



2025 CWRA Alberta Branch and IAH-CNC Conference

Lister Centre, University of Alberta

November 12 - 14, 2025

ABSTRACTS

***Presenter/s**

Thursday November 13, 2025

Maple Leaf Room

10:30 – 12:00: Social and Cultural Dimensions of Water

Title: Inclusion of Groundwater within Canada's Freshwater Monitoring

***Cathy Ryan, Cynthia N. McClain, and Richard Jackson**

Groundwater is critical to Canada's freshwater systems, sustaining baseflow in rivers, supporting aquatic ecosystems, and supplying drinking water to more than one-third of Canadians. Yet, unlike surface water, it is largely absent from Canada's national freshwater monitoring programs. The National Hydrometric Program (NHP) and Freshwater Quality Monitoring and Surveillance (FWQMS) program - both operated by Environment and Climate Change Canada - monitor thousands of surface water stations, but only nine groundwater wells, with no systematic inclusion of groundwater quality. In contrast, all other G7 have national groundwater monitoring programs. We examine the historical context, current patchwork of provincial and territorial monitoring, and the consequences of excluding groundwater at the national scale. Without integration, Canada lacks the ability to link groundwater levels and quality to streamflow generation, drought detection, fisheries health, or non-point source contaminant loading. Baseflow studies show groundwater contributes over half of total river discharge in many watersheds, making its omission particularly concerning under climate change. We propose a feasible pathway forward: coordinate existing monitoring networks into a shared, "network of networks", harmonize standards for well siting, monitoring methods, and analytes, and ensure data interoperability. Critically, groundwater monitoring should be administratively embedded within the NHP/FWQMS to support integrated freshwater management. Canada already has the institutional architecture to achieve this coordination. Success hinges on political will and administrative action. Establishing a national groundwater monitoring program is not only feasible but urgently necessary for resilient, science-based freshwater policy and reporting.

Title: Elevating Groundwater in Canada's Freshwater Future: Advocacy, Policy, and Outreach

*Cynthia McClain, Audrey Marie Hill, Reginald Somera, Cathy Ryan, Mike Wei, Jonathan Keizer, Maggie McLennon, Randy Stotler, Austin Lees, Brian Smerdon, and Brendan Mulligan

Over the past 2.5 years, the International Association of Hydrogeologists - Canadian National Chapter (IAH-CNC) has advanced a coordinated effort delivered by a committee of volunteers to strengthen groundwater advocacy and policy engagement in Canada. This work builds on early milestones, including a 2024 survey of federal, provincial, and territorial government staff on groundwater priorities and the submission of a parliamentary brief to the House of Commons Standing Committee on Environment and Sustainable Development, Groundwater is Critical to Effective Freshwater Management in Canada. In 2025, we rapidly expanded and strengthened organizational capacity by hiring a Mitacs intern, and onboarding new IAH-CNC volunteers. We conducted a membership demographics retrospective and survey on hydrogeologists' roles, challenges, and priorities in Canada which highlighted the need for increasing awareness, outreach, communications, funding, and capacity. The committee's work currently focuses on four priority areas: targeted advocacy, public communications, event participation, and policy review. Engagements with senior leaders at the Canada Water Agency, Natural Resources Canada, and Environment and Climate Change Canada have informed the Freshwater Data Strategy, and National Freshwater Science Agenda. Public communications has expanded through >20 LinkedIn posts, drafting a branding framework, and article. Members have amplified groundwater's profile at key forums, including the National Dialogue on Groundwater, Ontario Groundwater Geoscience Open House, BC Groundwater Science Symposium, and the annual IAH-CNC conference. The committee is also contributing to a national groundwater policy review led by Blue Range Labs. Through these efforts, the IAH-CNC is building momentum toward sustained national groundwater advocacy and impact.

Title: Combining Science and Community Priorities to Strengthen Groundwater Governance

Maggie Finkle-Aucoin, *Braeden Toikka, and Richard Johnson

Groundwater plays a central role in Alberta's water security, sustaining rural communities, municipalities, agriculture, and ecosystems. Despite its importance, groundwater remains under-monitored and under-represented in watershed planning. Communities across Alberta are experiencing drought, record-low surface and groundwater levels, and growing uncertainty about long-term availability. These challenges highlight the need for governance approaches that integrate scientific data and community priorities. Living Lakes Canada, in collaboration with the Oldman Watershed Council and the Piikani Nation Lands Department, has launched the Alberta Groundwater Program pilot in the Oldman Watershed to address this gap. Drawing from our successful Columbia Basin Groundwater Program, the project blends scientific assessments and technology with open data and community priorities, aligning monitoring with local decision-making needs. This approach strengthens the collective understanding of groundwater and its connections to surface water. It also engages communities directly in the process, supporting more informed watershed

governance. This presentation will explore how the program is advancing groundwater governance in Alberta by making data available that fills gaps in the provincial network, providing municipalities, Indigenous governments, and stewardship groups with the information needed for informed planning and management. It will highlight early insights from the pilot, discuss how community-driven priorities are shaping our monitoring and planning, and reflect on the opportunities this model offers for integrating science, community priorities, Indigenous knowledge, and local engagement into water management. Attendees will leave with a clear understanding of how the Alberta Groundwater Program offers a pathway for resilient watershed governance in a time of accelerating water stress.

Title: Missed Connections: Accounting for Interactions between Groundwater and Surface Water in Water Allocation Reform

Dustin Garrick, Mike Wei, Sophie Bhalla, *Isabel Jorgensen, Jonathan Keizer, and Alan Shapiro

Major reforms to groundwater permitting have been underway across Canada in the last decade, spanning from British Columbia to Prince Edward Island. There is a growing opportunity to learn from innovations and implementation efforts across jurisdictions to identify common challenges and governance responses. We share preliminary results from an ongoing study, commissioned by the Gordon Foundation, that reviews Canada's groundwater governance and policy and makes recommendations for addressing gaps and priorities. The study includes multiple objectives, ranging from analysis of provincial and territorial approaches to groundwater allocation to mapping federal roles in groundwater management and learning from Indigenous approaches to address groundwater in freshwater governance. In this presentation, we focus on preliminary results from a comparative analysis of provincial and territorial approaches to groundwater allocation and management. We synthesize information from laws, policies, available technical documents, and expert networks to compare provincial and territorial approaches to groundwater permitting and licensing. The proposed presentation will focus on the hydraulic connection between groundwater and surface water to identify different approaches to this challenge and share emerging lessons for research and practice.

Title: Innovative Licence Transfers to Support Growth and Community Resilience in Water-Limited Basins

Brie Nelson and *Rob Hough

Since 2006, Alberta's Bow, Oldman, and South Saskatchewan River sub-basins have been closed to new surface water licences, creating a highly allocated water system where municipal growth and industrial development must rely on alternative sources, efficiency improvements, and licence transfers. This context has fostered a collaborative water management system and an informal water licence market that often produces , "win-win-

win” outcomes. The Town of Cochrane, a fast-growing municipality in the Bow River Basin, has focused on acquiring additional water licences to support long-term growth. At the same time, Camp Jubilee – a longstanding Girl Guides facility providing outdoor education to the community - faced potential closure due to inadequate water and wastewater infrastructure and the impacts of the 2013 flood on its recreational water licence. Coordinated and facilitated by WaterSMART Solutions, the Town, Girl Guides, Bow River Irrigation District, and Alberta Environment and Protected Areas negotiated licence transfers and infrastructure support. This collaboration enabled the Town to secure licences for future growth while ensuring Camp Jubilee remained operational with necessary upgrades. By leveraging existing resources and partnerships, the project minimized the need for major new infrastructure investments, strengthened watershed stewardship, and maintained community access to recreational and educational opportunities. This case demonstrates how strategic water licence management and multi-stakeholder collaboration, guided by a facilitation partner, can balance municipal growth, watershed sustainability, and community benefit. It offers a replicable model for other water-limited regions seeking to integrate resource planning with social and environmental outcomes.

13:30 – 15:00: Alberta Innovates: Supporting the application of water research and technology

Title: Alberta surface-groundwater interaction assessment: project overview

*Tegan Holmes, Tricia Stadnyk, Andrea Brookfield, Alain Pietroniro, Jean Birks, Brandi Newton, and Benjamin Kissinger

An understanding of groundwater-surface water interactions in riverine systems across the province is needed to assess the current state of water resources and to support Alberta’s economic, environmental and social resilience into the future. This project was initiated to address the knowledge gap on surface-groundwater connections with the overarching goal of providing better access to water supplies and protecting water resources from over-allocation. This presentation will cover the planned scope and methods for assessing surface-groundwater connectivity at regional scales. The objective of this project is to use an innovative combination of groundwater indicators and state-of-the art models to quantify both groundwater-reliant streams and streamflow losses due to recharge, and the spatial and temporal variability of groundwater-surface water interactions. Riverine systems highly reliant on groundwater may be more susceptible to depletion from pumping, but also more resilient in times of short-term meteorological drought. The results of these methods will be combined and interpreted to generate provincial maps of groundwater-reliance to support evaluation of the provincial hydrometric and groundwater monitoring networks and management of Alberta’s water resources.

Title: Influence of shallow groundwater on surface water quality in the Bow, Oldman, and South Saskatchewan rivers

Humez, P., *Liggett, J.E., Birks, J., Taube, N., Moncur, M., Cabria, G., McClain, C., Strous, M., and Mayer, B.

High and increasing concentrations of key surface water quality indicators such as nitrate and sulphate have been observed along the mainstem and tributaries of the Bow, Oldman, and South Saskatchewan rivers. Given groundwater's important contribution to baseflow, and recent mapping showing high sulphate concentrations in groundwater in some areas of these watersheds, the objective of this study is to assess the influence of groundwater discharge on surface water quality. Using chemical and isotopic analyses from surface water samples collected monthly from March 2024 to March 2025, and from almost 20,000 groundwater samples from shallow (<150m) domestic and monitoring wells, we assessed the origin of nitrate and sulphate in surface water. We also investigated the hydrogeological setting of key tributary watersheds considering the origin of glacial sediments, location of buried valleys, presence of coarse-grained deposits above bedrock, and groundwater flow patterns. Chemical, isotopic and metagenomic analyses show that denitrification is an important nitrate removal process in Alberta's groundwater and hence only very shallow (<30m), low residence time groundwater with local agricultural nitrogen source(s) likely contributes to elevated nitrate concentrations in surface waters in southern Alberta. Conversely, groundwater contributions to streamflow have a significant impact on sulfate concentrations in surface waters, particularly where tributary watersheds are covered by sulphate-bearing till and streams are incised deeply into bedrock or coarse sediments in buried bedrock valleys, which increases hydraulic connections between surface water and groundwater. This study shows how groundwater contributions can influence surface water quality from natural, and in some cases anthropogenic, processes.

