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Technical, regulatory, and pore space challenges for geothermal in an urban setting: Examples from the City of Regina Deep Geothermal Project

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Abstract

The City of Regina is taking the lead among Canadian jurisdictions to become a sustainable municipality and by becoming 100% renewable by 2050. The city has adopted an Energy and Sustainability Framework that furthers the commitment to building a sustainable community.

The city is in the planning stages of developing a new indoor aquatic facility, which will be heated by deep geothermal energy that aims to utilize the energy extracted from an open-loop geothermal well pair. The targets for this geothermal system are the Cambro-Ordovician Winnipeg and Deadwood Formations at a depth of approximately 2,000 m. The geothermal system provides a clean source of energy that significantly reduces greenhouse gas emissions for the indoor aquatic facility, which will consume significant amount of energy.

Deep geothermal projects like these are common in Australia and parts of Europe, however this will be one of the first that operates in a large Canadian urban setting. From a regulatory standpoint, the geothermal project is regulated by the Saskatchewan Ministry of Energy and Resources (MER) and legislation that has been largely developed for rural oil and gas disposal wells. The project team has worked collaboratively with MER to understand concerns and develop project-specific considerations required to deliver a safe project in an urban setting. As the geothermal project advances into the operational stage, ongoing reporting and requirements will be provided to MER to ensure safe and transparent operating parameters are met.

This work will expand on regulatory/technical challenges related to monitoring for microseismicity, managing H2S in the aquifer brine, well setbacks, and rig spacing requirements. Further considerations also include pore space ownership including the challenge of densely spaced ownership city lots, and how the regulator and City are planning to approach these issues.

INTRODUCTION

In the winter of 1978-79, an exploratory geothermal well was drilled to the depth of 2,226 m at the University of Regina (UofR) campus in the City of Regina, Saskatchewan, Canada as shown in Figure 1a. The goal of the project was to explore extracting geothermal energy to support required heat for a sports complex planned to be built on campus at that time. Although the well was not utilized for the visioned purpose, significant invaluable information was attained about the geology of the target setting, and characteristics of the aquifers including productivity and temperature. The well was completed into the Basal Clastic Unit from the Western Canadian Sedimentary Basin (WCSB) which comprises the Winnipeg and Deadwood Formations from the Ordovician and Cambaria periods, and had an open hole section to the depth of 2,034- 2,226 m (Vigrass et al., 2007).

In 2018, the City of Regina (CofR) passed a motion to “Make Regina a Renewable City”. This Motion led to a prefeasibility study on utilization of geothermal energy conducted by Petroleum Technology Research Centre (PTRC). This study aimed to demonstrate the potential of geothermal resources in the CofR’s subsurface area, to supply a significant amount of energy for a new indoor aquatic facility with no direct GHG emissions. This study was built upon all valuable information and data acquired from the 1978 UofR well and other wells around the study area, along with the significant geological knowledge acquired across the region. Figure 1b, shows the results from the geological assessment and modeling, and demonstrates a high level of confidence for

geothermal development in the CofR. Deadwood and Winnipeg aquifers would be reached at an approximate depth of 2200 m and would result in accessing 60°C water. The results from the model did not show any significant temperature reductions or thermal breakthrough over 70 years of operation. The project would avoid emitting 457,080 tCO_2 by replacing burning natural gas with the heat extracted from the geothermal resource.

