BRBC Science Forum
Wednesday, May 04, 2022
Heritage Hall, Symposium Room, SAIT

Forum Agenda

08:15 am – 08:45 am	**REGISTRATION & COFFEE**
08:45 am – 09:00 am	**Welcoming remarks** – ***Wendell Koning and Mike Murray, BRBC***
09:00 am – 09:30 am	**Invited Speaker** - One person's waste is another person's treasure: Using wastewater-based epidemiology (WBE) to track SARS-CoV-2 across Alberta - ***Nicole Acosta, University of Calgary***
Session One: Climate Change & State of the Watershed *(Chair: TBD)*	
09:30 am – 09:50 am	Shifts in historic and future temperature and precipitation patterns related to snow accumulation and melt regimes in the Bow River basin - ***Brandi W. Newton, Alberta Environment and Parks***
09:50 am – 10:10 am	Patterns of organic carbon flux through the South Saskatchewan River Basin are shaped by human activities and climatic cycles - ***Matthew Bogart, University of Lethbridge***
10:10 am – 10:30 am	Geoarchaeological analysis of floodplain carbon cycling and Holocene landforming processes using buried soils, Bow River watershed, southern Alberta - ***Kelsey Serviss, University of Calgary***
10:30 am – 11:00 am	**MORNING BREAK / POSTER SESSION**
Session Two: Methods of Aquatic and Riparian Assessment & Connecting Science to Action *(Chair: TBD)*	
11:00 am – 11:20 am	Riparian health trend monitoring in Calgary (2007-2020): Key findings and case studies - ***Kathryn Hull, Cows and Fish***
11:20 am – 11:40 am	SWIM (Sustainable Watershed Integrated Management): a platform to share, analyse and visualise water-based data (and more) in watersheds - ***Leland Jackson, University of Calgary and & Jennifer Collins, IBM***
11:40 am – 12:00 pm	Gravel lane TSS abatement study and pilot projects - ***Stacey Zhao, City of Calgary***
12:00 pm – 01:00 pm	**LUNCH / NETWORKING**
Session Three: Threats to Human Health and Aquatic Ecosystems *(Chair: TBD)*	
01:00 pm – 01:20 pm	Assessing the source and fate of nutrients for mitigating aquatic vegetation growth within Alberta's irrigation districts - ***Richard Phillips, Bow River Irrigation District***
01:20 pm – 01:40 pm	Predicting low DO events in the Bow River during low flow years. What can we expect on the DO sag intensity, location and timing? - ***Nancy Martin, Alberta Environment and Parks***
01:40 pm – 02:00 pm	Understanding risk to Calgary's drinking water due to wildfire in a source watershed area: Devil's Head Wildfire Monitoring Response - ***Eric Camm, City of Calgary and Michael Wagner, Alberta Agriculture, Forestry and Rural Economic Development***
02:00 pm – 02:20 pm	Assessing drinking water quality risks from firefighting products - ***Victoria Arnold and Jennifer Pouliotte, City of Calgary***
02:20 pm – 02:50 pm	**AFTERNOON BREAK / POSTER SESSION**
Session Four: Understanding Groundwater & Groundwater-Surface Water Interactions *(Chair: TBD)*	
02:50 pm – 03:10 pm	Flow and recharge to an alpine karst aquifer in the Canadian Rockies - ***Sarah Lilley, University of Calgary***
03:10 pm – 03:30 pm	Watershed-Scale Characterization of Alpine Aquifer Systems - ***Brayden Maxwell Ralph, University of Calgary***
03:30 pm – 03:50 pm	Characterizing Groundwater Geochemical Influences on Stormwater Infrastructure - ***Lucas Ogrins, University of Calgary***
03:50 pm – 04:10 pm	Interaction between the Sunnyside alluvial aquifer and the Bow River in Calgary-Alberta: Hydrogeochemical and isotopic perspectives - ***Francisco Castrillon Munoz, Innotech Alberta***
04:10 pm – 04:20 pm	**Closing Remarks – *Wendell Koning, BRBC Science Forum Chair***

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Venue

The 2022 BRBC Science Forum is held at **Southern Alberta Institute of Technology (SAIT)** (1301 16 Ave NW, Calgary, AB, T2M 0L4). The **Symposium Room** is located in the **Heritage Hall** building of the SAIT main campus, close to the C-Train line and SAIT parking garage (see star on map below). Please look for signs directing you to the appropriate room.