Title: Apportioning Bow River Discharge in an Eastern Slopes River

*Kendall Marshall, Cathy Ryan, Eowyn Campbell, Nadine Taube, Jean Birks, and Brandi Newton

Mountain groundwater systems are increasingly recognized as important contributors to river baseflow, particularly in snow- and glacier-fed watersheds. In the Canadian Rockies, more than 95% of the Bow River's flow originates in mountain headwaters, supplying freshwater to over 1.5 million people downstream (The Watershed - Bow River Basin Council). Yet no studies have directly quantified the role of mountain block recharge in sustaining the Bow River. These systems are difficult to study due to their complex and heterogeneous hydrogeology but understanding them is essential for current and future water resource management. This study uses geochemical and isotopic tracers to characterize the spatial and seasonal variability of groundwater contributions to the Bow River, focusing on contrasting geological settings between the Main Ranges and Front Ranges. Preliminary results support the hypothesis that groundwater is a major contributor to Bow River discharge. They also suggest

that carbonate units contribute substantially to winter baseflow and become increasingly important downstream, consistent with regional flow paths and longer residence times. Principal component analysis and end-member mixing models indicate that groundwater accounts for more than half of the annual flow in the Bow River's headwater reaches a finding consistent with estimates from the Elbow River, where ~two-thirds of annual discharge is groundwater-derived (Campbell et al., 2021). Pending tritium/helium analyses will further constrain residence times and clarify the extent to which subsurface storage buffers the system against climate-driven reductions in recharge. This work highlights the resilience of mountain groundwater systems and their importance for long-term water allocation and climate adaptation in alpine regions.

Title: Managing and Predicting the Impacts of Mountain Forests, Water Storage and Climate Change on Downstream Water Supplies

*Alain Pietroniro, John W. Pomeroy, Cherie Westbrook, Richard Petrone, Masaki Hayashi, and Martyn P. Clark

Understanding the hydrological dynamics of mountain environments is essential for predicting water supply under changing climate and land-use conditions. This study presents new insights into the interactions among forest structure, wetland processes, snow dynamics, and groundwater systems in the Canadian Rockies. Field investigations revealed that ground cover—particularly bryophytes and litter—exerts a dominant control over evapotranspiration, while microtopographic features have a limited direct influence. Subalpine forests were observed to initiate transpiration prior to complete snowmelt, underscoring the importance of early spring transitions and snowpack characteristics in regulating seasonal water use. Building on these field observations, process-based hydrological modelling was advanced through the development of a semi-physical soil evaporative efficiency model and the integration of alpine aquifer dynamics into basin-scale simulations. Enhanced satellite-based snowfall estimation algorithms and refined representations of snow interception in forest canopies significantly reduced uncertainty in precipitation and streamflow predictions. Wetland buffering capacity was also shown to be sensitive to forest harvesting, with implications for watershed-scale water regulation. To support large-scale forecasting, a modular and reproducible Model-Agnostic Framework was implemented, streamlining hydrological model configuration across multiple platforms and enabling scalable ensemble simulations. Collectively, this work demonstrates a comprehensive progression from field-based data collection to process understanding and ultimately to the development of robust predictive systems for mountain water supply under change.

Title: Groundwater-surface connectivity across the spectrum in urbanizing watersheds

*Edwin Cey, Daniel Ilg, Blair Cann, Jessica Wyse, Sean Elliot, Samuel Johnson, Masaki Hayashi, Jennifer He, Angus Chu, Bert van Duin, and Leta van Duin

Urbanization substantially alters natural hydrologic systems, most notably with increased stormwater runoff from impervious surfaces. Low impact development (LID) practices are nature-based solutions that are increasingly used to mitigate the adverse effects of urbanization and restore natural hydrological function to watersheds. However, infiltration-based LID systems, such as rain gardens and bioretention, may also increase risks to other urban infrastructure (e.g., basements, road bases) from the increased infiltration. To better understand these trade-offs, we conducted a series of studies in Calgary and Okotoks, Alberta examining the influence of urban development on groundwater-surface water connectivity across a spectrum of temporal and spatial scales. Approaches included a paired watershed experiment evaluating the influence of urbanization on stream flows, estimating the water budget and subsurface impact of two community rain gardens, and multi-year assessment of bioretention performance under frozen ground conditions. Results highlighted how urban development shapes hydrologic behaviour, from localized subsurface impacts beneath infiltration-based LID systems to watershed-scale differences in streamflow between developed and undeveloped landscapes. The relative importance of hydrological cycle components also varied with timescale, differing between individual stormflow events and longer-term seasonal trends or annual budgets. Collectively, these findings are being used to inform LID design practices and support more sustainable water management strategies in urbanizing watersheds.

15:30 – 17:00: Hydrologic and Hydrogeologic Modelling

Title: What don't we know about groundwater - surface water exchange?

*Jens Schumacher and Gordon MacMillan

Since the 2013 flood, Calgary has continued to explore groundwater behavior during flood events in its river valleys. In 2017, groundwater flooding was estimated to account for up to one-third of Calgary's average annual flood damage exposure (IBI, 2017). The Calgary River Valleys Groundwater Study was initiated to conduct advanced modelling to map groundwater behavior during floods in Calgary's low-lying communities.

The exchange between groundwater and surface water is sometimes described as a poorly understood process. Our contention is that integrated water management decisions are not impeded by a poor understanding cause and effect, but rather by challenges of characterization and upscaling that are inherent in all subsurface problems. The good news is there are tools in the hydrogeology community that deal with these characterization and upscaling problems. In the context of this study, groundwater flooding is driven by a short-term (days to weeks) rise in groundwater levels that result in flooding. These signals can be simulated using integrated models. The timing and magnitude of the groundwater flooding

depends on how quickly pressure moves in the subsurface, which is a function of the interconnection and permeability of the fluvial sediments. Geostatistical and non-linear inversion tools used in the groundwater community are well suited for this challenge. The methods summarized in this presentation place an emphasis on leveraging available data and exploring the prediction uncertainty caused by data gaps. In what is essentially an unknowable deterministic alluvial aquifer system, prediction uncertainty results from what is not constrained by available data.

Title: Tracking surface water and groundwater contributions to flooding in an alluvial aquifer

*Michael Callaghan, Steven Frey, Diana Zhang, and Steven Berg

There is an increasing recognition that in certain cases groundwater flooding can be an important cause of damage to infrastructure during flood events. Groundwater flow in coarse alluvial deposits can bypass overland flood defences and result in the inundation of subsurface structures (i.e., basements), without the water table reaching the surface. During the widespread flooding across southeastern Alberta in June 2013, groundwater flooding was implicated as an early flood mechanism in urban environments adjacent to streams and rivers. Groundwater flooding can have a strong component of surface water-groundwater (SW-GW) interaction well suited to simulation by integrated hydrological models, such as HydroGeoSphere (HGS). By accounting for both surface water and groundwater processes, better quantification of the risk of groundwater flooding is enabled. A relatively new technology implemented in HGS for investigating SW-GW interactions is the Hydraulic Mixing Cell (HMC) approach. The HMC method tracks the fraction of different water sources in space and time providing a quantitative measure of those sources at any point downstream. The utility of the HMC approach has been demonstrated for tracking hyporheic exchange in alluvial channels, calculating groundwater contributions to streamflow, and identifying sources of streamflow. Here we apply the HMC approach to track components of surface water and groundwater during the passage of the June 2013 fluvial flood wave through the Town of High River. The HMC results give insight into the transient nature of the passing of the flood wave and SW-GW interactions that may have implications for the design of flood defences.

Title: Short-term streamflow forecasting for the Oldman River

*Rahel Amare Kidanu, Evan G. R. Davies, and Nesa Ilich

Streamflow forecasting is critical for water resources planning and management, impacting hydropower operations, agricultural planning, and flood control. Accurate predictions are essential for reservoir and river basin management, optimizing water use efficiency, and providing early warnings for droughts and floods. This study explores 5 machine learning (ML) methods, such as Artificial Neural Networks (ANNs), Support Vector Machines (SVMs), and advanced techniques like Extreme Gradient Boosting (XGBoost) and Long Short-Term

Memory (LSTM), that have shown promising results in recent research and will be used to develop reliable 1- to 5-day daily streamflow forecast models for the Oldman River, Alberta. Results found showed that all the models captured the trend of the streamflow well, achieving R^2 values above 0.9 for 1-day forecasts and above 0.79 at 5 days. Comparing the different models, SVR was found to be the best-performing model, followed by XGBoost, consistently outperforming ANN and LSTM. To translate these findings into practice, a user-friendly web application was developed that automatically retrieves real-time streamflow and weather data, handles missing inputs, and generates 5-day forecasts with minimal user interaction. Designed for accessibility, the system provides timely and reliable predictions to support water managers and decision-makers in irrigation districts. By improving streamflow forecasting capabilities, it underscores the potential of machine learning to enhance reservoir management, water supply allocation, and decision-making for irrigation districts based on up-to-date hydrological data. This presentation will discuss the ML models developed for daily streamflow predictions and demonstrate the web application.

Title: Spatially Distributing 1D Groundwater Recharge Modelling Estimates Using Surface Morphology in Southern Alberta

*Shiv Khetarpal, Liggett, J.E., Onojeghuo, A., Atkinson, N., and Pooley, K.E.

Understanding groundwater recharge is important for evaluating groundwater availability. The Alberta Geological Survey is conducting a hydrogeological study across southern Alberta where groundwater recharge is limited. In this region, the dominant recharge mechanism is depression-focused recharge, which occurs as water accumulates in small surface depressions, primarily from spring snowmelt. As the ground beneath these ephemeral ponds thaws, water infiltrates, recharging the underlying groundwater system. Previously, depression-focused recharge in southern Alberta was modelled using a 1D soil water balance model and spatially distributed based on climate and depression characteristics of different surficial geology units. However, surficial geology reflects sediment origin rather than surface morphology, possibly affecting recharge values where morphology varies. To resolve this, we spatially distributed the existing 1D recharge modelling results using new mapping that more accurately characterizes discrete morphology types across southern Alberta. First, we mapped surface depressions and their associated catchments using a high-resolution LiDAR DEM and extracted depression-catchment characteristics from different morphology types. Next, we distributed average annual recharge across the study area based on surficial morphology and climate. Results show less variation in depression-catchment characteristics within surficial morphology types compared to the surficial geology. Hummocky morphology has the highest recharge, consistent with the presence of closed depressions, while gullied morphology has the lowest, consistent with a more open drainage network. Planar, streamlined, undulating, and reticulated morphology have moderate recharge. Spatially, recharge varies from previous maps, especially where surficial geology includes varied morphologies, such as moraine, highlighting the influence of surface morphology on depression-focused recharge estimates.

Glacier Room

10:30 – 12:00: Hydrologic and Hydrogeologic Modelling

Title: Integrated Surface Water-Groundwater Modelling for Mine Water Management: Insights from Two Canadian Case Studies

*Peter John Thompson, Michael Takeda, Sarah Grass, and Braydon Ralph

The assessment and management of water resources at open pit mines present a long-term challenge that begins before construction and extends beyond closure. Rigorous hydrologic and hydrogeologic assessments are required at the feasibility and environmental assessment stages, and robust tools are needed to address operational and post-closure problems. As mining alters both the groundwater and surface water regimes, effective assessment requires interdisciplinary teams and integrated tools that capture site hydrology and hydrogeology. Integrated surface water and groundwater models (ISGMs) offer a single transient framework to quantify linked impacts and support defensible decisions.

