The Beaty Water Research Centre Symposium

November 13th, 2019

Program Book

Agenda

8:30 AM – 4:00 PM

Rm. 103 Mitchell Hall (Event Commons) and Biosciences Atrium

8:30 - 9:00 AM *(Rm. 103 Mitchell Hall)*	Registration (coffee, tea and light breakfast provided)
9:00 - 9:10 AM *(Rm. 103 Mitchell Hall)*	Opening Remarks from Dr. Kent Novakowski (Associate VP Research), Dr. Amir Fam (Associate Dean, Research, FEAS) and Dr. Nick Mosey (Associate Dean, Research, FAS)
9:10 – 9:30 AM *(Rm. 103 Mitchell Hall)*	Introduction from BWRC Director, Dr. Pascale Champagne
9:30 – 10:30 AM *(Rm. 103 Mitchell Hall)*	Keynote speaker presentation from Dr. Matt Hipsey (University of Western Australia, School of Agriculture and Environment)
10:45 – 12:15 PM *(Biosciences Atrium)*	Student Poster Session
12:15 – 1:15 PM *(Biosciences Atrium)*	Lunch
1:45 -3:15 PM *(Rm. 103 Mitchell Hall)*	Select Oral Presentations
3:15 – 3:30 PM *(Rm. 103 Mitchell Hall)*	Health Break
3:30 – 4:00 PM *(Rm. 103 Mitchell Hall)*	Announce winners of poster session and closing remarks from Dr. Champagne

Poster Presentations

Section 1

Judge: Stephen Brown (Chemistry & Environmental Studies)

11:00 – 11:15. Poster 01, Jennifer Mcleod (Chemistry). *Stabilizing proteins on surfaces towards Biosensing.*

11:15 – 11:30. Poster 02, Wei Xu (Chemistry). *Electrochemical Bacteria Biosensor*.

11:30 – 11:45. Poster 03, Brianna Jackson (Environmental Studies). *Investigating the toxicity of naphthenic acid fraction components (NAFCs) from oil sands process-affected water (OSPW) on developing fathead minnow (Pimephales promelas).*

11:45 -12:00. Poster 04, Liam Price (Civil Engineering). *Effect of Ebullition on Contaminant Transport in the Subsurface.*

12:00 – 12:15. Poster 05, Zoe Armstrong and Katherine Moir (Biology). *Impacts of sedimentary metal contamination on lower-trophic-level ecology in a fluvial environment.*

Section 2

Judge: Sarah Jane Payne (Civil Engineering)

11:00 – 11:15. Poster 06, Yiqun Han (Civil Engineering). *What's the best way to protect cities from stormwater problems?*

11:15 – 11:30. Poster 07, Alexandria Cushing (Civil Engineering). *Developing an experimental pipe rig to grow biofilm communities to examine antimicrobial resistance (AMR) in municipal drinking water distribution systems.*

11:30 – 11:45. Poster 08, Katrina Paudyn (Environmental Studies). *Long-term Stability of Arsenic Minerals in Yellowknife Bay Sediments.*

11:45 -12:00. Poster 09, Artur Sass Braga (Civil Engineering). *Preliminary assessment of biofilm formation on pipe-walls of a full-scale drinking water distribution laboratory*

12:00 – 12:15. Poster 10, Xiao-long Wu (Civil Engineering). *A modified global sensitivity analysis approach for discrete variables in numerical modeling.*

Section 3

Judge: Zhe She (Chemistry)

11:00 – 11:15. Poster 11, Nada Sadeq (Environmental Studies). *Detection of antibiotic resistance in Enterococcus spp. by growth kinetics measurements in the presence of different concentrations of vancomycin using the TECTA-PDS system.*

11:15 – 11:30. Poster 12, Aida Mohammadi (Chemical Engineering). *Graphene oxide membranes for heavy water filtration.*

11:30 – 11:45. Poster 13, Jessica Hooper (Environmental Studies). *Tracking the fate of nickel during transformation of nesquehonite to dypingite at 35°C.*