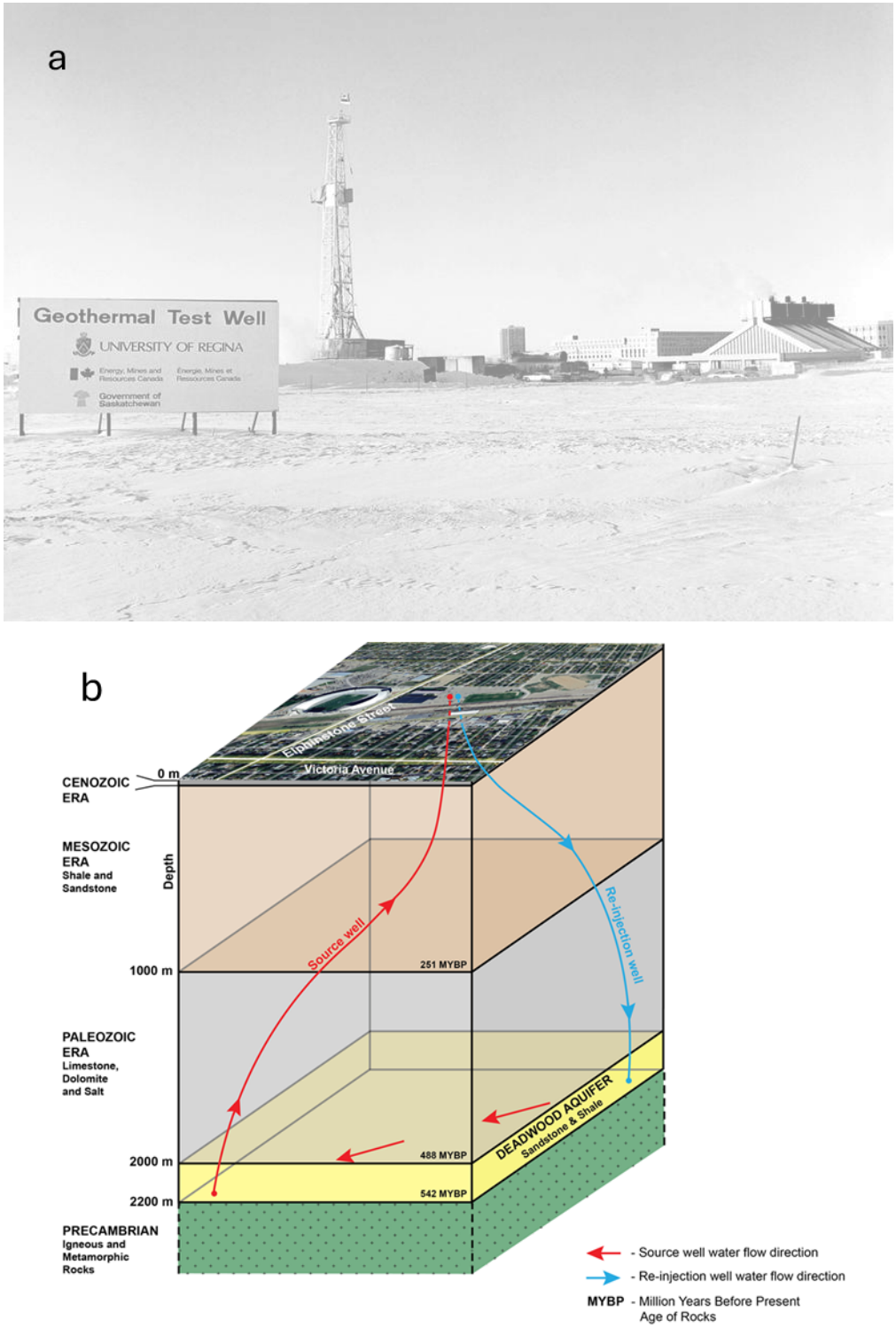


Figure 1. a) The drilling rig of the geothermal test well at the UofR campus in 1979, b) the possible well design of the new indoor aquatic facility in the CofR downtown area

Following that study, the CofR secured a $285.1 million budget for building the Indoor Aquatics Facility (IAF), with an additional $28.5 million allocated for the Geothermal Heating Facility (GHF) construction. The budget is a cumulative total of federal, provincial, and municipal government funding to support sustainable development and infrastructure with net-zero emissions. The CofR broke ground for the IAF on August 19, 2025 (The City of Regina, 2025).

A team of local and international experts is working alongside the CofR management on the geothermal component of the project. This includes new modelling, further geological and geophysical characterization, well design and cost optimization, drilling strategies, and acquiring the required licenses. This team has brought a broad perspective, knowledge and expertise to work on the project and overcome challenges to make the very first geothermal project in a major Canadian city a success.

The Oil and Gas Conservation Act (OGCA) (CO2 The Oil and Gas Conservation Act NOTE, Accessed 2025) is administered by the Saskatchewan Ministry of Energy and Resources (SMER) to regulate activities associated to any conservation and development of oil and gas resources in Saskatchewan, which includes drilling for oil and gas exploration purposes, production from the drilled wells, and operation around this industry comprising transportation, distribution, processing and disposal of any main and side products of extraction. The ministry also governs and supervises regulations and policies of all other natural resources. SMER has 31 Directives in place to outline organizations' obligations for certain requests or activities.

Our work included in this paper attempts to expand on these existing regulations around the oil and gas industry, which are more dominant in rural areas of Saskatchewan, and then bridge and adjust regulations for geothermal in urban settings.

PORE SPACE

In the province of Saskatchewan, according to the Crown Minerals Act, the Crown (government) owns the right to lease out minerals and pore space of Crown lands to different entities for production. However, the Crown has no authority over leasing out minerals or pore space for freehold mineral rights holders. If the land is Disposed Crown Land: "Consent must be received from holders of Crown disposition for directly impacted lands, including where disposition is a result of oil and gas leases, licenses or permits issued pursuant to The Crown Minerals Act." (Randy Brunet, 2024).