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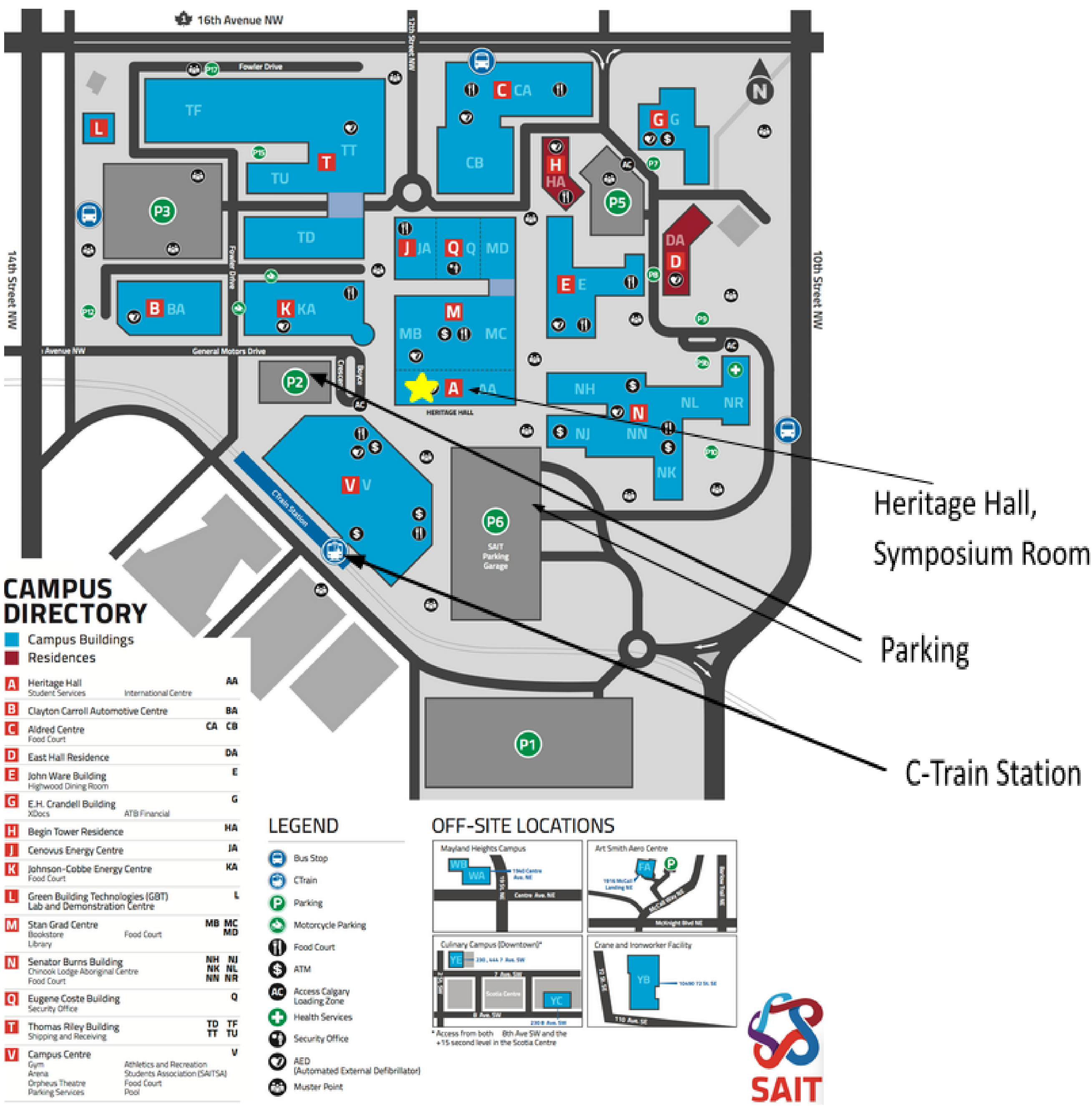

Abstracts: Oral

Presenter names are in bold.

Invited Speaker

One person's waste is another person's treasure: Using wastewater-based epidemiology (WBE) to track SARS-CoV-2 across Alberta

Nicole Acosta

Cumming School of Medicine, University of Calgary

A community's wastewater is not just waste, it has proven to be a valuable tool for public health professionals. It can provide comprehensive, unbiased, and inclusive information such as evidence of the circulation and levels of certain infectious agents like SARS-CoV-2 in the community. In 2020, University of Calgary researchers together with Advancing Canadian Wastewater Assets (ACWA), The City of Calgary, and Alberta Health Services (AHS) teamed up to test Calgary's wastewater for early signs of COVID-19 cases at different scales. In the fall of 2021 researchers at the University of Calgary and the University of Alberta came together to expand their COVID-19 wastewater monitoring programs. The joint effort monitors the wastewater of approximately 3.2 million people or nearly three-quarters of the population of Alberta three times per week. Results are shared on the COVID data tracker website (https://covid-tracker.chi-csm.ca) which allows members of the public to view data points and see how SARS-CoV-2 RNA signals are trending in different communities across the province of Alberta.

Session One: Climate Change & State of the Watershed

Shifts in historic and future temperature and precipitation patterns related to snow accumulation and melt regimes in the Bow River basin

Brandi W. Newton[1], Babak Farjad[2], and John F. Orwin[1]

[1] Airshed and Watershed Stewardship Branch, Resource Stewardship Division, Alberta Environment and Parks
[2] Environmental Knowledge and Prediction Branch, Resource Stewardship Division, Alberta Environment and Parks

Shifts in winter temperature and precipitation patterns can profoundly affect snow accumulation and melt regimes. These shifts have varying impacts on local to large-scale hydro-ecological systems and freshwater distribution, especially in cold regions with high hydroclimatic heterogeneity, such as the Bow River Basin. The Bow River Basin is characterized by large topographic and biogeographic gradients, spanning four ecozones - Mountains, Foothills, Parkland, and Prairie. We evaluated historic and future changes in winter climate for these ecozones and present them in the context of the Bow River Basin. Analyses were conducted using high-resolution (~10km) interpolated historic data and downscaled projections for the 2050s (2041-2070) and 2080s (2071-2100) under medium (RCP 4.5) and high (RCP 8.5) emissions scenarios. Results indicate declines in winter duration and earlier onset of spring above-freezing temperatures, with greater changes in Prairie and Mountain ecozones. Future scenarios suggest winter precipitation increases are expected to predominantly fall as rain, and shifts in precipitation distributions lead to historically-rare high-precipitation extreme events becoming more common. This study increases our understanding of historic trends and projected future change effects on winter snowpack-related climate and can be used to inform adaptive water resource management strategies.