11:45 -12:00. Poster 14, Jian Wu (Civil Engineering). *Bubble-facilitated Mobilization of Trapped Dense Non-aqueous Phase Liquid at Residual Saturation.*

12:00 – 12:15. Poster 15, Anbareen Farooq (Chemistry & Chemical Engineering –RMC). *A silver lining: The fate of released silver nanomaterials from commercial products in subsurface wetlands mesocosms.*

Section 4

Judge: Geof Hall (Civil Engineering/BWRC)

11:00 – 11:15. Poster 16, Qianli Xie (Civil Engineering). *Numerical Study of Volatile Organic Compound Removal by Thermal Treatment.*

11:15 – 11:30. Poster 17, Max Robinson (Civil Engineering). *Sediment Dynamics and the growth/decay of biofilms in a mixed primarily gravel-cobble stream (The Salmon River, Ontario, Canada).*

11:30 – 11:45. Poster 18, Matthew Howroyd (Civil Engineering). *The Use of Constant Head Tests for Determining Fracture Transmissivities in Sparsely Fractured Rock.*

11:45 -12:00. Poster 19, Kerri Bascom (Civil Engineering). *Predicting the evolution of meandering rivers.*

12:00 – 12:15. Poster 20, Zenith Wong (Civil Engineering). *Influence of Carbon Dioxide on In-Situ Thermal Treatment Technology.*

Section 5

Judge: Melissa Lafreniere (Geography and Planning)

11:00 – 11:15. Poster 21, Cale Gushulak (Biology). *Millennial-scale lake-water production history of a small boreal lake in northeast Ontario, Canada.*

11:15 – 11:30. Poster 22, David Blair (Civil Engineering). *Evaluating DOM in commercial bacteria growth methods via temporally-extended two-dimensional synchronous fluorescence scan.*

11:30 – 11:45. Poster 23, Eden Hataley (Environmental Studies). *Can microplastics act as a medium to concentrate waterborne microcystin?*

11:45 -12:00. Poster 24, Madeleine Kelly (Environmental Studies). *The spatiotemporal distribution, phylogenetic and antibiogram profile associated with E. coli contaminated groundwater sources in southeastern Ontario.*

Section 6

Judge: Warren Mabee (Geography and Planning)

11:30 – 11:45. Poster 25, Sarah Lavallee (Environmental Studies). *Drivers of Health Behaviours Among Private Well Users in Ontario: A Cross-Sectional Survey of Awareness, Perception, Attitude and Experience.*

11:45 -12:00. Poster 26, Gisell Pazmino-Sosaa (Civil Engineering). *Cultivation of acclimated and non-acclimated microalga strain Chlorella vulgaris on different centrate wastewater for nutrient removal and biomass production.*

12:00 – 12:15. Poster 27, Virgilio R. Góngora-Echeverría (Civil Engineering). *Microbial growth involved in pharmaceuticals removal from water by biofiltration using a biobed-based biofilter.*

Poster 28, BWRC Infographic

Oral Presentations

1:50 – 2:10. Alexander Rey (Civil Engineering). *Real-time high-resolution forecasting of the coastal ocean during a hurricane*

2:10 – 2:30. Corinna Dally-Starna (Environmental Studies). *Adding to the Engineer's toolbox: Achieving First Nations Drinking Water Infrastructure Resilience with a Next-Generation Design Decision Support.* Tool

2:30 – 2:50. Cody McLaughlin (Civil Engineering). *Modelling waves and storm surge in the gulf of Maine and Bay of Fundy system*

2:50 – 3:10. David Patch (Chemistry and Chemical Engineering, RMC). *From Sock to Stream – Characterization of Released Silver Nanomaterials from Commercial Products after Simulated Wearing.*

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Poster Abstracts

1. STABILIZING PORTEINS ON SURFACES TOWARDS BIOSENSING

Jennifer McLeod[1], Zhe She[1]. [1]Department of Chemistry, Queen's University.