An ISGM is a calibrated, spatially distributed, transient model that couples surface water processes with subsurface flow, allowing changes in one domain to propagate to the other, preserving feedbacks that control wetlands, coldwater streams, recharge, and interactions with pits and mine infrastructure. We present two Canadian case studies where ISGMs support operational and post-closure planning by quantifying site water balances, stockpile runoff and infiltration, pit design alternatives, environmental flows and levels, habitat impacts, dewatering requirements, and cumulative effects. Scientific defensibility was established through calibration and validation against multi-year datasets including groundwater levels, streamflow, lake stages, snowpack observations, and measured flows from sumps and collection ditches. ISGMs demand substantial data, cross-disciplinary expertise, and effort to build and calibrate. Despite these requirements, they provide an integrated, transparent, and reproducible platform for understanding mine-environment interactions, improving confidence among regulators and stakeholders, and enabling adaptive planning and compliance across the mine life cycle.

Title: Hydrogeological Modeling Limitations and Solutions for Mine Sites in Permafrost Regions Under Climate Change

*Amir Niazi, Kalina Malowany, and Andrew Gault

Current groundwater modeling approaches used to support water resource management and remediation efforts carry significant uncertainties and are not adequately equipped to reflect the complexities of northern climate systems. These approaches, developed for different climatic conditions, have limited applications and often oversimplify highly complex hydrological processes, posing serious challenges for accurate forecasting and effective decision-making in cold regions experiencing rapid environmental change. A major limitation is the absence of explicit permafrost characterization, which, under

current climate change, is critical for understanding thaw-induced impacts on groundwater flow patterns, surface water processes, and their dynamic interactions. Permafrost degradation creates new preferential flow paths, alters watershed boundaries, and generates hydrogeochemical impacts. This fundamentally transforms the hydrogeological regime in ways that approaches adapted from other climatic conditions, or predictions based on models calibrated using current system data, fail to capture. Furthermore, environmental shifts caused by climate change in northern geographies are not well understood or adequately integrated into current modelling approaches. Given accelerating climate change impacts, there is an urgent need for immediate updates to modeling approaches addressing the region's heightened vulnerability to climate-driven shifts. We examine the critical gaps between current modeling capabilities and the complex realities of cold region hydrogeology, emphasizing the need for integrated observational networks, numerical tools, and proper uncertainty assessment to predict future conditions under accelerating climate change. We present some of our approaches to incorporate these complexities into existing workflows, developing predictive frameworks essential for supporting adaptive management strategies in environmental planning for mine sites.

Title: Integrated Watershed Modeling for Mine Closure: An Assessment Framework

*Rubaiat Sharmeen, Kenza Bouznari, Richard Simms, and Rudy Maji

Mine closure presents significant challenges for long-term hydrological sustainability, ecological integrity, and regulatory compliance. Typically, mining and oil sands operations considerably alter their pre-development watersheds, resulting in closure conditions that differ from the pre-development states. In addition to this, altered watershed flow regime and seepage from the tailings facilities may adversely change downstream water quality, thus potentially impacting ecosystems and cultural resources, or economic value. Assessing surface water - groundwater as a fully integrated flow system and evaluating impacts are critical to support designing mitigation systems and meeting regulatory requirements. In Alberta, regulations mandate that reclaimed oil sands watersheds perform similarly to comparable naturally occurring watersheds in the area, and as such, the cumulative impacts on water quality and ecosystems are to be assessed for all mine closure plans. Operators must demonstrate that reclaimed systems will function sustainably, requiring evaluation of seepage, travel times, and water quality changes. This study presents the water flow component of the assessment framework that WSP developed and has been using to assess hydrological, hydrogeological, and water quality impacts. The approach involved conceptual and numerical modelling, calibration to pre-development conditions, and adaptation to closure scenarios integrating complex processes like infiltration, evapotranspiration, and freeze-thaw effects. The integrated model enabled simulation of water table depth, pit lake water balance, and seepage under varying climates, considering potential future climate change effects.

Title: Analysis of total water storage change with GRACE/GRACE-FO observations and coupled groundwater – surface water modelling in Southern Alberta

*Stephanie Bringeland, Steven K. Frey, Georgia Fotopoulos, John Crowley, Bruce Xu, Omar Khader, Hyung Eum, Babak Farjad, and Anil Gupta

In the Prairie Ecozone of Canada, climate change threatens to increase the frequency of extreme meteorological events and negatively impact agricultural sustainability. Analysis of hydrological dynamics in the Canadian Prairies is needed to better understand risks. This analysis is challenging, in part due to the complex interactions between atmospheric processes, land surface, and subsurface. To further our understanding of hydrologic variability in the Prairies, this study leverages a HydroGeoSphere (HGS) physics-based fully integrated groundwater (GW) - surface water (SW) model of the South Saskatchewan River Basin (SSRB) in Southern Alberta that has been calibrated using GW wells and SW flow gauges. Output from the HGS model is compared to satellite gravity data from the Gravity Recovery and Climate Experiment (GRACE) and its follow-on mission (GRACE-FO). Results indicate that the HGS model produces interannual trends very similar to those observed by GRACE/GRACE-FO (correlation coefficient = 0.78) in the SSRB, although the amplitudes of the seasonal signal differ between HGS (+/- 7.8 cm equivalent water height) and GRACE/GRACE-FO (+/- 10.1 cm equivalent water height). Potential explanations for the differences are explored using HGS-derived water storage fluctuations in surface, soil moisture, and groundwater flow systems, and by evaluating interannual snowpack variability. Results also indicate that correlations exist between ENSO cyclicity and water storage levels in the SSRB.

Title: Groundwater levels in Alberta and their meteorological drivers

*Nadine Taube, J. P. Laceby, J. Birks, M. Moncur, and J. F. Orwin

Long-term (>50 years), provincial-scale observation and comprehensive analysis of groundwater levels are still relatively rare but provide critical insight into the hydrological response of groundwater systems to meteorological and climate patterns. Alberta has a large groundwater monitoring well network with over 200 active wells; some of them have been managed by Alberta Environment and Protected Areas since the 1960s. The purpose of this study was to investigate the variability of groundwater levels (GWLs) and their response to varying intensities of drought conditions. Preliminary analysis focused on change point analysis at approximately 90 wells. The drought periods of 1988/89 and 2001-03, and the wet period after 2010 are visible in the GWL record at a number of wells spanning a variety of depths and geologic formations. The analysis will be enhanced with calculation of wavelets to give better insight into what seem to be systematic periods of GWL increases and decreases. The Standardized Groundwater Level index reflects dry and wet conditions well. Correlations of GWLs to precipitation and temperature as well as two drought indices show strong relationships but also highlight local variability of responses of groundwater levels in Alberta.

13:30 – 15:00: Ecosystem Resilience and Source Water Protection

Title: Balancing Ecological Protection in Mine-Affected Streams with Mining Operational Requirements

*Alyssa Bourgeois

Mining operations can alter hydrologic regimes through landscape changes, modifications to ground and surface water pathways, and consumptive water uses (e.g., process water, dust suppression). Collectively, these changes may alter instream flows, seasonally or annually, potentially affecting fish habitat and aquatic ecology. Flow-related environmental effects can be mitigated to some extent through mine design and development, and additional mitigation can be applied through application of Cut-back or Cut-off Thresholds, below which consumptive water use is curtailed. Further, flow augmentation can be applied to supplement base flows during periods of low flows. Determination of flow thresholds or flow targets depends on the ecosystem values present (including the life history timing of key fish species) as well as potential trade-offs (e.g., water availability, water quality, cost). To evaluate the effectiveness of alternative flow regimes, a suite of flow thresholds can be developed and evaluated. Flow thresholds may be developed based on hydrology (e.g., 80% exceedance rate, 20% mean annual discharge) or built considering site specific information on fish life-cycle requirements and habitat conditions. Developing and evaluating a suite of flow thresholds allows for quantitative analysis of trade-offs, informing engagement with regulators, stakeholders, and First Nations. This approach provides a transparent and robust process to identify flow targets that balance ecological protection with mining operational requirements and other values.

Title: Managing Harmful Algal Blooms: Strategies for Resilient Source Water

Elizabeth Crafton and *Elyse Bonner

Water systems face growing threats from climate change, eutrophication, and wildfire impacts, making adaptive watershed management essential to protect source water and ecosystem health. This presentation explores the core elements of effective source water protection, emphasizing site-specific approaches tailored to the unique characteristics and evolving pressures of each watershed. A central focus is the role of ecosystem imbalances in driving harmful algal blooms (HABs). Comprehensive monitoring programs - tracking seasonal physicochemical trends and biological indicators - provide the data needed to guide management decisions. Successful HAB mitigation requires addressing both external watershed inputs, such as nutrient loading and land-use practices, and internal reservoir dynamics, including sediment nutrient release and thermal stratification. Three case studies illustrate how collaborative planning and integrated strategies can enhance watershed resilience. The first highlights a regional partnership that successfully developed and implemented a source water protection plan. The second demonstrates how a long-term reservoir monitoring program can prioritize management actions and inform

adaptive responses. The third examines HABs and post-wildfire impacts, showcasing strategies to manage compounding stressors and protect water quality. Attendees will gain actionable insights into designing and implementing watershed management programs that are responsive, resilient, and evidence driven. By integrating monitoring data, stakeholder collaboration, and targeted interventions, utilities and watershed managers can better safeguard water quality, support ecosystem function, and prepare for evolving environmental challenges.

Title: Operational Flexibility and Habitat Protection: Case Studies on Applying Severity-of-Ill Effects Modeling to Sediment Management

*Dan Greenacre and Kevin Ganshorn

Suspended sediment (SS) is a key stressor for aquatic ecosystems and fisheries, yet current regulatory frameworks often emphasize maximum concentrations while overlooking the importance of exposure duration, including naturally turbid conditions. This creates challenges for managing in-stream projects, where limiting concentrations alone can extend timelines while prolonging exposure which also carries ecological risks. The severity of ill-effects (SEV) model (Newcombe and Jensen 1996) offers a practical, science-based solution. Built on empirical observations of salmonid responses to SS, the model integrates both SS concentration (mg/L) and duration (h-d) to predict biological effects ranging from mild behavioural changes to mortality. Expressed on a 0-14 scale, SEV can be used to develop clear thresholds for assessing risk and setting project criteria. In BC, the SEV model has been accepted by regulators as a tool to guide operational management of SS on major projects. Coupled with real-time turbidity monitoring and a site-specific relationship between SS and turbidity, SEV-based criteria enable adaptive management that protects fish while maintaining operational flexibility and efficiency. Use of SEV modelling thus offers a transparent, flexible framework that may be used to balance regulatory compliance, operational needs, and ecosystem protection. This presentation highlights case studies at two BC Hydro facilities: Site C dam construction on the Peace River and a headpond sediment release trial on the Shuswap River below Wilsey Dam. These case studies demonstrate real-world implementation of the SEV model approach and its potential to support SS management in Alberta.