Patterns of organic carbon flux through the South Saskatchewan River Basin are shaped by human activities and climatic cycles

Matthew Bogard, Sarah Ellen Johnston, Panditha Gunawardana, and Stewart Rood

Department of Biological Sciences, University of Lethbridge, Lethbridge, AB Canada

Grasslands are among the most disturbed systems on Earth due to extensive agricultural development and river regulation for irrigation and other human uses. To define how these factors impact the movement of carbon (C) through river networks, we quantified seasonal patterns of dissolved organic C (DOC) fluxes through the South Saskatchewan River Basin over the past four decades. We surveyed trends from upstream sites along the Oldman, Bow, and Red Deer Rivers to the outflow below Lake Diefenbaker reservoir, in SK. The amount of DOC exported through all sites was low relative to other major rivers, but consistent with rivers of other arid regions. Despite urbanization and effluent release in recent decades, we did not observe trends in DOC fluxes over twenty-to-forty-year monthly sample records. Interannual variability in DOC flux was linked to climate cycles, most strongly the Pacific Decadal Oscillation, which was correlated with the regional droughts of the 1930s and 1980s. Human impacts were more apparent on the seasonality of flux, since spring export dominated DOC flux in most sub-watersheds, but seasonal changes were absent at the river mouth due to river regulation. In grassland regions such as the Canadian Prairies, agriculture and urbanization impact water quality but do not appear to have enhanced DOC flux through the main river reaches. DOC fluxes appear to be shaped by a complex interaction between natural climate cycles and increasingly by hydrological consequences from climate change.

Georchaeological analysis of floodplain carbon cycling and Holocene landforming processes using buried soils, Bow River watershed, southern Alberta

Kelsey Serviss, Andrea Freeman, and Yvonne Martin

Department of Geography, University of Calgary

River processes such as erosion and deposition and soil forming processes such as organic matter decomposition and carbon mineralization operate on floodplain land surfaces to create distinct depositional layers in long-term sediment storage. These soil and sediment layers may also be the deposition matrix for the materials that comprise the geoarchaeological record in a floodplain. Multiple publications on the geoarchaeological records within the Bow River watershed followed the monumental flooding and subsequent geomorphological impacts in June of 2013. Several years removed from the flooding, there is now an opportunity to use this newly generated data and knowledge, combined with primary data collection and analysis, for geoarchaeological research within the Bow River watershed. My research will combine the existing studies with primary empirical research to advance knowledge regarding the role floodplain soils occupy in carbon sequestration and archaeological site preservation and to contribute to the reconstruction of Holocene channel evolution in the Bow River watershed. The methods include a systematic review of existing archaeological studies, a GIS aerial imagery overlay analysis, and field sampling and organic carbon and particle size measurements of stratified soil and sediment from sites selected based on the results of the archaeology review and overlay analysis. Data will be interpreted using a combination of established theoretical archaeological and geomorphological frameworks regarding soil formation and stratified floodplain sediment storage. This research would contribute new data and knowledge regarding the magnitude and mechanisms of floodplain carbon cycling in the Northern Great Plains, plus enrich contextual knowledge of regional geoarchaeology.

Session Two: Methods of Aquatic and Riparian Assessment & Connecting Science to Action

Riparian health trend monitoring in Calgary (2007-2020): Key findings and case studies

Kathryn Hull, Alberta Riparian Habitat Management Society (Cows and Fish)
Kristina Boehler, Cows and Fish
Norma Posada, City of Calgary Water Resources
Harpreet Sandhu, City of Calgary Water Resources
Mike Gallant, Kerr Wood Leidal Associates Ltd.
Pierre Raymond, Terra Erosion Control Ltd.
Andre Evette, INRAE, Grenoble, France
Alan Dodd, Longview Ecological

Riparian areas are increasingly being recognized as important natural assets for stormwater management, biodiversity conservation and climate resiliency, especially within an urban context. Enhancing these and other riparian ecosystem services has been a recent priority focus for Calgary's Parks and Water Resources business units. The City of Calgary's 2013 Riparian Strategy and 2017 Riparian Action Program (RAP) demonstrate a strong commitment to conserving and improving the ecological health of riparian areas. Riparian health monitoring is important for tracking progress toward this objective and targets established for the RAP as part of an integrated, adaptive management approach. Since 2007 extensive riparian health inventories (RHIs) have been conducted in Calgary's Bow, Elbow and Nose Creek sub-watersheds by the Alberta Riparian Habitat Management Society (Cows and Fish) on behalf of The City of Calgary. RHI trend results provide a unique opportunity to track riparian health response to the 2013 flood and ongoing management interventions, bioengineering, and riparian rehabilitation efforts. This presentation will highlight key findings from this long-term monitoring initiative (2007-2020) such as invasive species trends, beneficial balsam poplar response to flooding, and successful case studies of riparian habitat enhancement. Riparian health in a densely populated urban area has inherent constraints from current and historic cumulative land uses and hydrological impacts at a local and regional watershed scale. Long-term monitoring of riparian plant communities, species composition shifts, soil and hydrological conditions and other riparian health indicators provides insight into prioritizing and directing conservation planning, management and rehabilitation efforts at multiple spatial scales.