Having access to safe drinking water is a basic human right. However, according to a recent report by UNESCO, more than 2 billion people lack access to safe drinking water and the demand for potable water is going to increase 33% by 2050.[1] Testing for waterborne pathogens is one essential step to ensure water is safe for consumption. Unfortunately, current methods for water testing require multiple days to culture bacteria and obtain results in a well-equipped analytical laboratory. These methods also require input from highly trained technical personne[l,2] A rapid point-of-care pathogen detector can significantly increase the efficiency of pathogen monitoring and reduce the risk of exposure to contaminated water sources.

Electrochemical biosensors offer rapid detection with high sensitivity and low cost.[3,4] The electrochemical transducer is highly portable with no need for optical lenses. The electrochemical signals are stable, and are less effected by the environment than piezo based transducers. The biological selectivity and specificity of the sensors can be obtained from incorporating biological molecules such as proteins and DNA molecules. We have been investigating a new class of pathogen biosensors using immune receptors to provide wide scope of detections.[5] Specific detection of one pathogen strain does not eliminate possibility of other strains in the environment; therefore a board spectrum sensor can provide a more suitable detection for water source monitoring. The designs of the sensors have been explored and validated with bacteria whole-cells. In this presentation, we will share some recent results on stabilizing these receptors on sensor surfaces.

1. Unesco; World Water Assessment Programme. Nature-Based Solutions for Water; 2018.

2. Cabral, J. P. S. Water Microbiology. Bacterial Pathogens and Water. International Journal of Environmental Research and Public Health 2010, 7 (10), 3657–3703.

3. Kuss, S.; Amin, H. M. A.; Compton, R. G. Electrochemical Detection of Pathogenic BacteriaRecent Strategies, Advances and Challenges. Chemistry - An Asian Journal 2018, 13 (19), 2758–

4. Pandey, C. M.; Tiwari, I.; Singh, V. N.; Sood, K. N.; Sumana, G.; Malhotra, B. D. Highly Sensitive Electrochemical Immunosensor Based on Graphene-Wrapped Copper Oxide-Cysteine Hierarchical Structure for Detection of Pathogenic Bacteria. Sensors and Actuators B: Chemical 2017, 238, 1060–1069.

5. She, Z.; Topping, K.; Ma, T.; Zhao, T.; Zhou, W.; Kamal, A.; Ahmadi, S.; Kraatz, H.-B. Detection of the Lipopeptide Pam3CSK4 Using a Hybridized Toll-like Receptor Electrochemical Sensor. Analytical Chemistry 2017, 89 (9), 4882–4888.

2. ELECTROCHEMICAL BACTERIA BIOSENSOR

Wei Xu[1], Zhe She[1]. [1]Department of Chemistry, Queen's University.

A rapid and portable bacteria detection method is needed for environmental monitoring. While the current method is reliable and sensitive, it is time consuming and can take up to 5 days to achieve a reliable identification. In Canada, 8.9 million people, or 30.3% of the population obtain their water from sources such as wells. It is not possible to analyze this water onsite or on a regular basis; therefore, developing low-cost, portable bacteria detection will be very beneficial for these communities. In our lab, we focus on developing electrochemical sensors using antibody and toll-like receptor proteins as biorecognition elements. Their interactions with bacterial whole-cells and toxins are monitored by modulation in electrochemical current and resistance changes. The proof-of concept development could lead to portable devices for bacterial analysis.

3. INVESTIGATING THE TOXICITY OF NAPHTHENIC ACID FRACTION COMPONENTS (NAFCS) FROM OIL SANDS PROCESS-AFFECTED WATER (OSPW) ON DEVELOPING FATHEAD MINNOW (PIMEPHALES PROMELAS) Brianna Jackson[1], Diane Orihel[1,2]. [1]School of Environmental Sciences, Queen's University. [2]Department of Biology, Queen's University