Title: Into Depths Unknown: Modeling a New Intake Location to Address Climate Change and Water Quality Challenges

*Marcus Brunelle and Eric Segal

Lake Major, the drinking water source for 125,000 Halifax residents, is under mounting pressure from climate change and long-term recovery from acidification. Since 1999, sulphate concentrations have halved while pH, natural organic matter, colour, and total organic carbon (TOC) have all significantly increased. In 2023, a dry spell followed by intense

rainfall flushed unprecedented levels of TOC and dissolved organic carbon into surface waters - exposing the vulnerability of the current intake, situated only 3 metres deep in the epilimnion. Water supply reliability is also threatened by more frequent droughts and harmful algal blooms. To safeguard both quality and reliability, Halifax Water is considering a new intake at Site 3, a 20-metre-deep recessed basin one kilometre upstream. Drawing water directly from the hypolimnion could bypass algal blooms and enhance drought resilience. Yet, the unique bathymetry raised concerns that such withdrawals might destabilize stratification, negating water quality benefits. To address these uncertainties, Hazen leveraged and adapted two existing models: the OASIS mass-balance system model (simulating supply, demands, and operations to evaluate safe yield) and CE-QUAL-W2, a two-dimensional hydrodynamic and water quality model updated with high-resolution bathymetry. Despite limited inputs, calibration was sufficient to assess thermal structure at the proposed intake. Results indicate a Site 3 intake would consistently access hypolimnetic water, preserve stratification, and substantially increase safe yield - providing Halifax Water with evidence to de-risk a major infrastructure investment and guide a strategy for a more resilient future supply.

15:30 – 17:00: Floods, Droughts, and Climate Extremes

Title: Bridging the Gap Between Flood Mapping and Emergency Response in Resource-Limited Communities

*Spencer Roberton

Small municipalities across Canada face growing challenges from extreme weather events, with increasing flood risks threatening infrastructure, services, and public safety. While provincial and federal governments have invested in flood hazard mapping, many municipalities lack the resources and technical capacity to translate this information into actionable emergency response plans. This presentation highlights the work undertaken in Drumheller, Alberta, as a case study in developing a comprehensive flood emergency response framework, using the provincially-developed flood mapping. The project involved moving from static flood maps to a dynamic, GIS-based platform that links forecasted river flows to specific emergency response actions such as evacuations, temporary berm construction, and outfall closures. The approach required collaboration among municipal staff, engineers, and emergency management personnel to ensure that plans were practical, clear, and adaptable under evolving flood conditions. The presentation will outline the methodology used to develop these response plans, the integration of forecasting tools with municipal decision-making, and the lessons learned in balancing technical requirements with limited municipal funding and capacity. Outcomes from this work illustrate how small communities can improve climate resilience by bridging the gap between flood mapping data and operational response plans.

Title: Groundwater Flood Mapping for Calgary's River Communities

*Soren Poschmann and Andrew Forsyth

Since the 2013 flood, Calgary has continued to investigate groundwater behavior during flood events in its river valleys. In 2017, groundwater flooding was estimated to account for up to one-third of Calgary's average annual flood damage exposure (IBI, 2017). While the City has advanced flood protection along the Bow and Elbow Rivers through capital investments and land-use policies targeting regulated open water flood conditions, elevated groundwater during river floods remained less understood. To address this, the Calgary River Valleys Groundwater Study was initiated to model and map groundwater behavior during flood events, aiming to inform groundwater-driven flood hazards and guide land-use policy, property-level mitigation, and emergency management practices. Decades of hydrogeologic and geotechnical data were compiled into a unified GIS database, including digitized borehole logs and standardized lithologic descriptors (e.g., coarse/fine material ratio). A novel modeling approach was developed, featuring a 3D lithologic framework built using multi-point statistics and coupled to a numerical groundwater model. An uncertainty analysis was included to address spatial and temporal data gaps. New flood protection infrastructure was incorporated, and community-scale risk was assessed using municipal records on building age and basement development. Results were reviewed through multi-departmental City workshops to structure hazard/damage pathways and screen mitigation options. Ongoing work is focused on updating land-use policy and property-level tools. The study has produced a defensible tool defining groundwater flood extent, elevation, and risk layers that complement open water flood maps - advancing integrated flood resilience across Calgary's river valley communities.

Title: Identification of Snow Drought in the Bow River Basin Using Machine Learning Techniques

*Nadie Rupasinghe and Tricia Stadnyk

The Bow River Basin, primarily sustained by snow and glacial melt, supports nearly 45% of Alberta's irrigated agricultural lands. As such, accurately monitoring winter snow accumulation is critical for water resource management. Snow drought - defined by reduced snowfall or premature snowmelt caused by warmer-than-average winter temperatures - poses a growing risk in this region under changing climate conditions. This study applies the Snow Drought Response Index (SnoDRI) to evaluate snow drought conditions across the basin. Advanced machine learning techniques, particularly the Random Forest algorithm, are employed to extract relevant features from a suite of snow-related variables. The analysis utilizes Canadian Surface Reanalysis (CaSR) v3.1 data spanning from 1980 to 2023, providing a comprehensive long-term dataset for snow and climate indicators. To validate SnoDRI's performance, it is compared against established drought indices, including the Standardized Snow Water Equivalent Index (SWEI) and the Standardized Precipitation Index (SPI). The results demonstrate the potential of SnoDRI to detect snow drought with improved accuracy by integrating multiple variables through machine learning. In addition to the

analysis, modular and reproducible workflows have been developed and generalized, enabling broader application and transparency. These workflows, along with data preprocessing and model implementation steps, will be made publicly accessible through GitHub, contributing to open science and supporting future snow drought monitoring and research efforts.

Title: Antecedent Hydroclimatic Drivers of Groundwater Droughts in the Upper Reaches of the Bow River: Towards Early Warning and Management

*Aruna Kumar Nayak, He. J., Newton. B., Birks. S. J., Taube. N., and Ryan. M.

Drought is a major natural hazard with wide-ranging socioeconomic impacts. Groundwater droughts typically develop later than streamflow droughts, so understanding their drivers is crucial for integrated watershed management. This study investigates the drivers of groundwater droughts in the Bow River reach near Canmore Valley, where groundwater contributes substantially to streamflow. Groundwater droughts were identified using groundwater levels at four Alberta groundwater observation well network stations using the Standardized Groundwater Index and streamflow drought in the Bow River at Canmore was identified using the Standardized Streamflow Index. To identify the climate drivers, groundwater drought events were clustered based on average antecedent conditions of rainfall, snowmelt, and temperature, where antecedent windows were defined as the average from drought onset month to lag times of 0-12 months. Results show that groundwater droughts at two wells (one that is screened above the river elevation and a second that is near a regional groundwater spring) were linked to the lack of rainfall and snowmelt in a two-month period prior to drought onset, whereas the two wells that were completed in the river-connected valley aquifer were linked to antecedent conditions immediately at the drought onset. Across the four wells, two distinct groups of groundwater drought events were identified: droughts caused by rainfall and snowmelt deficits combined with above-or below-average temperatures, and droughts caused by above-average temperatures alone. Causal analysis using the PCMCI algorithm indicated that groundwater droughts led to streamflow droughts for the two valley aquifer wells, while no clear direction was observed for wells screened above the river elevation. These findings highlight the critical role of groundwater in sustaining streamflow and underscore the importance of monitoring identified drivers for improved groundwater drought prediction and management.

Title: Climate and Human Impacts on Groundwater Sustainability in Prince Edward Island, Canada

*Muhammad Qasim Mahmood, Xiuquan (Xander) Wang, and Farhan Aziz, Qing Li

Groundwater is the sole source of drinking water for Prince Edward Island (PEI), making its sustainability a critical concern under growing human and climate pressures. This study presents an island-wide groundwater flow model developed to investigate how future

population growth and climate change may affect groundwater availability. The model incorporates multi-layered aquifer representation together with specified-flux and head-dependent flux boundaries for a comprehensive simulation of the island's groundwater system. The calibrated results showed strong consistency between simulated and observed groundwater levels and baseflows. To evaluate future risks, a series of climate scenarios and stress-test runs were conducted. Results show that intensified abstraction and recharge reductions during critical dry periods lower water tables and substantially reduce baseflows at headwater streams. Importantly, the projected shift from winter- to summer-dominated drought highlights the increased vulnerability of groundwater resources during months of peak water demand, emphasizing the trade-offs between human use, ecological flow needs, and long-term groundwater sustainability in PEI. The presentation will highlight the modelling approach, key findings, and their implications for adaptive water management in PEI.

Poster Session

Title: Groundwater Contribution to Proglacial Streams in the Canadian Rockies

*Jasmine Skirten, Cathy Ryan, Brandi Newton, Eowyn Campbell, Jean Birks, and Nadine Taube

Continued glacier retreat raises concerns over shifts in hydrologic regimes of headwater streams. An understudied aspect of these regimes is the contribution of groundwater to these streams. This study quantifies groundwater contributions to the proglacial stream and lake at Boundary Glacier (Columbia Icefields, Alberta) using an integrated hydrometric, isotopic, and hydrogeochemical approach. During 2023 - 2024, we sampled at multiple locations along the proglacial stream, and combined these observations with continuous stage, water temperature, and field-measured discharge records. Source partitioning emphasized conservative tracers selected for this watershed (EC , Ca^{2+} , Mg^{2+} , HCO_3^- , SO_4^{2-} , Na^+), with SiO_2 and stable water isotopes ($\delta^{18}\text{O}$, $\delta^2\text{H}$) used to confirm endmember signals and support residence-time inferences. Principal component analysis helped delineate endmembers, followed by two-endmember mass-balance models that resolve groundwater versus low solute-based interflow. Preliminary results show that groundwater fractions increased as the melt season concluded, with median estimates of 65 - 85% from September to November along the transect and at the lake outlet. Hydrograph behaviour aligned with the mixing results including, sustained baseflow post-melt season, a reduction in amplitude of signal strength of diurnal melt pulses, and localized discharge gains at till seepage zones. Spatial patterns indicate focused recharge through moraine, faulted bedrock, and alluvial aquifers. Findings refine the conceptual model of groundwater - surface water connectivity in glacierized headwaters and have direct management relevance under continued glacier retreat. Results will inform post-melt season environmental flow targets, drought preparedness, source-water protection, and allocation planning in the upper Bow and North Saskatchewan River basins of the Eastern Slopes of the Canadian Rockies.