SWIM (Sustainable Watershed Integrated Management): a platform to share, analyse and visualise water-based data (and more) in watersheds

Leland Jackson[1] & **Jennifer Collins**[2]

[1] Department of Biological Sciences, University of Calgary
[2] IBM Canada Centre for Advanced Studies

To manage water at a watershed scale requires that data from disparate sources be combined to avoid piecemeal, siloed management that is characteristic of many basins where management objectives are set by different agencies and utilities respond to regulations largely as individual organizations. It can be difficult to analyse and visualise large amounts of data on maps, yet an integrated solution that allows combining, manipulating, analyzing and visualizing data is crucial to understanding pressures on water resources across large basins and to identify options for integrated solutions. Furthermore, engagement of landowners and the public to increase water awareness and literacy requires data be made accessible to a range of science literacies. SWIM is a data collaboration platform that was designed to share, analyse and visualise watershed data. Here we report on

updates to the SWIM platform that have happened over the last couple years and invite participation from basin stakeholders.

Gravel lane TSS abatement study and pilot projects

Stacey Zhao and Erica Yaholnitsky

Study prepared for the City of Calgary by MPE Engineering Ltd., Applied Research Associates Inc., and Kerr Wood Leidal Associates Ltd.

The City of Calgary is committed to protecting local surface water quality. Studies of Calgary's stormwater pollutant loadings to waterways revealed that gravel surfaced laneways are a significant source of sediment that washes through city infrastructure and settles in storm ponds, streams, and rivers. Gravel surfaced back lanes are susceptible to weather-related events and conditions, which leads to gravel erosion and development of rutting and potholes. This leads to stresses on maintenance, capital and personnel resources and community dissatisfaction. A comprehensive study of gravel lanes and alternative surfacing treatments was completed to assess their current and potential application in Calgary using a triple bottom line (TBL) assessment approach.

For new developments, asphalt paving is the top alternative, but the top alternative varies for existing lanes based on location, length, etc. The project team is completing pilot projects for the top three alternatives to confirm the economic, environmental, and social benefits. These pilot projects include:

- Asphalt with infiltration trenches
- Applying a chip seal to existing gravel
- Using higher quality gravel

The pilot projects will be used to confirm the assumptions for cost of installation and maintenance, reduction in TSS and social acceptance that are included in the gravel lane study.

Session Three: Threats to Human Health and Aquatic Ecosystems

Assessing the source and fate of nutrients for mitigating aquatic vegetation growth within Alberta's irrigation districts

Richard Phillips[1], Alan Harrold[2], Jason Miller[3], David Westwood [4], Janelle Villeneuve[5], Nicole Seitz Vermeer[5], Isabel Plata Enriquez[6], and Bernhard Mayer[6]

[1] Bow River Irrigation District
[2] Lethbridge Northern Irrigation District
[3] Raymond Irrigation District
[4] St. Mary River Irrigation District
[5] Alberta Agriculture and Forestry
[6] University of Calgary

Irrigation districts are increasingly challenged by excessive aquatic vegetation growth. Such growth can result in obstruction of screens, reduced conveyance capacity of canals, and an overall reduction in the volume of water available to irrigators. Irrigated crop production relies on the delivery of irrigation water at critical times of crop growth and delays or inability of irrigation water to be reliably delivered can reduce production or quality of the crops grown. Excessive growth of aquatic vegetation is caused in part by an abundance of dissolved nutrients, such as carbon, nitrogen, and phosphorus in surface waters, but the source and fate of these nutrients within irrigation systems are largely unknown. Four irrigation districts in southern Alberta investigated the sources and fates of these nutrients using isotopic analysis of carbon, nitrogen, and phosphorus found in irrigation water to those of possible sources. Potential nutrient sources included fertilizer, manure, agricultural soils, drainage water, and non-agricultural sources such as urban waste water. It was found that nutrient sources were linked to predominant land use in the districts. Isotopic analysis was successful at identifying sources of nitrogen and carbon in irrigation water but could not be used for phosphorus due to insufficient concentrations for isotopic analysis. Increased knowledge and understanding of the source and fate of these nutrients in irrigation infrastructure enables irrigation districts to make informed decisions about nutrient management practices to reduce the risk of excess aquatic vegetation growth within irrigation systems.

Predicting low DO events in the Bow River during low flow years. What can we expect on the DO sag intensity, location and timing?