The extraction of bitumen from Alberta's oil sands region generates large volumes of oil sands process-affected water (OSPW) that is stored in tailings ponds. Toxic constituents present in OSPW such as naphthenic acid fraction components (NAFCs) can cause adverse effects to aquatic life. Recent research has focused on the toxicity of NAFCs to highly vulnerable early life-stages of fish. Here we examined the embryotoxicity of NAFCs extracted from OSPW to native fathead minnow (Pimephales promelas). Embryos were exposed to 0 to 40 mg/L of NAFCs from 1-day post-fertilization (dpf) to hatch at Queen's University Biological Station (QUBS) in a semi-natural setting. Embryonic heart rate, hatch success and viability, and developmental abnormalities at hatch was examined. Embryonic heart rates at 3 dpf declined with increasing NAFC exposure. NAFCs caused an exposure-dependent increase in embryo mortality (LC50 = 19.96 mg/L, nominal concentration), with 100% mortality occurring at NAFC concentrations ≥ 30 mg/L. The prevalence and severity of developmental abnormalities at hatch increased with increasing NAFC exposure (EC50 = 14.29 mg/L, nominal concentration). Developmental abnormalities included cardiovascular (pericardial edemas and hemorrhages; present in 81.51% of non-viable hatches), craniofacial (reduced jaw and head growth; 68.96%), myoskeletal (spinal curvatures; 60.90%), and other (yolk sac edemas; 26.44%) abnormalities. This study contributes to an understanding of OSPW-NAFC toxicity to early life stage fish following embryonic exposure in a novel, outdoor environment.

4. EFFECT OF EBULLITION ON CONTAMINANT TRANSPORT IN THE SUBSURFACE Liam Price[1], Kevin Mumford[2]. [1]Department of Geology and Geological Engineering, Queen's University. [2]Department of Civil Engineering, Queen's University.

The production of unconventional oil and gas by hydraulic fracturing is crucial to satisfy the global fuel demand; however, environmental and human health risks have been identified in association with this technique. One potential hazard is leaking of natural gas wells, which may lead to fugitive hydrocarbon

gases contaminating shallow aquifers and/ or being released to the atmosphere, typically referred to as stray gas migration. In addition, a recently-performed controlled methane release found that immediately after injection of methane into a shallow aquifer there was an increase in ions in groundwater samples collected above the injection point. This led to the hypothesis that deeper groundwater can be entrained with upwards-migrating gas, leading to a degradation in groundwater quality in shallower systems. This represents an additional risk associated with unconventional oil and gas development. In this study, a series of laboratory experiments were performed to better understand the transport of dissolved solutes by gas flow through porous media. Nitrogen gas was injected into a water-saturated, sand-packed two dimensional (30 × 30 × 1 cm3) flow cell that contained a plume of dyed water near the bottom of the pack. Experiments were performed under both water flowing and static conditions. Movement of the plume was determined using image analysis, facilitated by a back light and a visual light transmission technique. The results indicate that the vertical transport of dissolved contaminants can be enhanced by flowing gas. This can occur in systems with aqueous flow, but is more pronounced under static conditions. These results demonstrate that both direct and indirect effects of stray gas migration should be considered when assessing risks to shallow aquifers from unconventional gas production.

5. IMPACTS OF SEDIMENTARY METAL CONTAMINATION ON LOWER-TROPHIC-LEVEL ECOLOGY IN A FLUVIAL ENVIRONMENT Zoe Armstrong[1], Katherine Moir[1], Brian Cumming[1]. Paleoecological Environmental Assessment and Research Laboratory (PEARL), Department of Biology, Queen's University.

Aquatic sediments are important habitats for benthic organisms, particularly those that occupy lower-trophic-level positions in the food web. Factors such as grain size, organic content, and the presence of anthropogenic contaminants are strong drivers of benthic ecology. Once introduced into the aquatic environment, contaminants can persist in sediments for decades following deposition, where they may be continuously bioavailable to benthic organisms. Elevated concentrations of sedimentary contaminations can alter benthic community structure (e.g., elimination of sensitive species or dominance of pollution-tolerant species), thereby affecting inter-trophic-level interactions. Throughout the twentieth century, industrial activity at Cornwall, Ontario discharged large contaminant loads into the St. Lawrence River (SLR), generating high concentrations of mercury and other metals in fluvial sediments. Despite the implementation of a formal remediation strategy 15 years ago, legacy sedimentary contamination persists above provincial management guidelines. Although the impacts of these sedimentary contaminants on higher trophic levels (e.g., fish) are well-studied in the area, little is known about their effects on lower-trophic-level organisms. We use a paleolimnological approach to assess the influence of metal contamination on assemblage structure and morphological deformations in two groups of benthic organisms, diatoms (Class: Bacillariophyceae) and midge larvae (Order: Chironomidae). We analysed biological remains of these organisms from SLR surface sediments collected along a contamination gradient to evaluate the impacts of elevated metal concentrations on lower-trophic-level structure. The results of this study will improve our understanding of the ecological impacts of metals on the aquatic food web, as well as inform ongoing remediation efforts for the region.