Title: Changes in Fallow Field Snow Hydrology Across the Western Canadian Prairies

*Zoe Johnson, John Pomeroy, and Peter Lawford

Snow is a major component of the manageable freshwater supply on the Canadian Prairies. With about one third of annual precipitation falling as snow, changes in snow cover accumulation, duration, and melt dynamics have profound impacts on water management and agricultural practices in the region, as spring runoff, streamflow, and soil moisture are strongly influenced by wintertime conditions. To assess trends and changes in Prairie snow processes and water budgets, the Cold Regions Hydrological Modelling platform was forced with ERA-5 reanalysis data from 1950 to 2020 and used to model over 4000 , “virtual basins” across the Canadian Prairie ecozone. Each virtual basin was subdivided into hydrological response units (HRU) corresponding to fallow and cropped fields, grassland, woodland, wetlands and channels. The virtual basin and HRU approach allowed for sub-regional and discretized analysis by landcover type. Simulated blowing snow transport, sublimation, accumulation, and snowmelt were examined on monthly, seasonal, and annual bases, with consideration of land use and climate change influences. Observed changes have not been spatially uniform, and there are important regional differences in changes to snowmelt water supply. Water resources in the Prairies are governed by snow processes, and this research offers insight into how climate warming is changing the region’s hydrology.

Title: McClelland Lake Wetland Complex: A Tale of Two Fens

*Sherry Heschuk and Paula Evans

A published article about the McClelland Lake Fen which is a reference to lists of native plants that would be lost and biodiversity framework of the Lower Athabasca Region will be provided this information as if it were possible to stop the Fen from being destroyed in my lifetime. This is an article about the the potential loss of biodiversity and of the importance of wetlands to our wildlife and species which could be at risk. Now the fen has become more vulnerable because of a large-scale open pit mine that is being developed in the future on this fen which supports water ecosystems. To pursue our interest in and concern for the fen, a small group from Alberta Wilderness Association (AWA) and Alberta Native Plant Council (ANPC) arranged to visit McClelland Lake fen with the help of the Borealis Paddling Club from Fort McMurray. AWA and ANPC members travelled from Calgary, Edmonton and St. Albert for a field visit on September 9, 2023 and to identify species available of significant benefit to the fen.

Title: Mapping Regional Groundwater Flow and Interaction with Surface Water in the Alberta-Northwest Territories Transboundary Region

Allison Rubin, Dan Palombi, *Dan Utting

Knowledge of groundwater in the Alberta-Northwest Territories transboundary region is limited despite its significance in managing resources within our shared basins. The Mackenzie River Basin Board Bilateral Water Management Agreements commit jurisdictions to work collaboratively to achieve objectives related to sustainable groundwater use and management. To address this objective, the Alberta Geological Survey, in collaboration with the governments of Alberta and Northwest Territories, is seeking to better understand transboundary groundwater by collecting empirical data, developing a conceptual model, and assessing the interaction of groundwater and surface water. Initial work focused on evaluating subsurface data to support aquifer mapping including creating maps of bedrock topography and sediment thickness. Cross-border data harmonization was required for new mapping and building regional cross-sections to create a unified geological model. Water samples from the Hay River and groundwater wells in the lower Hay River sub-basin were collected for geochemical and isotopic analysis to develop an understanding of groundwater-surface water interaction and circulation pathways in sediment and bedrock aquifer systems. Preliminary results of isotopic and geochemical tracers suggest a lack of groundwater connection to the Hay River and low degree of circulation between surface water and groundwater in the sub-basin. Understanding groundwater contributions to surface water, or lack thereof, is important for determining transboundary water flows and establishing governance of shared resources. Future work will acquire new data to aid in quantifying groundwater conditions and devise monitoring programs in the Alberta-Northwest Territories transboundary region.

Friday November 14, 2025

Maple Leaf Room

10:30 – 12:00: Groundwater – Surface Water Interactions

Title: Understanding groundwater-surface water interactions in the Oldman and Bow rivers in southern Alberta using geochemical and hydrogeological evidence

*Tony Lemay, Kathryn Pooley, Jessica Liggett, Jessica Warrack, and Dan Palombi

Population growth and economic development is increasing the demand for water, particularly in Southern Alberta, which can be prone to drought and water shortages. With

groundwater a critical source of water in the region, there is a need to fill in gaps and better understand how much is available to support communities and businesses in the years ahead. To prepare for potential increases in groundwater demand, identify viable alternative water sources, and to support groundwater resource management, the Alberta Geological Survey is conducting a three-year project focused on advancing the knowledge of groundwater availability and sustainable use in southern Alberta. Identifying locations with potential groundwater-surface water (GW-SW) interaction is an important aspect of this work. Firstly, this assessment is using recent synoptic river sampling and long-term river network data and groundwater chemistry to provide important indicators of GW-SW interactions. River sampling was conducted to determine major, minor and trace elements, stable and radiogenic isotopes, and measurements of radon in water. Secondly, mapping of sediments above bedrock intersecting river valleys along with lithology modelling allows for the identification of favourable conditions for potential GW-SW interactions. Lastly, hydraulic head mapping in the sediments above bedrock and in bedrock units provides insight on the pressure regimes controlling these potential connections. Combining these approaches will identify the most likely locations of GW-SW interactions and provide important information to support management of water resources.

Title: Baseline hydrogeochemistry of the Milk River revealed by the 2024-2025 diversion failure

*Mike Moncur, Jean Birks, John Gibson, and Jeff Gutsell

The Milk River (MR) is a transboundary river originating in the Montana Rocky Mountains, flowing north into southern Alberta before re-entering Montana. Under natural conditions, MR discharge is low and may approach zero during the fall and winter. Since 1917, the St. Mary's River has been diverted into the MR during the irrigation season (April to October) to support agricultural operations, accounting for 80 - 90% of its flow. In June 2024, the diversion to the MR failed and was not restored until July 2025. This rare event provided an opportunity to document baseline MR hydrogeochemistry and assess groundwater - surface water interactions. Where the MR Formation outcrops along MR, it is bounded by shales of the Pakowki Formation and sandstone of the Foremost Formation, geological features that influence both groundwater flow dynamics and water chemistry. Water samples were collected at nine sites along a 180 km reach of the river under four flow regimes: during diversion, shortly after it ceased, four months after the 2024 failure, and during the 2025 spring freshet. Sampling included dissolved major ions and metals, nutrients, and both stable and radiogenic isotopes. During times of diversion, MR water chemistry closely resembled the St. Mary River, showing minimal synoptic variability. After the failure, solute concentrations increased, isotopic signatures shifted toward older sources, and synoptic heterogeneity emerged, most notably where the MR Formation outcrop intersects the channel. These findings provide the first baseline characterization of MR hydrogeochemistry under both natural and diverted conditions and demonstrate how diversion inflows mask groundwater and geological influences.

Title: The Role of Fractures in Groundwater Flow and Geochemical Evolution of the Milk River Aquifer

*Avadhoot Date, Bernhard Mayer, Pauline Humez, Ranjeet Nagare, Roland Purtschert, Reika Yokochi, Neil Sturchio, and Stephen Wheatcraft

The Milk River Aquifer (MRA) is a transboundary aquifer covering an area of 26,000 km² across southern Alberta (Canada) and northern Montana (USA). In recent decades, increased water demand has caused decrease in groundwater levels, emphasizing the need for informed water management strategies. This study aims to improve the understanding of groundwater flow using age dating with radioactive isotopes, numerical modeling, and mapping of water quality trends. Earlier research proposed porous media driven flow, but geochemical and isotope data (Cl⁻, δ¹³C, ⁸¹Kr, ³⁶Cl) reveal a mismatch between hydraulic gradients and groundwater flow pathways suggested by geochemical patterns. We present a revised conceptual model that resolves these inconsistencies by demonstrating the influence of fractures on groundwater flow in the MRA. We integrated hydraulic head measurements (n=3984), transmissivity data (n=116), fracture data (n=428), and tracer age dating results from 18 groundwater samples. Fracture analysis revealed a dual network of longer NW - SE trending primary fractures intersected by shorter NE - SW trending secondary fractures. Apparent tracer (⁸¹Kr) ages increase from <65,000 years near the recharge area (<25 km) to >500,000 years in more distant zones (>75 km), despite elevated transmissivity values (2.8 × 10⁻² m²/s). Similarly, Cl⁻ concentrations increase from <25 mg/L near the recharge zone to >150 mg/L at flow distances >125 km. A discrete fracture network (DFN) model with particle tracking reproduced a zig-zag groundwater flow pattern with rapid recharge through secondary fractures under regional hydraulic gradients and slow dispersion along primary fractures due to negligible hydraulic gradients. This flow pattern is consistent with Cl⁻ concentration patterns and tracer (⁸¹Kr) ages, indicating very slow (<0.1 m/yr) flow velocities thereby highlighting the role of fracture flow in the MRA. The new conceptual model offers a plausible and more consistent explanation for previously observed discrepancies in flow direction, groundwater age, and geochemical patterns, with potential implications for groundwater management in semi-arid regions of southern Alberta.

Title: Machine learning modeling of isotope tracers to expand streamflow source separations

*Jaxton Gray, Tricia Stadnyk, and Tegan Holmes

Stable water isotope tracers such as deuterium or oxygen-18 provide information on water age, groundwater contributions to streamflow and evaporation. In tracking the relative age of streamflow to one can begin to partition contributions from groundwater and precipitation. These isotope tracer methods can be used to help predict streamflow during drought conditions or provide insight into the vulnerability of streamflow to groundwater extraction;

however, they require isotopic composition of precipitation data. Unfortunately, there is a lack of isotopes in precipitation measurements on both local and global scales, limiting the application of isotopic surface-groundwater partitioning methods. To mitigate the sparsity of observed deuterium and oxygen-18 precipitation data, it has been common to use gap-filling methods such as linear regression, which are not adept at capturing the large scale and non-linear relationships of hydroclimatic processes. This research develops multiple machine learning models to estimate the isotopic composition of global precipitation using Long Short-Term Memory (LSTM) neural networks. By testing varying levels of complexity from combining different sets of input features and spatial schemes, the models may be able to better capture climatic impacts on the isotopic composition. Model performance is compared to a global dataset of observed isotopes in precipitation, to identify an appropriate model complexity. The goal is a viable tool for estimating the isotopic composition of precipitation on a global scale to produce input data for isotope tracer studies, particularly global estimation of changing surface and groundwater systems under climate change.

Title: Smelly Ponds: Unexpected role groundwater plays in stormwater quality and sulfur cycling

*Lucas Ogrins, Edwin Cey, and Harris Switzman

Stormwater ponds are used to manage water quality and quantity during heavy rainfall events in urban settings. Groundwater can potentially impact stormwater pond operation by altering pond water chemistry, although this influence is presently understudied. This study was undertaken to better understand groundwater-surface water interactions and sulfur cycling in a stormwater pond at the Calgary international airport. A site investigation was conducted to evaluate seasonal groundwater flow trends, sulfur sources and fate through stable isotope analysis, and groundwater contributions to stormwater infrastructure through a water budget. Groundwater flowed to the pond throughout the study period, indicating the pond was a net groundwater sink. However, the magnitude of groundwater contributions to the pond were minor in comparison with surface water flows. Elevated sulfate was identified in groundwater samples adjacent to the pond and was attributed to evaporative concentration. High sulfate concentrations caused sulfate diffusion into the pond, which allowed for bacterial sulfide reduction in pond-bottom sediments. Groundwater seepage with high dissolved solids, whether into the pond or into upstream stormwater infrastructure, contributed to stratification in the pond which could exacerbate hydrogen sulfide generation. Dissolved hydrogen sulfide oxidized to elemental sulfur as the upper portions of the pond oxygenated, leading to elevated turbidity. The study highlighted how groundwater interactions with stormwater ponds have the potential to alter pond composition and can contribute to hydrogen sulfide generation.