The CofR geothermal project experts have been fully aware of the obstacles and concerns around the pore space ownership and permit requirements for any subsurface development and energy harnessing projects. A very thorough study has been conducted to first optimize the location of the wells' bottomhole location, considering the reservoir properties in relation to the mineral owners.

According to Directive PNG009 (Government of Saskatchewan, 2020), all operators are obligated to provide offsetting or impacted mineral owners or operators with notification. This directive discusses the required regulations and procedures created by SMER that need to be followed by proponents of subsurface activities for the public notice process. It is stated in the regulations that acquiring consents from offset parties would eliminate the need for public notice.

The public notice should contain enough technical information to justify the project and the well or subsurface activity. It should be published on the SMER website called "posted for notice" as well as being mailed out to all affected parties unless otherwise already approved. According to SMER, the required zone to receive public notice for a geothermal project – only the disposal not the injection well – is a 1.6 km radius from the proposed bottomhole location of the well.

The CofR has been proactive in this matter by sharing the project information through holding several open houses, which took place in May 2025, and public announcements in March 2024. One of the integrated strategies and the backbone of this geothermal project is public engagement. The CofR has held meetings involving 50 community groups, organizations, and stakeholders, and has prepared three surveys with cumulative 3,900 responses. Figure 2 shows part of a distributed information pamphlet for the public engagement and open houses.

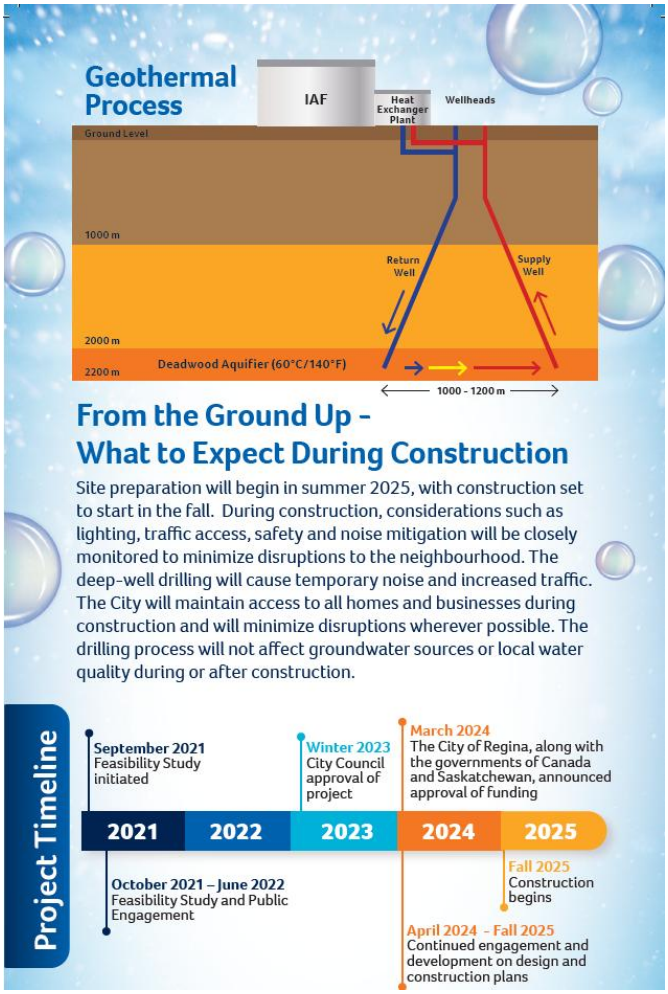


Figure 2. Indoor Aquatic Facility post card for public engagement activities

SET-BACK DISTANCE

Set-back requirements are outlined by the regulator for any wells drilled for oil and gas production, or for injection or disposal purposes in Directive PNG004. The set-back distances are defined as minimum distances that a well must be separated from a specific entity. The operators of such projects must be fully aware of the applicable legislation governed by SMER and comply with the requirements prior to launching any well construction activities on leased land. The document on compliance of the licensee with the required set-backs is available from SMER. The applicable set-backs for the CofR project are 75 m from right-of-ways of any surface improvements except surveyed roadways and road allowances, and 40 m from underground utilities. As well, set-backs should be 125 m away from bodies of water, occupied dwellings, public facilities, or any other urban centres. Surface improvements, according to the PNG004 Directive, include but are not limited to railways, water wells, above-ground pipelines, utility lines such as power and telephone lines, and access roads and roadways.