6. WHAT'S THE BEST WAY TO PROTECT CITIES FROM STORMWATER PROBLEMS? Yiqun Han[1], Bruce C. Anderon[1,2]. [1]Department of Civil Engineering, Queen's University. [2]School of Architecture, Tianjin University, China.

China, like many cities in the world, is facing a serious flooding problem in urban areas. To address this, under the guidance of the construction policy of the 'Sponge city' and the orientation of a "water safety" target, examining the urban fabrics and development tracks and constructing a sponge city with reasonable resource allocation and patterns optimization from a macroscopic viewpoint for stormwater management would be an economical and effective method for both new construction and existing cities (as opposed to the currently fragmented approach for Sponge city planning). This research uses Jizhou district, Hengshui city (China) as an example to examine the fundamental problems of constructing a practical pattern for Sponge city in China and the methods of spatial analysis and hydrological simulation analysis used in this research. Firstly, factors such as city development stage, transportation, ecological environment, terrain and landform and public facilities are taken into consideration in developing a suitability analysis for a Sponge city, and based on that result, a preliminary sponge city pattern for Jizhou District is formed. The software SWMM (Storm Water Management Model) can then be used to simulate the urban hydrological cycle in this Sponge city to evaluate the efficiency of stormwater management. From this macroscopic analysis, we will be able to propose city wide integrated strategies for water safety strengthening and efficiency promotion for stormwater management as a better solution to construction, evaluation and optimization of the Sponge city and the management of the stormwater problem in in China.

7. DEVELOPING AN EXPERIMENTAL PIPE RIG TO GROW BIOFILM COMMUNITIES TO EXAMINE ANTIMICROBIAL RESISTANCE (AMR) IN MUNICIPAL DRINKING WATER DISTRIBUTION SYSTEMS Alexandria Cushing[1], Victoria Rilstone[1], Leah Vignale[1], Artur Sass Braga[1], Pascale Champagne[1,2], Yves Filion[1]. [1]Department of Civil Engineering, Queen's University. [2]Department of Chemical Engineering, Queen's University.

Antimicrobial resistance (AMR) in source waters and, increasingly, in drinking water systems is a growing global concern. Previous research suggests that biofilm on pipe wall and filtration units are important environmental compartments that promote gene transfer and the development of antibiotic resistance in drinking water systems. The aim of this research is to report on the development of a new pipe rig design to grow multi-species biofilms for use in planned experiments that will examine the development of antimicrobial resistance in municipal drinking water. Three new individual pipe rigs will be constructed as a semi-continuous, coiled-loop system with PVC, PEX, and copper premise plumbing pipe. Each rig will be equipped with removable U-sections where the U-sections will be used in individual test rigs to study AMR. Each U-section will also be equipped with pipe coupons to harvest mature biofilms. The new rig will be operated at a temperature-controlled environment of 20ºC to ensure

reasonable biofilm growth rates. Flow regime (wall shear stress), nutrient levels, and disinfection levels will be controlled to exactly mimic the conditions of the AMR test rigs.

8. LONG-TERM STABILITY OF ARSENIC MINERALS IN YELLOWKNIFE BAY SEDIMENTS Katrina Paudyn[1], Heather Jamieson[1,2]. [1]School of Environmental Studies, Queen's University. [2]Department of Geological Sciences and Geological Engineering, Queen's University.