13:30 – 15:00: Monitoring and Mapping of Water Systems

Title: Advancing Groundwater Monitoring in Canada: Illustrative Hydrograph Analysis in Nova Scotia with R

*Audrey Marie Hill, Barret L. Kurylyk, Zijie Chai, Cynthia N. McClain, and M. Cathryn Ryan

Groundwater is the largest source of liquid freshwater in Canada and supplies 30% of Canadians. A Groundwater Inclusion Committee was formed by International Association of Hydrogeologists - Canadian National Chapter volunteers to advocate for groundwater management in Canada. In 2024, the Committee submitted a brief to the House of Commons Standing Committee on Environment and Sustainable Development: Study on Freshwater. This brief emphasized the importance of developing federal groundwater policy and communications to reflect the importance of groundwater in Canada. This brief made five recommendations to the federal government: 1) include groundwater in communications, 2) establish a national groundwater monitoring network, 3) report on groundwater trends, 4) include groundwater experts in freshwater management, and 5) improve education on groundwater. With this presentation, we aim to support two of these recommendations: establish a national groundwater monitoring network and report on groundwater trends. Firstly, we compared existing provincial and territorial groundwater monitoring networks in Canada. Secondly, we developed an R-based script to automate the analysis of groundwater hydrographs. As an illustrative example, the script was applied to groundwater levels in Nova Scotia to demonstrate how monitoring networks can be used to investigate long-term trends, recharge drivers, and aquifer characteristics. We found that winter precipitation resulted in more efficient recharge; however, variability in geology and depths made spatial trends difficult to identify.

Title: Tracing Subsurface Connections: Case Studies of Field-Based Thermal Methods for Mapping Groundwater-Surface Water Mixing Zones at Industry Sites, from Point Profiles to Airborne Spatial Scales

*Sami Morgan, Mikaela Geremia, Polina Abdrakhimova, Ron Coutts, and Louis-Charles Boutin

Understanding groundwater - surface water (GW-SW) interactions can be very important for hydrogeological studies in industrial settings. These interactions form a critical component of conceptual site models and can also guide monitoring program design for assessment of potential contaminant pathways. GW-SW exchange fluxes are inherently variable in both space and time; therefore, characterization methods must capture both spatial distribution and temporal dynamics to support risk assessment and monitoring design.

Temperature is an effective natural tracer of GW-SW exchange. Airborne thermal infrared (TIR) surveys provide rapid mapping of spatial discharge patterns, identifying gaining and losing reaches or localized seepage zones across large areas. In contrast, vertical streambed temperature profiling quantifies temporal variability of vertical fluxes at selected locations by analyzing diurnal and seasonal signals with depth. These complementary

methods operate at different scales: airborne surveys offer synoptic areal coverage, while streambed profiling provides continuous point-scale flux estimates.

Field-based case studies from industrial sites demonstrate the application of both approaches. Results highlight the advantages and limitations of each method, emphasize the value of combining point- and areal-scale data, and provide lessons learned for improving conceptual site model development and monitoring programs.

Title: Ephemeral Wetland Mapping Using High-Resolution Optical and LiDAR Data in Southern Alberta with Deep Learning

*Alex Onojeghuo, Liggett, J.E., Pooley, K.E., Hartman, G., Atkinson, N., and Palombi, D.

Wetlands act as natural sponges, absorbing surface water from rainfall and runoff, and gradually releasing the collected water into the ground supporting riparian ecosystems and replenishing aquifers. In particular, ephemeral wetlands, filled with water only during spring, are essential for understanding groundwater availability in southern Alberta because they serve as sources of groundwater recharge, which ultimately support baseflow to streams and lakes. The Alberta Geological Survey, under the Southern Alberta Groundwater Evaluation project, aims to develop a workflow for mapping ephemeral wetlands in the Pakowki Lake demonstration area using advanced remote sensing techniques based on artificial intelligence. Utilizing high-resolution optical and LiDAR data as inputs for a ResUNet deep learning segmentation model, monthly wetland maps for spring to summer (April to June) of a predominantly wet year (2020) and a dry year (2024) were produced. The monthly wetland maps were used as inputs for a change detection analysis aimed at better understanding the spatial dynamics of wetland transition. The study also explores the corresponding impacts of climatic variables (such as precipitation, temperature, and relative humidity) using a combination of spaceborne-derived drought indicators and ground weather station data. Groundwater is vital for maintaining wetland hydrological stability by providing saturation during dry periods. Hence, a better understanding of their spatiotemporal dynamics is essential for groundwater managers and decision-makers. Considering the high level of seasonality associated with wetlands in the Prairie Pothole region, having an effective workflow for accurately delineating these dynamic wetlands is crucial for understanding groundwater circulation and their connected ecosystems.

Title: Mapping terrestrial and aquatic groundwater dependent ecosystems in Alberta's boreal forest

*Cynthia McClain, Michael A. Merchant, Cris Gray, Jennifer N. Hird, David Evans, Jacqueline Dennett, Murdoch Taylor, David Roberts, Michael Wendlandt, Andrew Underwood, Marshall McKenzie, and Emily Herdman

Groundwater dependent ecosystems (GDEs) rely on groundwater to sustain critical ecological functions, including plant and wildlife communities, and can thus be sensitive to changes in groundwater dynamics induced by anthropogenic activities and climate change.

In Alberta's boreal region, GDE distribution and vulnerability, particularly for terrestrial GDEs (e.g., upland and riparian habitats), remain poorly documented. This project developed the first integrated aquatic and terrestrial GDE maps for a large portion of the Oil Sands Region (OSR), including portions of the Athabasca, Clearwater, McKay, Muskeg, and Steepbank River watersheds, a foundational step toward filling critical groundwater and ecosystem knowledge gaps. A terrestrial GDE literature review identified promising indicators including ecosite class and communities dominated by flood-tolerant plant species or potential phreatophytes. Fieldwork in 2024 collected water quality samples (e.g., isotopes, radon) and biotic observations from 29 sites, providing ground-truth information for aquatic GDE identification. For terrestrial GDEs, an expert- and rule-based approach using ecosite, depth-to-water models, and soil drainage generated additional training data. Model variables included satellite imagery, topography, hydrogeologic, climatic, and vegetation metrics. A key innovation was the unification of aquatic and terrestrial GDE mapping within a single machine learning framework, supported by evidence of shared geospatial predictors. Ensemble models achieved high internal accuracy (AUC >0.9) using widely available wetland class data, enabling broad applicability across the OSR. The resulting probability maps highlight riparian and floodplain systems previously unmapped as GDEs. This scalable GDE mapping workflow can be applied across the OSR to support long-term groundwater monitoring and cumulative effects assessment.

Title: Cumulative Impacts of Wildfires on Water Resources: Insights from Long-Term Monitoring and Hydrological Modelling

*Dayal Wijayarathne, Tiago Morais, Aprami Jaggi, Nicholas Kouwen, Tatiana Sirbu, Michael Wendlandt, and John Gibson

Within Alberta, wildfires are increasing in both frequency and intensity, placing compounding pressures on water resources already stressed by both population growth and climate change. This study examines the cumulative impacts of wildfires on water quality and quantity in watersheds monitored by the Regional Aquatics Monitoring Program (RAMP). By integrating historical wildfire perimeter data (1931 to 2023) with long-term monitoring of rivers, lakes, and sediments, we assessed both short- and long-term changes in physical and chemical parameters. Results indicate wildfire-driven decreases in dissolved oxygen, and conversely increases in phosphorus, turbidity, metals, and PAHs within rivers, in addition to noticeable changes in altered sediment composition and contaminant dynamics. Source tracing of PAHs revealed distinct pyrogenic, petrogenic, and biogenic signatures, providing insights into contaminant pathways and residence times in the receiving environment. In addition to water quality, impacts were also observed on water quantity. Hydrological modelling with WATFLOOD®/CHARM™ indicated an estimated increase of ~10% in runoff and higher peak flows following wildfire events. These findings highlight the importance of partitioning of wildfire impacts from industrial activities for quantifying both short and long-term hydrological responses, and for implementing long-term monitoring strategies to support water resource management and ecosystem resilience under a warming climate.

15:30 – 17:00: Contaminants and Water Quality

Title: Groundwater impacts around an oil and gas well with methane gas migration

*Rafael Terada, Tiago Morais, Sebastian Champagne, Bernhard Mayer, Steve Chapman, Beth Parker, and Cathryn Ryan

Groundwater exposed to fugitive gas from a low-leaking oil and gas (O&G) well for >20 years was monitored in three multilevel monitoring wells (maximum depth of 16.5 m) installed along the shallow groundwater flow direction. Severe water quality impacts were not observed, however higher Na, SO₄, HCO₃, Rn, CH₄ and CO₂ concentrations were detected, particularly focussed 5 m downgradient of the O&G well, at a depth of 14.5 m. Biogenic and thermogenic methane is supported by $\delta^{13}\text{C-CH}_4$ and $\delta^2\text{H-CH}_4$ values, trace C₂–C₃ compounds, and organoleptic evidence. Methane concentrations were relatively low (maximum value 0.95 mg/L), suggesting the thermogenic gases in the groundwater resulting from groundwater migration past the leaking well, which has fugitive methane gas migration around the outside of the wellbore. The elevated ions are consistent with contributions from deeper, more saline groundwater, whose upward dissolved solute transport could have been facilitated by buoyant fugitive gas flow around the wellbore. The results demonstrate that even decadal scale, low-leaking, O&G wells can slowly alter shallow groundwater geochemistry. The spatially heterogeneous impacts make them difficult to detect without multiple lines of evidence from depth-discrete (or purpose-built) monitoring. This challenges the balance of the liability and cumulative risk to shallow groundwater security posed by the thousands of wells with gas migration problems reported in Alberta.

Title: Environmental impacts of alternative diesel leaks on groundwater

*Nicholas Utting, Kaylee Onucki, Qin Xin, Nayereh Saborimanesh, and James Brydie

Biodiesel and renewable diesel are biofuels, which can be used as an alternative to petrol diesel fuel. Renewable diesel is considered as a “drop-in fuel”, meaning it can be used in engines without modification. Currently, both biodiesel and renewable diesel are commercially available in limited quantities in North America. Those alternative diesels made from diverse bio-feedstocks using various processes, results in fuels with varying chemical compositions. There is limited information available on their potential fate and transport should they leak into groundwater, especially in the scenario of a leak from a pipeline or from an underground storage tank. In this study we evaluated the potential environmental impacts of pipeline leakage of renewable diesel into a groundwater flow system by conducting a laboratory-based simulated spill experiment. A groundwater spill experiment was conducted with one renewable diesel which the benzene, toluene, ethylbenzene, and xylenes (BTEX) composition of the initial fuels revealed that the BTEX content of renewable diesel was 2.4x greater than petrol diesel. It also contained 6.2x higher concentrations of parent polyaromatic hydrocarbons (PAHs). Analysis of BTEX concentrations in the effluent from renewable diesel tank showed BTEX concentrations up

to 3.9x those from the petrol diesel effluent. Subsequent analysis of other renewable diesels has revealed much lower BTEX concentrations suggesting that the composition of renewable diesel is variable meaning the impact if spilled to groundwater may be variable.