Nancy Martin

Alberta Environment and Parks

Dissolved oxygen (DO) is a critical parameter to protect the aquatic ecosystem in the Bow River. Water quality models can help understand the potential extent of the DO problem if the total phosphorus (TP) loads increase from current conditions under different climate and flow conditions. We used the Bow River Water Quality Model (BRWQM) to predict the DO concentrations at increased phosphorus loadings up to meeting the DO instream guidelines. In this presentation, we will analyze the results of the model scenarios that define the TP maximum allowable load for the river reach Bearspaw to Above Highwood River and Highwood River to Bassano Dam. The results suggested critical DO areas downstream Bonnybrook WWTP and downstream Crowfoot Creek. The model predicted DO concentrations below the acute guideline for 14 km. The minimum DO observed at a single model segment was close to 2.6 mg/L. The DO sag lasted up to eight hours per day during the night and up to nine consecutive days during late August and early September. Although several studies have analyzed past DO sags in the Bow River, through modelling, we can predict and understand what we can expect if TP loadings increase in the future. These results provide valuable information for targeting management actions.

Understanding risk to Calgary's drinking water due to wildfire in a source watershed area: Devil's Head Wildfire Monitoring Response

Eric Camm[1] and **Michael Wagner**[2]

[1] City of Calgary
[2] Alberta Agriculture, Forestry and Rural Economic Development

Several major wildfires in Alberta including Kenow, Fort McMurray, and Lost Creek have resulted in a greater understanding of how wildfires represent an emerging risk to downstream water users through contaminant transport and disruption of water treatment processes. Through the development of Calgary's Source Water Protection Plan, contamination of source water from wildfire has been identified as a high risk. Following a wildfire, precipitation events can mobilize nutrients, organic carbon, and chemical contaminants, potentially altering aquatic ecology and downstream water quality as well as posing a risk to public health.

On September 4th, 2020 a wildfire started in the headwaters of the Ghost River region west of Calgary, AB burning approximately 2,153 hectares over a period of six weeks. Due to the location within Calgary's source water supply a water quality monitoring program was immediately implemented with sampling during the active wildfire, continuing overwinter and into 2021 to target snowmelt and rain event periods in an effort to characterize the presence and transport of contaminants within the Ghost River system. As there has not been a major wildfire event within this area since the 1910s, there was a unique opportunity to gather site-specific information and further our understanding of wildfire impacts to water quality. Results from a heavily burned monitoring location demonstrated an increase in concentrations of total and dissolved fractions of phosphorus and organic carbon.

Soil analysis revealed significant increases in concentrations of several polycyclic aromatic hydrocarbons; however, water quality results demonstrated these contaminants were not being mobilized into the river system. The presentation will provide an overview of the monitoring activities, water quality results, discussions of risk to water treatment, and highlight the collaborative response between governmental agencies.

Assessing drinking water quality risks from firefighting products

Victoria Arnold and **Jennifer Pouliotte**

The City of Calgary

Source water protection (SWP) is an important part of the multi-barrier approach to providing safe drinking water. SWP actions are often more effective and less costly than drinking water treatment upgrades. The City of Calgary published a SWP Plan in 2018 which identified a set of actions to mitigate risks to source water quality in the Bow and Elbow Rivers. Subsequently, a multi-agency Wildfire Task Force was created to examine the risks posed to water quality and treatability by wildfires, and contamination of source waters by chemicals present in firefighting products, such as per- and polyfluoroalkyl substances (PFAS), was identified as an associated risk.

In order to more fully explore this issue, a project was initiated to gain an understanding of: what firefighting products are being used in Calgary's source watersheds, how they are being used, what chemicals they contain, and if these chemicals are of concern from a drinking water perspective. A framework for assessing firefighting products was created using two freely available chemical toxicity databases. The framework will be presented, along with the results for some of the products assessed. The presence of PFAS and of unknown chemicals were key drivers in product ratings. The results of a survey of regional fire agencies used to gain insights into how these products are used and potential barriers to transitioning to fluorine-free products will also be shared. Finally, project outcomes, ongoing work, and some challenges and lessons learned will be discussed.

Session Four: Understanding Groundwater & Groundwater-Surface Water Interactions

Flow and recharge to an alpine karst aquifer in the Canadian Rockies

Sarah Lilley and Masaki Hayashi

Department of Geoscience, University of Calgary

The term 'karst' describes a bedrock topography formed by chemical dissolution, producing aquifers comprised of features like underground conduits and caves. The Front Ranges of the Canadian Rockies constitute thick and extensive deposits of carbonate bedrock that host alpine karst aquifers. The Watridge Karst Spring is the largest known spring in the Spray Valley Provincial Park, Alberta. Unlike other local groundwater springs, the one in question is not located below a discernible water reservoir. Yet, annual water budget calculations suggest that the effective watershed area for the spring is on the order of 15 – 40 square kilometers. Karst groundwater can flow independently of surface topography, making watershed delineation a major challenge in karst studies. This study uses continuous hydrochemical monitoring and dye tracing of groundwater flow paths to build a conceptual model for the governing processes that control the recharge and transmission of water through this alpine karst aquifer. It is estimated that 25% of the global population relies on karst-hosted groundwater. Rising air temperatures in alpine zones are expected to influence future water availability in regions where water supply is dominantly from melting snow or ice. A changing hydrologic regime is expected to influence karst water resources and have implications for water management strategies. There is still limited knowledge about how alpine karst systems may respond to climate change. This conceptual understanding can improve the capabilities of hydrological models to predict water quality and availability in response to a warming planet.