Yellowknife Bay, a northern extension of Great Slave Lake located in the Northwest Territories, Canada is a waterbody valued by the surrounding communities of Dettah, Ndilo, and Yellowknife for its cultural, subsistence, and recreational uses. Located adjacent to the historical Giant and Con Mines, Yellowknife Bay has received inputs from multiple mine waste streams since the regional onset of gold mining in the late 1930s. A combination of stack emissions, tailings water decant released via Baker Creek, and direct disposal of Giant Mine tailings has led to widespread and geochemically complex arsenic contamination in Yellowknife Bay sediments. Previous research indicates that arsenic contained in sediments associated with peak mining activity is not being buried effectively over time, and is mobile in the post-depositional environment. Investigating the solid-phase speciation of arsenic minerals in Yellowknife Bay sediments will assist in predicting their long-term stability under changing environmental conditions.

During three field seasons (August 2018, March 2019, and July 2019), nine sediment cores were collected in Yellowknife Bay. Sampling sites are proximal to Baker Creek, tailings beach, Ndilo, and Con Mine. Sediment cores were extruded in oxygen reduced conditions and divided for transport to Queen's University in Kingston, ON and Environment Canada in Ottawa, ON for mineralogical and geochemical analysis, respectively. Samples will have their modal mineralogy determined by scanning electron microscopy (SEM)-based automated mineralogy, and EMPA (Electron Microprobe Analysis) may be used to understand the long-term stability of arsenic solid phases.

9. PRELIMINARY ASSESSMENT OF BIOFILM FORMATION ON PIPE-WALLS OF A FULL-SCALE DRINKING WATER DISTRIBUTION LABORATORY Artur Sass Braga[1], Alexandria Cushing[1], and Yves Filion[1]. [1]Department of Civil Engineering, Queen's University.

The accumulation of sediments in pipe-walls of pressurized networks is currently one of the major water quality issues of drinking water systems. The resultant material accumulation is expected to depend on multiple factors, which combines the hydrodynamic effects of pipes turbulent flow with sedimentation of suspended particles, precipitation of iron and calcium scales and microorganism growth as biofilms. Latest studies suggest that the occurrence of biofilms have potential to justify much of the accumulation processes. These layers of cells and organic substances are known to enhance the pipe surface adhesion contributing to particulate attachment, and intelligently adapt to environmental conditions by modifying layer strength and density to resist shear forces impose by the flow. However, most of assumptions still lack on experimental evidence, what motivated this preliminary study on developing a realist experiment method to investigate biofilm formation under controlled conditions.

The experiment was conducted in a full-scale drinking water distribution laboratory, with two pipe-loops of approximately 200 m of length in 100 mm PVC pipes that simulate the hydraulics of a drinking water network. Both systems were initially cleaned and filled simultaneously with a water volume of approximately 5 m^3 of drinking water, which was not refreshed during the entire experiment. A period of 2 months was used to build up material in the pipe-walls, maintaining constant conditions in the system: flowrate = 0.5 L/s, pressure = 250 kPa, free Cl = 0.3 mg/L. Identical flushing procedures with 3 sequential steps at 6.5, 11 and 14.3 L/s were realized at the beginning and the end of the experiment to mobilize material layers from the walls and permits an adequate comparison. The growth of biofilms at the walls was characterized through water samples collection, tested for total and suspended solids (fixed and volatile), DOC, Total N, Ammonia as N, Nitrite, Nitrate. Additionally, pipe-wall samples were also tested with preliminary microscopy methods to detect biofilm formation. The results showed that very little biofilm had grown in the experimental conditions, possibly as a consequence of low initial planktonic cells instead of the environment. A few focalized clusters of biofilms were identified in the pipe-walls. Next experiments will be focused on maintain planktonic concentrations during the conditioning phase, hoping to result in more biofilm layers.

10. A MODIFIED GLOBAL SENSITIVITY ANALYSIS APPROACH FOR DISCRETE VARIABLES IN NUMERICAL MODELING

Xiao-long Wu[1], Kent Novakowski[1], and Bernard Kueper[1]. [1]Department of Civil Engineering, Queen's University.