The required set-backs can be overruled for underground utilities if the utility is operated and owned by the licensee or it provides the service for a specific well or facility. If the well drilling and operation cannot meet the residential set-back requirements, the licensee must obtain consent from residents and owners of that area while providing the information on the estimate of H_2S concentrations from the planned well or production stream. In the event that set-back distance requirements regarding water bodies and surface development cannot been met, the proper consent from the rightful owner must be obtained prior to the license application submission.

The well and surface design teams of this project have done comprehensive studies to find the optimum locations for the geothermal doublet wellheads to fulfill the SMER set-back requirements. However, the logistics of the project, which aims to construct a geothermally heated recreational facility, means the project is directly located in the downtown urban setting. Therefore, it is inevitable the wellheads will not fulfill some of the set-back regulations due to its location and connection to a major new public facility. The ministry notes a sub-

clause in Directive PNG004 that exemptions can be made for the set-back distance obligations if the proper consent and approaches take place to acquire permissions from affected rightful owners and infrastructure operators. Figure 2 indicates the satellite picture of the geothermal project area.

Observations by the technical team at the drilling site and the potential wellhead location indicate there would be adequate space for the drilling rig, its movement from one wellhead to another, and all designated areas for the drilling equipment and testing.

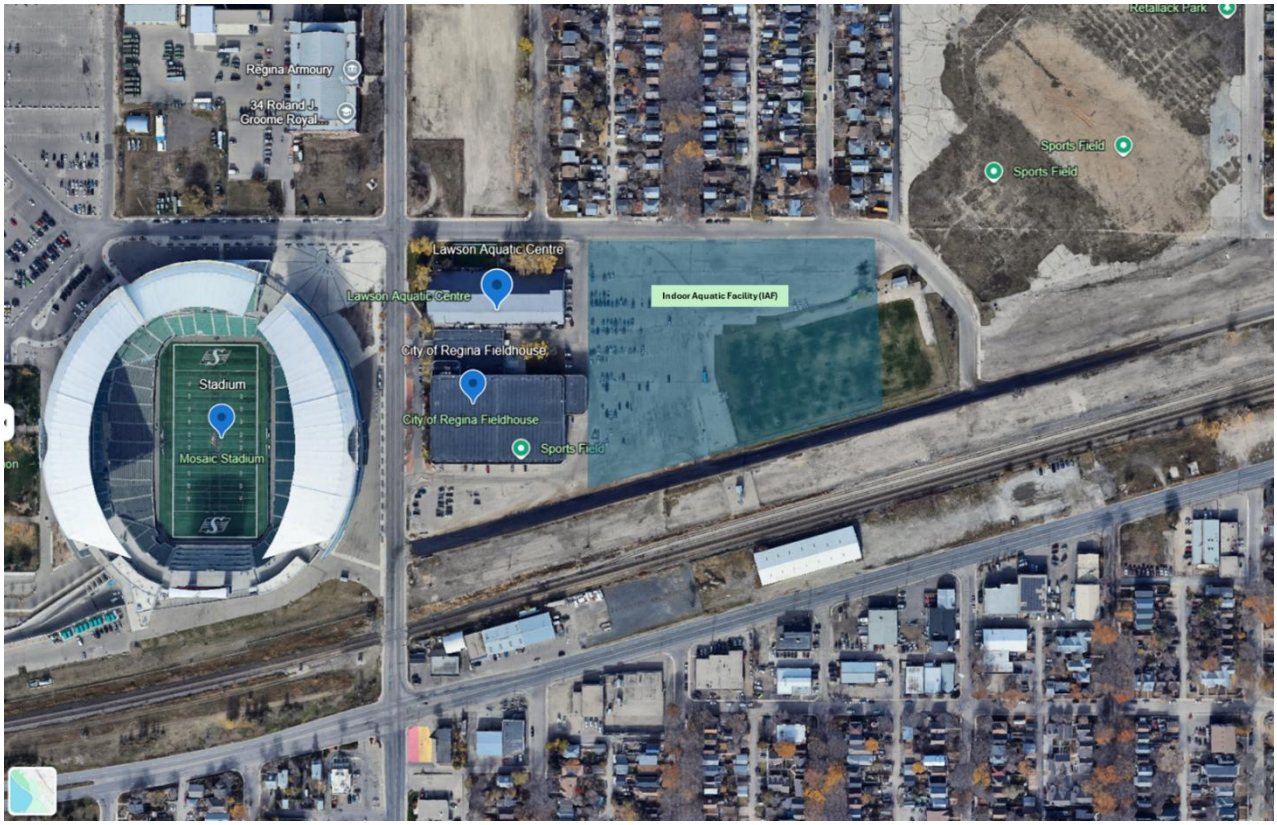


Figure 3. Google Earth view of the IAF estimate perimeter (shaded blue)

H_2S MANAGEMENT

A study published by Vigrass (Vigrass et al., 2007) on the University of Regina's geothermal project reported the dissolved gases collected from the Basal Clastic Unit through a pump test. The study showed the possibility of the presence of H_2S in the reservoir fluid and the separated gas stream. However, discussions with geology and drilling experts in Saskatchewan did not strongly come to the conclusion that H_2S is present in the targeted aquifers in the Regina area. Drilling new geothermal wells and precise testing will definitely provide answers to this question.