Watershed-Scale Characterization of Alpine Aquifer Systems

Brayden Maxwell Ralph and Masaki Hayashi

Department of Geoscience, University of Calgary

Major rivers that originate in mountainous areas provide the main water supply for more than one third of the world's population. These rivers typically exhibit a four-to-five-month high flow period driven by snowmelt and rain, followed by a seven-to-eight-month low flow period sustained by groundwater discharge from mountain headwaters. Recent small-scale and field-based studies have identified talus slopes, moraines, and alpine meadows as the main landforms responsible for storing and discharging groundwater in these headwater environments and have further classified them as alpine aquifers. However, there has not been much progress upscaling our current small-scale understanding of alpine aquifers to the watershed-scale. This study aims to upscale our knowledge of alpine aquifers by developing a geospatial modelling approach that can 1) map the spatial extent and distribution of different aquifers that are common in alpine watersheds and 2) employ a numerical groundwater flow model to simulate annual groundwater storage and discharge for a given watershed. The Opabin sub-watershed, located within the Lake O'Hara watershed in British Columbia will be used as the pilot site. The resulting model will be calibrated and validated using measured stream discharge data from Opabin creek, and the model efficacy will be evaluated by applying it to two other watersheds in the Canadian Rockies, specifically within the Bow River basin. The new modelling approach will provide an efficient tool to quantify and predict the annual groundwater contributions from mountain headwaters to major rivers, which will in turn help downstream populations sustainably manage their water supply.

Characterizing Groundwater Geochemical Influences on Stormwater Infrastructure

Lucas Ogrins[1], Ed Cey[1], Harris Switzman[2], Megan Roche[2], and Sarah Nelson[2]

[1] University of Calgary
[2] Calgary International Airport

Stormwater retention ponds are common elements of urban drainage systems intended for both flow and water quality control when intense precipitation occurs. Groundwater can interact with stormwater drainage systems and affect their performance. This altered performance can influence geochemical dynamics in the drainage system, leading to potential problems for certain redox sensitive species like sulphur (e.g odours, mineral precipitation, elevated dissolved solids).

The goal of this project is to contribute to knowledge on groundwater interaction with urban drainage systems in a cold climate setting. The study is specifically focused on quantifying the water balance and geochemical dynamics (focused on sulphur) of two storm retention ponds and associated drainage network at Calgary International Airport. To accomplish this, stable sulphur, oxygen, and hydrogen isotopes from pond sediments, groundwater, and surface water samples were analyzed to 'fingerprint' the water compositions. This analysis allowed the determination of the extent of interaction between the ponds and the groundwater, delineated the zone of interaction in pond sediments, and determined sulphur sources in the area. A combination of hydraulic, geophysical, and geochemical data was used to estimate groundwater flows, pond water budgets, and sulphur transport. Mineralogical analysis of pond sediments along with water quality analysis helped determine the fate of sulphur compounds as they traveled through the stormwater system. The results of this project will support urban water management decisions for Calgary International Airport as well as enhance understanding groundwater influences on stormwater infrastructure in the surrounding area.

Interaction between the Sunnyside alluvial aquifer and the Bow River in Calgary-Alberta: Hydrogeochemical and isotopic perspectives

Francisco Castrillon Munoz[1], Jean Birks[1], John Gibson[1,2], Neal Tanna[1], Paul Eby[1], Tatiana Sirbu[1], Dustin Lockwood[3], and Andrew Forsyth[3]

[1] InnoTech Alberta
[2] Geography, University of Victoria, Victoria BC, Canada
[3] City of Calgary, Alberta

As part of its Urban Hydrology program during 2021, InnoTech Alberta conducted hydrochemical and isotopic investigations within the City of Calgary focused on data collection and interpretation to characterize surface water and groundwater interaction in Alberta's growing cities. This presentation provides a summary of the hydrogeological, hydrochemical and isotopic research is aimed at understanding interactions between the Bow River and the Sunnyside alluvial aquifer, an area prone to river flooding. Analysis of hydrographs, groundwater level monitoring during the low-flows and hydrochemical signatures provide clear evidence that the alluvial aquifer is supplied by a mixture of multiple sources, including lateral recharge from the Bow River (Ca-Mg-HCO_3 composition), lateral recharge from the foothills (Ca-Mg-SO_4-HCO_3 composition) and vertical infiltration from surface (Na-Ca-Cl-HCO_3 composition). Due to low dispersion properties of $\delta^{18}O$ and δ^2H isotopic signatures to be a very useful tool for characterizing the influence of the river on the alluvial aquifer during low and high flows. Contrast in radon-222 activities increase systematically with distance from the Bow River. The $\delta^{15}N$ and $\delta^{18}O$-NO_3 values from the Sunnyside alluvial aquifer were also found to be useful indicators of groundwaters affected by sewage derived from human and animal waste. High variability in surface infiltration rates estimated from mass balance modeling suggests that additional research is required. The hydrochemistry and isotope results from the Bow River during the low-flow season suggest that the direct river influence within the alluvial aquifer is largely confined to a 30m fringe from the river edge.