Latin Hypercube – One at A Time (LH-OAT) method is a novel approach for parameter screening and ranking based on their significance that allows a global sensitivity analysis with a limited number of simulations. This study proposes a modified framework of LH-OAT for models with discrete multi-variables. The framework successfully verified sensitivities of six parameters by numerical simulations of thermal-hydrologic (TH) processes in fractured rock with a control-volume finite element simulator HydroGeoSphere (HGS). Among the six parameters, radius of Target Treatment Zone (r) is identified as the most influential factor controlling heat transfer in a multiple fracture system, followed by energy injection configurations (input power)(P) . Nonlinear significance within the input space is strongly associated with interaction effects between parameters. Overall, the application indicates that the framework is qualified to provide robust parameter ranking and screening within predefined input space.

11. DETECTION OF ANTIBIOTIC RESISTANCE IN ENTEROCOCCUS SPP. BY GROWTH KINETICS MEASUREMENTS IN THE PRESENCE OF DIFFERENT CONCENTRATIONS OF VANCOMYCIN USING THE TECTA-PDS SYSTEM

Nada Sadeq[1] and Stephen Brown[1,2]. [1]School of Environmental Sciences, Queen's University. [2]Department of Chemistry, Queen's University.

The spread of antibiotic resistant organisms has increased in different water environments[1,2]. This originates from the disposal of antibiotics from hospital wastes, irrigation from animal and agricultural farms, aquaculture, domestic antibiotics drug disposal in sewage, pharmaceutical production wastes and effluents from wastewater treatment plants[3,6]. Antibiotic resistant bacteria (ARB) are capable of spreading

their genes into water-indigenous microbes, circulating in the water environment and potentially altering microbial ecosystems[4]. Antibiotics in water environments are considered contaminants of emerging concerns (CEC), based on the UN and WHO groups who are predicting the increase in illnesses caused by antibiotic resistance and as such becoming a major global health issue in the future[7,8]. This project focuses on establishing an efficient, cost effective and feasible method that will aid in quantifying the ARB in water, which can be incorporated as part of water quality controls and monitoring assessments. This method will be confirmed by comparing results to traditionally used methods. In addition, there is currently an absence of a routine system to continuously monitor the effectiveness of wastewater treatment plants in regards to disinfection and the removal of ARB before the treated water is released to the environment, which may also be a pathway for ARB into drinking water. This is a major concern as the World Health Organization predicts antimicrobial resistance to have significant impacts on human health globally by 2050, accounting for 10 million deaths annually and a financial burden of approximately US $100 trillion[5].

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7. United Nations Environment Programme, 2018. UNEP Press Release: UN Environment and World Health Organization Agree to major Collaboration on Environmental Health Risks, [online]. https://www.unenvironment.org/news-and-stories/press-release/un-environment-and-world-health-organization-agree-major.

8. World Health Organization, 2015. Global Action Plan on Antimicrobial Resistance, [online]. http://www.who.int/antimicrobial-resistance/publications/global-action-plan/en/.

12. GRAPHENE OXIDE MEMBRANES FOR HEAVY WATER FILTRATION

Aida Mohammadi[1], Mark R. Daymond[2], and Aristides Docoslis[1]. [1]Department of Chemical Engineering, Queen's University. [2]Department of Mechanical and Materials Engineering, Queen's University.

There is an increasing demand for nuclear reactors, driven by the global need for low producing CO2 producing energy sources. CANDU (Canada Deuterium Uranium) reactors, which utilize heavy water (D2O) as moderator and coolant, produce radioactive tritiated-heavy (DTO) water as a by-product. Technology that can efficiently separate D2O from DTO in nuclear reactors is, therefore, highly desirable.

Here we present an experimental approach for producing and evaluating graphene oxide (GO) membranes for D2O filtration. First, we designed and successfully test a pressurized filtration assembly using commercially available GO membranes and H2O/D2O mixtures as model systems. Subsequently, we investigated the effect of the physiochemical properties of GO (membrane building blocks) on membrane filtration efficiency by preparing our own GO membranes. We demonstrate that our in-house prepared membranes can provide high rejection and flux for D2O removal. The long-term goal is optimization of these membranes and use in D2O/DTO separation.

