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# Optimisation of Surface Infrastructure and Heat Sinks for Low Enthalpy Direct-Use Geothermal Energy Systems in the City of Regina Indoor Aquatic Facility

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## INTRODUCTION

Commercial applications of low enthalpy geothermal systems are challenged by their relatively high capital cost in comparison to conventional heating systems. Geothermal system return-on-investment (ROI) is significantly improved by extending the system to year-round utilization applications, by optimizing the heat extraction from pumped geothermal resource water, and by minimizing the peak sizing of energy extraction systems relative to the overall energy consumption of the heat sink.

The City of Regina has embarked on the implementation of a low enthalpy Geothermal Heating Facility (GHF) to provide heat to the Indoor Aquatic Facility (IAF) in Regina, Saskatchewan, currently under design. This is one of the largest applications of a deep well low enthalpy direct use geothermal system in Canada and is intended to make a significant contribution to the City of Regina's goals in their Energy and Sustainability Framework.[1, 2]

## DISCUSSION: PRECEDENTS FOR LOW ENTHALPY GEOTHERMAL SYSTEMS INFORMING THE CITY OF REGINA INDOOR AQUATIC FACILITY HEATING SYSTEM DESIGN

**Low enthalpy direct-use geothermal systems** have been in use in the Perth Basin of Australia for over 25 years. These have primarily served large aquatic centres with their year-round heating load. Despite system inefficiencies, ROI was typically sufficient to displace the gas-fired systems, without credit for carbon displacement.

**Second generation systems** now developed have employed optimisation techniques to improve reliability and efficiency. These designs employed in large aquatic centres in Western Australia have resulted in ROIs sufficient to justify investment in geothermal heating systems when compared to electrically driven heat pumps.

Optimisation techniques employed typically result in **coefficients of performance (CoP) often in the range of 25 to 35** in second generation systems.

**Sites in the Netherlands** have become common over the past 15 years, serving district heating systems, occasionally aquatic centres, but more commonly industrial applications—particularly greenhouses—which have near year-round heating requirements. Aquifer productivity and injectivity are less than that of the Perth basin, with consequent lower CoP; however, their designs have provided important lessons for the Regina IAF geothermal heating system.

## RESULTS: CITY OF REGINA INDOOR AQUATIC FACILITY GEOTHERMAL HEATING SYSTEM DESIGN

The City of Regina GHF is being planned to take advantage of lessons learned from Perth Basin second generation geothermal systems optimisation, while dealing with the specific characteristics of the source aquifers at the Regina IAF site using techniques and materials selections evolved from Netherlands and Paris Basin wells.

The hydrogeological conditions at Regina are similar to that of the Netherlands sites, but with anticipated lower gas to liquid ratios, some risk that hydrogen sulphide in low concentrations may be present in the fluid, and anticipation of dissolved mineralisation which may induce scaling particularly at the varying pressures and reduced injection temperatures following the heat exchange process. The chosen system concept is one of a pressurised system intended to keep all gas in solution and reinjected into the aquifer.

The currently modelled IAF design load at project Schematic Design stage is nominally 7.3 MW. The geothermal system integration into the IAF mechanical systems has displaced the common and expensive mechanical dehumidification process in aquatic facilities, saving capital cost, building area, electrical infrastructure capacity and operating costs.

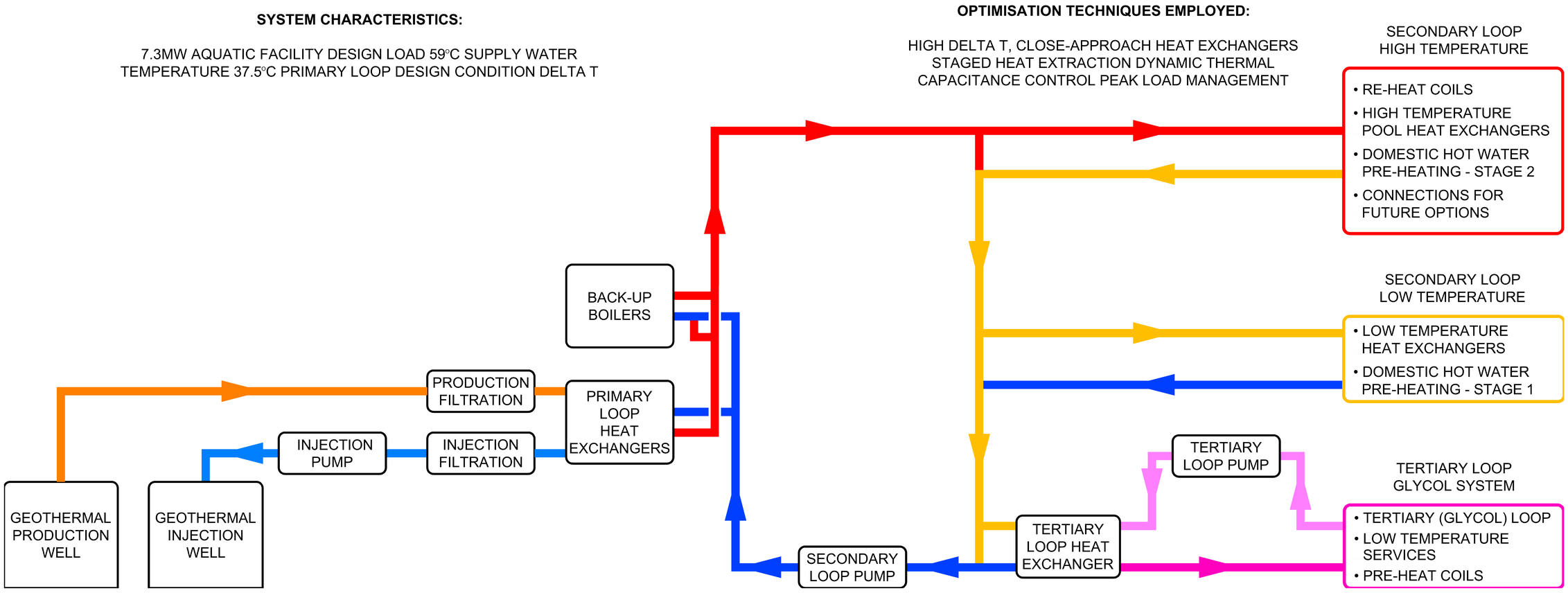



**Figure 1. Simplified Process Flow Diagram.**

## CONCLUSION: THE CHALLENGES OF APPLYING LOW ENTHALPY GEOTHERMAL HEATING IN CANADA

The Regina GHF project is the first of its size in the region:

- There remain **unknowns in subsurface conditions** which will impact surface infrastructure design construction, and operation. Subsurface and hydrogeological conditions can be challenging in comparison to conventional heating system design, and lessons learned from applications in other jurisdictions are essential for such new projects.
- The Canadian **regulatory regime is evolving** and has yet to develop specific processes and policies fully appropriate to deal with the differences between geothermal systems and the much better understood oil and gas industry applications.
- Building **Heating, Ventilating and Air Conditioning (HVAC) designs require re-thinking** from past conventional approaches in order to fully benefit from geothermal system applications.
- The City of Regina IAF design team is continuing to conduct thermal modelling for the IAF which will inform overall seasonal coefficient of performance. The City is considering **opportunities for service to additional facilities** to increase the seasonal utilisation factor and operational cost savings.
- The production well is anticipated to be **drilled and tested by October 2026**, at which time aquifer performance and geochemistry will be analysed leading to refined optimisation strategies on scale management, primary system pressure control, fluid delta T, aquifer productivity and injectivity and thus flowrates, pump selections, and heat exchanger selections.

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