Abstracts: Poster

Assessing the functionality of rain gardens and bioretention systems in cold climates

Sean Elliot[1], Edwin Cey[1], Jianxun He[2], Angus Chu[2], Leta van Duin[3], and Bert van Duin[2,4]

[1] University of Calgary, Department of Geoscience
[2] University of Calgary, Department of Civil Engineering
[3] Alberta Low Impact Development Partnership
[4] City of Calgary

Urban development impacts Calgary's natural water bodies by creating large impermeable surfaces that reduce stormwater infiltration and evapotranspiration. Instead, stormwater is directed into surface water systems, which can lead to flooding, contamination, and stream degradation. Low Impact Development (LID) systems include engineered and landscaped features designed to reduce these impacts of urban development. This study focuses on bioretention and rain gardens, two types of LID systems that are designed to filter stormwater and promote stormwater infiltration and evapotranspiration. While these LID features have been implemented successfully in Calgary, questions remain, specifically related to the interaction with the surrounding land. The purpose of this research is to determine the effectiveness of rain gardens and bioretention systems in Calgary's unique setting, quantifying the relevant hydrologic processes (e.g. infiltration and lateral subsurface flow) that control water movement and storage year-round. The study sites include two newly constructed rain gardens located at community centres in Calgary, as well as a pilot bioretention research site in

Okotoks. Detailed monitoring across all sites includes soil moisture, soil temperature, groundwater levels, inflow and outflow, precipitation, and an estimation of evapotranspiration. Ongoing monitoring of the water balance for each system allows for an understanding of key hydrologic processes throughout the year, including quantification of water partitioning between soil moisture storage, evapotranspiration, and groundwater recharge. Understanding the key processes and functionality of these LID features will help with site design optimization and large-scale implementation as a stormwater management strategy.

The impact of urban development on stream flow in northwest Calgary

Samuel Johnson[1], Edwin Cey[1], Masaki Hayashi[1], Bert van Duin[2]

[1] University of Calgary, Dept. of Geoscience
[2] City of Calgary

The City of Calgary is a rapidly growing community and as the landscape is developed the hydrologic cycle is altered. Urban development removes vegetation, introduces impermeable surfaces, and alters the subsurface, which inevitably disrupts the natural processes governing the hydrologic cycle. It is important to understand the hydrologic processes that are disrupted by urban development to better manage and protect our water resources and mitigate potential adverse impacts such as flooding, drought, and erosion, as well as water quality and ecosystem degradation. This study focuses on evaluating the influence of urban development on hydrologic processes, particularly surface water-groundwater interactions, and the resulting influence on streams in northwest Calgary. Two headwater catchments in northwest Calgary were selected to assess the impact of urban development on the surface water-groundwater connectivity that sustains stream flows throughout the year because they provide a unique opportunity to compare similar streams in pre- and post-development settings. Preliminary findings of a detailed hydrologic monitoring program that began in the summer of 2021 will be presented. Ongoing monitoring includes stream flow gauging at multiple locations, groundwater and soil moisture monitoring, geochemical sampling, and geophysical surveys. The combined hydrogeologic and geochemical analyses provide insight into the spatial and temporal variability in stream discharge and groundwater connectivity. Additional multi-year monitoring will be used to refine our conceptual model of the hydrologic process occurring in developing and developed landscapes, which can then be used to improve water management and support better preservation of hydrologic, environmental, and ecological function in urban watersheds.

Anthropogenic particles in wastewater - assessing ultrafiltration as a method of removal

Paige V Jackson, Sean M Rogers and Leland J Jackson

Department of Biological Sciences, University of Calgary

Wastewater samples were collected from five locations in a tertiary wastewater treatment plant including an ultra-filtration membrane module inflow and outflow to enumerate and characterise the anthropogenic particles present. Samples were sieved to isolate the 250 µm - 5 mm size fraction, followed by a 50% hydrogen peroxide digestion to remove organic material prior to identification and enumeration by microscopy. Ultra-filtration (UF) membrane module inflow and outflow samples collected before and after membrane repair and deep cleaning served to assess the potential of ultra-filtration as a method to remove anthropogenic particles from wastewater. UF inflow showed no differences in particle counts before and after membrane repair. UF outflow samples showed no difference in particle counts before and after membrane repair. The UF inflow and outflow showed no

significant differences from each other, before or after repair, indicating there is not a significant effect of the membrane system on anthropogenic particle removal at the times of sampling. We also discuss measures of UF module performance over the course of our study. Removal of anthropogenic particles in wastewater is an important area of study because wastewater treatment plants serve as conduits of particles from municipal and industrial sources to receiving environments. Furthermore, removal techniques must be explored and assessed to mitigate potential impacts to freshwater and terrestrial environments.