Despite the possibility of the presence of H_2S from the targeted geothermal reservoir, the topic has been reviewed and discussed by the CofR project team to consider precautionary actions should the issue arise, and in accordance with what is described in Directive PNG036 on "Venting and Flaring Requirements" and Directive PNG001 on "Facility License Requirements".

The regulator advised that the licensee carry out air dispersion modelling as advised in the Saskatchewan Air Quality Modelling Guideline to calculate H_2S should it occur around the operating facility (Venting and Flaring Requirements, Retrieved 2025).

The facility intending to acquire a license is obligated to incorporate a proper Corporate Emergency Response plan (ERP), which must include an emergency contact number in the application submitted to the ministry. The ERP can also incorporate emergency planning zone (EPZ). In the EPZ calculation, H_2S should be considered according to Directive PNG001 (Facility Licence Requirements Directive PNG001 Record of Change Revision Date Description, 2023).

This geothermal extraction will be operated in a completely closed loop system at the surface, meaning that no reservoir fluid will be exposed at surface. However, a precautionary plan will be in place if the H2S presence is proven.

MICROSEISMIC MONITORING

According to the Saskatchewan Oil and Gas Conservation Act, a specific storage project needs to obtain authorization from SMER through the Integrated Resource Information System (IRIS) before licensing, recompleting or reclassifying a well related to projects which include underground reservoirs or salt caverns, hydrocarbon and waste disposal storage, geothermal, and CO_2 storage. The authorization application requires project-specific documents and approvals, which should be submitted in an operator's IRIS account. One of the required documents to be submitted is the "Application for a geothermal project form" that is composed of necessary and applicable supporting documents such as seismic data and a report as a part of a monitoring program (Government of Saskatchewan, Retrieved 2024).

The CofR has considered the monitoring program and recognizing the importance of the public safeguards. It is planned to install an optimum number of seismic monitoring devices set up around the injection well's bottomhole at optimum location. The stations will record ambient baseline noises prior to injection and following during the operation/injection phases. The baseline records will assist in better processing data during operations, by eliminating environmental noises that are very predominant in the downtown area of Regina due to all public transportation, railroads, and public and industrial activities. Data from a recorder is processed along with filtering the noises to the best of the devices' abilities, and consequently analyzing and studying any activities in the area.

CONCLUSIONS

Saskatchewan is the second-largest oil-producing province in Canada, therefore many years of oil and gas industry exploration and operational data have brought invaluable knowledge, information, expertise, hands-on experience about different jurisdictions' geology, drilling awareness, and well operational experience. Regina has always advocated for utilizing renewable energies and working toward integrating more sustainable technologies into its metropolitan area development for the welfare of its residents. In 1978, the very first attempt in harnessing geothermal energy was done on the University of Regina campus with drilling the first geothermal exploration well to the depth of 2,226 m into the Precambrian and the Winnipeg aquifer. Despite the well not being deployed for the planned goal, all the acquired information and samples were preserved to be studied and utilized for future developments and planning.

In 2024, the City of Regina was granted $285.1 million from civic, provincial and federal government sources to construct a new indoor aquatic facility heated by geothermal energy, aimed to be one of the first investors in geothermal energy infrastructure development in Canada. The Saskatchewan Ministry of Energy and Resources is administering the Oil and Gas Conservation Act to regulate any subsurface extraction and exploitation activities, including oil/gas exploration and drilling, as well as other storage and production operations. The Ministry has Directives in place to obligate subsurface developers in the directing of these activities. Geothermal projects are classified under storage projects for acquiring licenses and must comply with all applicable Directives extracted from PNG 001, PNG004, PNG009, and PNG036. Directives highlight regulations on oil and gas activities and do not directly cover geothermal expansion regulations, specifically for urban settings. However, The City of Regina and the designated team of experts working on this project are working closely with the ministry to overcome all challenges and fulfil the regulator's requirements to operate one of the very first successful geothermal project in Canada.

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