Title: The role of groundwater-surface water interactions in PFAS risk management

*Harris Switzman

Per- and Polyfluoroalkyl Substances (PFAS) are emerging contaminants of concern due to their persistence in the environment and their potential cumulative and adverse effects on both human health and ecological systems. The presence of PFAS in surface water in particular has the potential to be significantly affected by groundwater-surface water interactions. Examples include urban drainage systems acting as preferential flow paths for infiltrated groundwater, direct seepage of groundwater to surface water bodies, riverbed sediments high in organic matter adsorbing PFAS molecules in discharging groundwater, and ponds or lakes recharging aquifers with dissolved PFAS. This presentation will provide an overview of the mechanisms by which PFAS can and has been shown to be influenced by groundwater-surface water interactions, and will discuss how these processes influence the ways in which organisations manage their PFAS risk (i.e., source control, monitoring, assessment and remediation). The presentation will draw on case study examples from sites actively considering groundwater-surface water interactions in their management of PFAS risks, and an analysis of anonymised water and soil PFAS data from 130 samples across 19 different sites within Montrose's internal database. The objective of the presentation is to provide attendees with insights into the unique considerations organisations could face in PFAS management on sites where groundwater-surface water interactions may be influential.

Glacier Room

10:30 – 12:00: Social and Cultural Dimensions of Water

Title: Water is Life: Collaborative Partnerships for Indigenous Water Stewardship in Alberta's Boreal Region - A Case Study

*Fabian Grey and *Zoey Wang

Water holds profound cultural and spiritual significance for Indigenous communities across Alberta. Whitefish Lake First Nation #459 is a northern boreal community situated within the Peace and Athabasca oil sands regions and in an area of forestry development. This case study highlights how collaborative partnerships can support Indigenous-led water stewardship in the boreal region. From 2017 and 2020, Whitefish Lake First Nation partnered with researchers and Alberta Environment and Protected Areas staff to monitor water quality in Utikumasis and Utikuma Lakes. Recognizing that water connects all ecosystem elements,

Whitefish Lake First Nation has since expanded monitoring efforts to include wildlife, traditional plants, lake habitat, and fish health. These efforts continue through collaborative partnerships with a diverse network of researchers and organizations. This work highlights how community-based approaches can deepen understanding of ecosystem health while supporting the development of resilient community-based monitoring programs and enhancing Indigenous water stewardship capacity. In this presentation, Fabian Grey, Consultation Manager, Whitefish Lake First Nation #459 and Zoey Wang, Community-Based Monitoring Program Coordinator, Alberta Environment and Protected Areas will share insights on how collaborative partnerships and diverse knowledge systems contribute to a deeper collective understanding of ecosystem health. Their reflections underscore Whitefish Lake First Nation's strengthened capacity for Indigenous water stewardship in an era of environmental change.

Title: Watershed Management - by whose authority?

*Adam Norris

Watersheds host the meeting of not just surface waters and ground waters but of the range of communities and people living there. Decision-making in watershed matters is often challenged not only by a lack of data, but by a lack of shared understanding. This presentation explores the complexities of evidence-based water management in contexts where scientific knowledge is not universally recognized or prioritized. Drawing on real-world examples, we tell stories of how systems of knowledge - scientific, Indigenous, local, and experiential - intersect and conflict with each other in our attempts to support water governance. To address these challenges, we propose that relationship-building and time are critical tools for successful watershed management. Trust, reciprocity, and sustained engagement can create the conditions for co-development of knowledge and shared decision-making frameworks. We highlight how engaging in the conversation - such as fielding calls, training people for community-led monitoring, and knowledge translation - can allow for the common space needed to tackle watershed management and achieve positive outcomes. These stories will reveal some of our failures, our successes and most importantly the formation of relationships in which real conversations are achievable. Resilience in watershed management is not only ecological but also social, requiring deliberate efforts to recognize epistemological divides and continue on to find common ground. By embracing diverse ways of knowing and investing in long-term relationships, we can move toward decisions that are not only evidence-informed but also contextually grounded and culturally relevant.

Title: A Decision-Support Framework for Developing a Water Management Roadmap for the North Saskatchewan River Basin

*Alison Regan and Kayla Garvey

Alberta's rapid municipal and economic growth depend on continued access to reliable water resources. In the face of climate change and increasing demand, water managers and

users in the North Saskatchewan River Basin (NSRB) need timely, actionable tools and information to support resilient decision-making. Effective watershed management and climate adaptation require collaboration across sectors to ensure solutions are locally relevant and broadly beneficial. In this project, WaterSMART Solutions, under contract to the North Saskatchewan Watershed Alliance, convened a Working Group of key water users to co-develop strategies for sustainable water management in the NSRB. Central to this effort was the creation of a decision-support tool that integrates a hydrological model with a water management model - enabling informed discussions and scenario testing. The project's cornerstone is the Water Management Roadmap: a science-based, community-informed framework that aligns with Alberta's regulatory landscape. It outlines practical adaptations to guide future planning, support sustainable watershed practices, and identify immediate priorities and next steps for governments, water managers, and users. This presentation will highlight the collaborative modelling process, showcase the development of the Water Management Roadmap, and explore its potential to adapt to and shape resilient water management in the NSRB.

Title: Securing Calgary's Water Future: A Collaborative Roadmap to 2100

Brie Nelson, *Laura Sandhu, Rob Hough, Monika Villeneuve

WaterSMART Solutions, in partnership with the City of Calgary, is developing a Water Security Roadmap to guide long-term planning and investment decisions through 2100. As Calgary supplies water to nearly one-third of Albertans, ensuring future water security is critical in the face of climate change, population growth, and finite supply. Building on prior analyses, the project has undertaken a detailed risk assessment to identify and evaluate threats to Calgary's water system. Risks were collaboratively defined and assessed for likelihood and impact using customized tools developed through stakeholder workshops. This process created a shared understanding of vulnerabilities spanning infrastructure, policy, and environmental systems. Preliminary findings highlight diverse mitigation opportunities, including wastewater effluent reuse, stormwater capture, new infrastructure, and policy innovations. These actions are now being evaluated against detailed criteria, including effectiveness, feasibility, and alignment with community values. The most promising options will be sequenced on the Water Security Roadmap to support proactive, flexible decision-making under uncertain future conditions. Now entering its final year, the project will deliver the Roadmap by March 2026. This presentation will share key findings from the risk assessment and early mitigation planning, while demonstrating how this collaborative, values-based approach offers a transferable framework for other municipalities seeking to strengthen resilience and secure their long-term water future.

Title: Collaborative Water Sharing in Times of Drought: Lessons from Alberta's 2024 Water Sharing Memorandums of Understanding

*Rob Hough and Randy Paquette

Drought mitigation is an urgent priority in Alberta's South Saskatchewan River Basin (SSRB), where water scarcity threatens communities, ecosystems, and industries alike. In early 2024, forecasts of severe drought spurred a province-wide response: the development of Water Sharing Memorandums of Understanding (MOUs) to reduce demand through voluntary, cooperative action. Led by Alberta Environment and Protected Areas, in partnership with WaterSMART Solutions, these MOUs were shaped through extensive stakeholder engagement, data-informed planning, and adaptive management strategies tailored to each sub-basin. Between January and October 2024, licence holders across the Red Deer, Bow, Oldman, and Southern Tributaries of the Oldman River basins agreed to voluntary reductions, demonstrating that collaborative action can yield meaningful water savings in real time. The MOUs balanced regulatory requirements with local priorities, while fostering trust, flexibility, and shared responsibility. They also provided government with a governance tool that respected existing water licences while enabling coordinated action under drought conditions. Importantly, the agreements advanced provincial policy goals of proactive drought management without requiring legislative or regulatory change. This presentation will share outcomes from Alberta's 2024 Water Sharing MOUs, highlighting how voluntary, stakeholder-driven agreements reduced drought impacts, strengthened resilience, and offered a replicable model for water management. Lessons learned extend beyond Alberta, offering guidance to other regions facing the growing challenges of water scarcity and climate change.

13:30 – 15:00: Climate Adaptation and Infrastructure Resilience

Title: Targeting the Calgary Buried Valley Aquifer: A Water Solution in the Bow Valley

Brendan Ray

Securing a sustainable groundwater supply for the Municipal District of Bighorn's low-carbon industrial facility near Exshaw, AB required navigating cost, regulatory and environmental constraints. Piping water from existing infrastructure in Exshaw was cost-prohibitive and Bow River diversions were restricted by the South Saskatchewan River Basin moratorium. Shallow groundwater, being hydraulically connected to the river, were ineligible for new licences. Purchasing a licence from existing users was uncertain and costly, requiring negotiations, fees, and legal expenses in addition to drilling costs. These limitations led the project to target the Calgary Buried Valley Aquifer (CBVA), a deep (>175 m) preglacial fluvial channel largely unexplored in the Bow Valley. The CBVA extends from southeastern Alberta through Calgary and into the Bow Valley, with prior drilling confirming its presence near Canmore, Dead Man's Flats, and Exshaw. Basal gravels display fining-upward sequences consistent with fluvial origins predating glaciation. Water levels rise close to surface in parts of the valley, with potential for artesian conditions. Despite regional mapping, limited local drilling data introduced uncertainty and site constraints such as land titles, and rights-of-way added complexity. Licensing also required proof of hydraulic separation from shallow aquifers. The CBVA was successfully drilled and pumping tests confirmed a prolific supply. Licensing secured a sustainable drinking-water source, while

borehole data revealed thick alluvial fan sediments, later used to develop an open-loop geothermal system. The project highlights the CBVA's role in supporting industrial water supply and the potential for geothermal integration in the Bow Valley.