River Flows, Water Quality and Isotopic Evaluation of the Lower Elbow River, Calgary

Francisco Castrillon Munoz[1], Jean Birks[1], John Gibson[1,2], Neal Tanna[1], Paul Eby[1], Tatiana Sirbu[1], and Andrew Forsyth[3]

[1]InnoTech Alberta
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InnoTech Alberta has developed an Urban Hydrology Research Program focused on understanding processes, resolving problems, and proposing management strategies for groundwater-river interaction of concern to Alberta's main cities. We assessed a 5-year (2015 – 2020) monthly water quality time-series collected for the Lower Elbow River including concurrent flow data collected by the City of Calgary, and isotopic data at five (5) sampling stations, with the purpose of assessing the presence of sewage in groundwater and surface water of the river. Tracers included $\delta^{15}N$ and $\delta^{18}O$ in NO_3, radon-222, rare-earth elements (REEs) including gadolinium (Gd), artificial sweeteners (Ass), and per-and polyfluoroalkyl substances (PFAS). Correlation between Elbow River flows, rainfall and water quality was used to identify two distinct flow regimes: the first defined by low flows, lack of rainfall and reflective of groundwater baseflow; and, the second being flashy, discontinuous and controlled by peak river flows. Total Coli and E. coli counts were found to increase during peak flow events in June and August and to decrease during low flows in February. Consistently high radon-222 from September to October 2021 also suggest also enhanced groundwater discharge to the river during that period. Combined, our results suggest aquifer recharge is a dominant source of the river during September-October.

Coho salmon response to environmental variation on western Vancouver Island

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Anthropogenic environmental change continues to impact fish habitat in complex and interacting ways (e.g., logging can influence substrate composition and temperature). Predicting phenotypic variation can contribute to understanding the role of environmental variation on the fitness of an organism. Salmon hatcheries on western Vancouver Island, British Columbia, produce Coho Salmon (*Oncorhynchus kisutch*) fish to manage Pacific salmon stocks within critically important rivers and creeks of First Nations territories. In these programs, the application of environmental enrichment during juvenile and parr rearing has been proposed to improve enhancement, which provide an opportunity to test the consequences of environmental change on fitness. We used a common garden approach to examine the cumulative impact of temperature and substrate as a metric for habitat quality to test the impacts of these variables on development and norms of reaction for ecologically relevant traits. Our objective was to elucidate how environmental variation may impact ontogeny and whether these stressors altered organismal response to environmental stressor later in life. We reared Coho salmon from two populations in three ecologically relevant temperatures (average winter temperatures, maximum winter temperatures, and projected maximum temperatures) and substrate types (no substrate, 2+ mm gravel, and 20% >2 mm silty gravel). We observed variation across treatments in the timing of hatching, survival, and behaviour. Preliminary results on these juveniles suggest a role for plasticity in growth rate, critical thermal minimum and maximum thresholds, with

impacts of total body lipid content to determine the direct effects of rearing environment in early life ongoing.

Long-term trends and spatial patterns in phosphorus retention in a restored wetland

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Wetlands are key ecosystems for mitigating aquatic pollution, especially in terms of nutrient removal preventing eutrophication of downstream waters. Wetland capacity to effectively store nutrients depend on sediment composition and on historical nutrient loads, particularly for phosphorus (P), which can be remobilized if sediments become saturated. Knowing a wetland's capacity for P retention is essential for effectively managing and preserving the function and services these systems provide in the landscape. Frank Lake is an iconic restored wetland located in Little Bow River headwaters (Oldman River Watershed) that serves as a biodiversity hub and a natural wastewater filtration system for the town of High River and for a large beef processing facility. This system has been receiving very high P loads since its restoration, but it's unclear if this has reduced its sediment P sorption capacity over time and if it can sustain such inputs on the long-term. In this study, we collected samples from 15 sites in Frank Lake and measured water and sediment/soil P content and P sorption capacity. Spatial variability of measured parameters was high due to extreme P inputs from the wastewater effluent. This local point source of P creates heterogenous conditions of P exposure and sediment saturation within the system. Comparing our results with similar data taken 25 years ago in Frank Lake shows that the sediment P sorption capacity of the system has changed over time. Information derived here will help inform stakeholders on sustainable management practices in terms of P loads to Frank Lake.

Application of temperature loggers 2020/2021 in Bighill Springs Creek, Cochrane

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The Bighill Creek Preservation Society was formed in 2015 in Cochrane, Alberta, to study the creek water/sediment, springs, aquatic and terrestrial insects, fishery and riparian areas of the Bighill Springs Creek and its watershed. The idea of water temperature profiles of the creek and its major Spring water source came from Trout Unlimited – Calgary. Funding to purchase 11 HOBO Onset MX2202 Water Temperature Loggers came from the Cochrane Environmental Action Committee (Tim Giese-President). Construction of the apparatus containing the loggers, their placement into the creek and data recovery will be presented. The data from the temperature loggers was transferred to a cell phone program.

The summary analyses of temperature data points collected in 2020 and 2021 at each site (11) every 30 minutes from May to late October will be presented. Importantly, 2020 was a normal weather event year but 2021 was very warm with drought conditions. The flow of the vital Spring water from the Provincial Park was always very consistent but the surface flow from headwater creek branches decreased in 2021. Thus, in 2021, there was a reduction in the flow of water in the creek throughout the valley to its confluence with the Bow River.

The temperature logger data is vital for considering the demands made by temperature on aquatic insects and the fishery in this important small tributary of the Bow River. Despite the lower flows and higher air temperatures in 2021, our monitoring shows the water temperatures in the lower reaches of the creek remained low (a critical requirement for survival of resident salmonids) due to the consistent cold water flows from the upstream Big Hill Springs.

Water quality monitoring is continuing in 2022.