdiction where an integrated-style water resource management appears to be emerging under various provincial statutes, with the assistance of federal environmental assessment legislation. Notwithstanding this framework in B.C., stronger measures are needed to protect water quality standards and water allocation.

²⁷⁷ *Ibid.*

²⁷⁸ *Ibid.*

²⁷⁹ *Ibid.*

²⁸⁰ *Ibid.* at 34.

c. Proposed Environmental Mitigation Measures for Sustainable Water Management Practices in Canada's Geothermal Sector

Federal and provincial geothermal legislation in Canada should draw upon current water sustainable management practices in the U.S. and New Zealand. As discussed by Bradbrook, geothermal resource development requires separate legislation in accordance with the experiences of jurisdictions where this resource is in use.²⁸¹ After reviewing the water sustainability approaches in the U.S., New Zealand, and B.C., the following five mitigation measures are recommended that will lead to more sustainable water management practices in a future geothermal industry in Canada: (1) Re-injection of produced geothermal water into wells; (2) Drainage and discharge practices (Geysers wastewater management and storm water management program); (3) Casing of geothermal wells; (4) Baseline aquifer testing; and (5) a Water Quality and Quantity Monitoring Program.

Re-injection measures help recycle discharged water flowing from the geothermal plant by returning to the produced water into the geothermal reservoir, thereby replenishing areas that experience water scarcity due to regular extraction of water from ground sources. Drainage and discharge practices should follow the Geysers wastewater model, where municipal wastewater systems supply water to nearby geothermal reservoirs with the help of stormwater management programs. Well-casing is a valuable mitigation measure because it prevents water contamination from occurring around the geothermal well, where boreholes are sealed by cement.

Aquifer testing is an important hydrogeological method that exposes the properties of the aquifer to preserve its character for recreational and aesthetic/cultural purposes. Finally, a monitoring program will ensure that chemical (arsenic and other metals) and physical properties of the water resources are not creating adverse effects in terms of water quality standards. These

²⁸¹ Adrian J. Bradbrook, "The Contents of New Geothermal Legislation" (1987) 5 J. Energy Nat. Res. L. 81, at 84. See also A.D. Tarlock & R.L. Waller, "An Environmental Overview of Geothermal Resources Development" (1977) 13 Land and Water L. Rev. 289, at 293.

recommended water mitigation measures are designed to protect and preserve the quantity and quality of both surface and groundwater resources following the modern approaches in the U.S. and New Zealand, two jurisdictions with decades of experience in applying environmental mitigation measures to promote sustainable water management practices for geothermal development.

CONCLUSION

Water plays an important role in geothermal development. But, the management of this precious resource must reflect sustainability – which means the maintenance of water quality and water allocation. Sustainable water management practices are essential in the geothermal industry because they protect potable water supplies for human/animal consumption and natural habitats. They also prevent water from being depleted from a given area over the long-term, thus preserving water resources so that geothermal developers may continue extracting geothermal fluids using the same water supply. Although geothermal energy will reduce greenhouse gas emissions rather than fossil fuels, water management issues must be addressed through mitigation measures to reduce adverse environmental effects from heavy metals such as arsenic on surrounding environments. Water mitigation measures in the geothermal sectors of the U.S. and New Zealand lay the foundation for law and policy in Canada’s emerging geothermal industry to avoid water contamination, depletion, and achieve water sustainability for direct and indirect uses.

The U.S. geothermal regulatory experience shows how detailed environmental impact studies requiring mitigation measures (such as re-injection) for proposed projects can protect water resources from adverse effects that flow from such activities. The New Zealand regulatory experience has an integrated resource management regime that allows regional councils to issue resource consents to monitor water use for geothermal projects, particularly those on a large-

scale such as Wairakei. The U.S. and New Zealand experiences influence recent geothermal projects in B.C., which are applying similar mitigation measures to promote sustainable water management practices. Using this comparative approach on a broader level, governments in Canada should adopt new environmental mitigation measures to create sustainable water management practices under federal and provincial regulatory frameworks.