Title: Open-Loop Geothermal Exchange: Developing a Low-Carbon Heating and Cooling System Using Groundwater in the Bow Valley

*Steve Sturrock

The Municipal District of Bighorn is developing a new operations facility near Exshaw, Alberta that will be heated and cooled by a groundwater-sourced heat pump. The system extracts stable-temperature groundwater from the Bow River Aquifer, circulates it through a closed-loop heat exchanger, and returns the same volume to the aquifer, achieving decarbonization without consumptive use of groundwater. We present the hydrogeological evaluation, proof-of-concept testing, and licensing approach used to demonstrate reliability, protect other users, and support authorization under Alberta's Water Act. Two wells were designed and installed in the unconfined alluvial sediments. Stratigraphic positioning and well construction enabled high-capacity pumping and recirculation, with aquifer tests demonstrating high deliverability and mean transmissivity of $\sim 4,300 \text{ m}^2/\text{day}$. Proof-of-concept circulation sustained production and return rates exceeding 100 l gpm ($655 \text{ m}^3/\text{day}$), with minimal drawdown (0.19m) and injection pressures (0.27m), despite fluctuations tied to Bow River and spring freshet recharge. These results highlight the challenges and opportunities of licensing in an unconfined aquifer hydraulically connected to a major river. The system's closed-loop surface design ensures all groundwater is returned to the aquifer, streamlining regulatory approval as non-consumptive use. This approach results in no net groundwater loss and no change in water quality. Groundwater entering the system at $\sim 7.5^\circ\text{C}$ is discharged at a lower temperature, producing a moderate cooling effect in the aquifer, and a monitoring program is proposed to track thermal impacts. This work demonstrates a replicable, low-carbon solution for climate adaptation in high-transmissivity alluvial settings, reducing reliance on fossil energy while safeguarding aquifer integrity and neighboring users.

Title: Estimating Groundwater Contributions to Alpine Lake Water Budgets

*Kayla Harris, Cathryn Ryan, Jean Birks, Brandi Newton, Nadine Taube, Janet Fischer, Mark Olson, and Richelle Allen-King

Canada's Rocky Mountains supply critical water resources to ecosystems, communities, and industries downstream. Climate change and increasing drought conditions threaten the sustainability of these resources, particularly in the semi-arid eastern slopes. Alpine lakes, fed by rainfall, glacier and snowmelt, and groundwater, are vital to mountain hydrology and serve as headwaters for streamflow. Groundwater, often overlooked, is key to maintaining these systems and their behaviour within the watershed. We examine groundwater contributions to alpine lakes in both a glaciated (Zigadenus Lake) and an unglaciated (Elbow

Lake) watershed. The research integrates water, isotope, and solute mass balances with field sampling, geochemical analysis, and meteorological data. Bathymetric surveys estimate lake volumes, while streamflow, temperature, and conductivity monitoring enhance the understanding of water movement.

Title: A Delicate Balance: Mine Water Management Under Rapid Environmental Change in the North

*Kalina Malowany and Krystal Chin

Climate change is fundamentally reshaping the environmental narrative in northern regions, prompting a need to critically reassess assumptions that underpin the management and planning for mining operations and closure for projects. The effects of climate change are experienced more acutely in the north, where many sites are already showing rapid transformations, particularly in water systems, as previously frozen conditions are now thawing and climate patterns start to change. Over the next 70 years, permafrost is likely to disappear completely from certain areas and disrupt the delicate balance between groundwater and surface water systems. This is exposing the vulnerability of projects to changes in water balance and underscoring the urgent need to adapt both operation and remediation practices for mining and remediation projects. We examine the predictions for environmental change at northern sites and the potential effects to groundwater and surface water systems. Risk management is likely to play a critical role in adapting to these changes, however, a better evaluation of regional changes to water systems should be undertaken to provide context for projects that will need to manage water for the decades to come.

Title: Central Ohio Water Study - Integrated Planning for People, Place, and Water Reuse

*Stephanie Ishii and Kathleen Smith

An integrated water resources model developed for 15 counties in Central Ohio demonstrates how system-scale planning can inform reuse, infrastructure investment, and long-term policy. The model links historical and projected data on population growth, water demand, surface and groundwater availability, reclaimed water, infrastructure capacity, land use, and climate variability. This regional, multi-jurisdictional approach supports coordinated decision-making for project development, industrial siting, and resilient funding strategies. By framing water resources as deeply interconnected with land use and community development, the model helps identify where municipal and industrial reuse can be effectively integrated into planning efforts. Scenario-based analysis enables stakeholders to explore future conditions, uncover infrastructure gaps, and prioritize investments in ways that reflect both environmental and social needs. The study underscores the value of watershed-scale collaboration and demonstrates how integrated modelling can guide governance, align cross-sector priorities, and strengthen resilience. By connecting technical analysis with planning and policy, the Central Ohio Water Study offers a transferable

example of how regions can leverage integrated water management to balance growth, resource protection, and equity in an era of increasing climate and population pressures.

15:30 – 17:00: Contaminants and Water Quality

Title: Tracing PFAS in Public Water Systems: Monitoring and Source Identification Approaches

Conner Murray and *David Rosen

Emerging contaminants continue to challenge the water sector, particularly where conventional treatment trains are limited in their capacity to remove constituents present at trace levels. Per- and polyfluoroalkyl substances (PFAS) are a prime example, with concentrations documented in water supplies across Canada. Addressing PFAS requires utilities to strengthen monitoring and source identification efforts as regulatory scrutiny increases. This presentation emphasizes technical approaches to the early stages of PFAS management. Multiple sampling and analytical methods suitable for PFAS detection will be discussed, along with a PFAS screening tool that can help differentiate potential sources. These techniques provide utilities with practical strategies to characterize PFAS occurrence, evaluate transport across treatment processes, and identify inputs within their systems. Two case studies will be shared that illustrate the application of these methods. The first involves a surface water utility that deployed passive samplers to trace and ultimately confirm intermittent PFAS discharges into source waters. The second highlights a wastewater facility that designed a comprehensive sampling program across both the treatment train and sewer shed, enabling the identification of several distinct PFAS discharge points. By integrating monitoring, analytical screening, and targeted sampling, utilities can establish a foundation for PFAS management that supports both regulatory compliance and long-term risk reduction.

Title: Re-surveying wastewater effluents discharging into receiving mainstem rivers in Southern Alberta

*Natalie Kromrey and Cecilia Chung

In August 2014 a lagrangian survey was completed in the South Saskatchewan watershed of Southern Alberta. Samples were collected from major tributaries, continuously discharging wastewater facilities and mainstem receiving rivers from upstream to downstream as a time-of-travel synoptic. In 2023 the same wastewater facilities were re-visited with samples being collected as a snapshot synoptic in winter (February), high-flow (June) and low-flow (August). Additionally, one wastewater facility was sampled every second day in the month of June to assess daily variability in parameter concentrations. Parameter comparisons for physical & biological, nutrient, bacteria, pesticide and total & dissolved metals parameters provide a look into what can change within days and what has changed in almost a decade.

Title: Detection of Microplastics in Surface Water Conditions

*Alexander Laycock, Sampurna Nandy, Emily Quecke, Ania Ulrich, and Petr Kuznetsov

Microplastics are ubiquitous in surface water. These polymer particles between 5 µm and 5 mm have been found in upwards of 83% of tap water, indicating a higher presence in pre-treatment surface water. A viable method of microplastic removal from surface water is phytoremediation, the use of plants and the microorganisms living in their rhizosphere to uptake and break down the microplastic particles. Determining how effective phytoremediation is for the removal of microplastics proves to be a challenging task, as this requires a reliable detection method of the polymer particles in water. This preliminary study tests various methods to quantify and qualify microplastics in water before being subjected to removal and transformation via macro- and microorganisms. Gravimetric analysis is trialed as a simple way to calculate the amount of plastics in an aqueous sample by vacuum filtering the sample and taking initial and final measurements of the mass. Fluorescence microscopy combines the quantitative and qualitative analyses by viewing microplastics that have been dyed and filtered out of water, exposing them to an excitation wavelength of light, and determining the amount of fluorescing particles and any changes to their fluorescence under a filter. Fourier transform infrared spectroscopy (FTIR) is used to establish the type of plastic and amount of degradation it has experienced. These detection methods are compared and contrasted in this study to determine the best approach to observe changes in the amount and stage of disintegration of microplastics when phytoremediation is applied.

Poster Session**Title: Microbial Profiling for Groundwater Remediation: Enhanced Degradation of Petroleum Hydrocarbons & Chlorinated Ethenes**

*Sampurna Nandy, Sydney Kennedy-Flynn, Petr Kuznetsov, Miles Dyck, and Ania Ulrich

Groundwater contamination with petroleum hydrocarbons (PHC) and chlorinated ethenes is a persistent challenge across Alberta. The integration of nutrient amendments combined with microbial bioaugmentation is a recognized, effective solution. In this view, a historically contaminated site (north Edmonton) was assessed and subjected to nutrient amendments and microbial bioaugmentation strategy for enhanced remediation. Baseline groundwater chemistry revealed the presence of benzene (up to 9.6 mg/L), toluene (926 mg/L), cis-1,2-dichloroethylene (336 mg/L), and vinyl chloride (71.7 mg/L) across several injection and monitoring wells. Following amendment, microbial activity and community responses were tracked using functional assays and molecular tools. Dehydrogenase activity, an indicator of overall microbial metabolism, increased markedly in enriched wells, rising from <0.7 to >11 µg/mL within three weeks. Catechol dioxygenase activity was found to be 2-fold across most wells, confirming activation of aromatic hydrocarbon degradation pathways. Additionally, community-level physiological profiling showed broader substrate utilization and higher

average well colour development values within 21 days. Furthermore, the quantitative PCR demonstrated a 5 to 10-fold increase in total bacterial 16S rRNA gene copies, with one injection well exceeding 9.5×10^7 copies/mL. Notably, the *Dehalococcoides* spp., a key reductive dechlorinator, increased from $\sim 10^3$ to $>10^5$ copies/mL, suggesting stimulation of chlorinated ethene biodegradation alongside PHC degradation. This work suggests that addition of nutrients and targeted microbial inputs significantly enhanced the metabolic and degradative potential of groundwater microbial communities. These findings highlight the feasibility of integrated bio-stimulation and bio-augmentation approaches for concurrent remediation of BTEX and chlorinated ethenes in contaminated aquifers.

Title: Canada's Aquifer Mosaic: Stitching Together Publicly Available Maps for More Resilient, Equitable Futures

*Julie Zettl and Tom Gleeson

Aquifers provide a foundation for water security, climate resilience, and community well-being across Canada. Yet aquifer information remains fragmented, varying widely in scope, resolution, and accessibility across jurisdictions. This presentation introduces graduate research compiling and synthesizing publicly available aquifer maps into a coherent yet fragmented 'aquifer mosaic' for Canada. The work is grounded in a decolonizing mapping process that incorporates treaty and territory boundaries alongside hydrological and hydrogeological frameworks. Respecting original data sources, rather than reinterpreting them, is a central principle. This initiative is grounded in comparable international mapping initiatives, as well as the contexts of climate change and Indigenous resurgence. We geospatially analyze key questions including: What percentage of treaty, territory, watershed, hydrogeologic regions, or hydrogeological units have mapped aquifers? What percentage of aquifers cross jurisdictional, watershed, and treaty boundaries? Where are the largest spatial and thematic gaps in existing coverage? Preliminary findings highlight the value and limitations of national and provincial efforts while identifying priority areas for future synthesis. The longer-term goal is to integrate existing sources into unified, consistent descriptions of aquifers that are both technically robust and accessible. This research supports more equitable and actionable groundwater knowledge across Canada by connecting diverse datasets, honoring data sovereignty, and creating tools that are simpler and more usable than existing complex systems.