13. TRACKING THE FATE OF NICKEL DURING TRANSFORMATION OF NESQUEHONITE TO DYPINGITE AT 35°C Jessica C. Hooper[1] and Anna L. Harrison[1,2]. [1]School of Environmental Studies, Queen's University. [2]Department of Geological Sciences and Geological Engineering, Queen's University.

The process of Carbon mineralization stores CO2 within solid, stable carbonate minerals like nesquehonite, by reacting CO2 with alkaline, earth metal-bearing hydroxide and silicate minerals. Engineered storage carbon mineralization is an attractive method of offsetting greenhouse gas emissions to mitigate climate change. This method is favourable because carbonate minerals persist at Earth's surface for thousands of years, and are considered permanent over geologic time. However, ultramafic rocks commonly contain transition metals that can be released during enhanced dissolution, which is required to promote carbon mineralization. Certain trace metals such as Ni, Co, and Cr are toxic to biota and could be released into surface or groundwater during an engineered carbon mineralization scenarios. In this study, we track the fate of Ni during the transformation of nesquehonite ($MgCO_3 \cdot 3H_2O$), which can be used to store CO_2, to dypingite ($Mg5(CO_3)4(OH)_2 \cdot 5H_2O$), a more stable carbonate. The transformation of nesquehonite to dypingite is temperature dependent, and was completed over 30 days at a temperature of 35°C. Transformation occurs through dissolution – reprecipitation mechanisms. Our results demonstrate that nesquehonite readily sequestered Ni present in solution. Ni was immobilized, likely by substitution for Mg; however, it was partially released during the transformation to dypingite. Therefore, these metals may be sequestered and stored rather than released during accelerated carbon mineralization, and are unlikely to pose a risk to the environment.

14. BUBBLE-FACILITATED MOBILIZATION OF TRAPPED DENSE NON-AQUEOUS PHASE LIQUID AT RESIDUAL SATURATION Jian Wu[1] and Kevin G. Mumford[1]. [1]Department of Civil Engineering, Queen's University.

Gas bubble mobilization can result in the transport of DNAPL as coatings on the gas bubble surface. This could move a great mass of DNAPL to the groundwater table, potentially increasing the NAPL-impacted area. However, it could also serve as a removal mechanism, shortening source lifetimes as part of a remediation strategy.

A series of experiments was conducted in a two-dimensional glass flow cell ($10 \times 20 \times 1$ cm^3). It was packed with medium sand and contained a creosote source zone below a clean sand layer. A free water layer was placed above the clean sand. Gas was injected through the creosote source zone through a stainless needle using either a syringe pump or a mass flow controller. The cell was backlit with a LED panel to facilitate visualization of gas and NAPL. Heptane was added above the water layer as a solvent trap to collect creosote mass transported through the sand by gas bubbles, and was analyzed by GC for PHC and PAHs.

Results showed that gas bubbles leaving the source zone were often coated in creosote, and that creosote travelled with the gas bubbles as either thin films or tails below the bubbles. PHC concentrations measured above the clean sand indicated that creosote mass was constantly released out of the sand pack over 8 hours, with more mass being released through thinner and finer clean sand layers. In the long-term experiment, clearly visible evidence has also suggested significant depletion of the source zone over 30 days.

15. A SILVER LINING: THE FATE OF RELEASED SILVER NANOMATERIALS FROM COMMERCIAL PRODUCTS IN SUBSURFACE WETLANDS MESOCOSMS

Anbareen Jan Farooq[1], Vincent Gagnon[1], Mark Button[3], David Patch[1], Denis O'Carroll[2], and Kela Weber[1]. [1]Environmental Sciences Group, Department of Chemistry and Chemical Engineering, Royal Military College of Canada, Kingston, Ontario, Canada. [2]School of Civil and Environmental Engineering, UNSW Water Research Laboratory, The University of New South Wales Sydney, 110 King St, Manly Vale, Australia. [3]Fipke Laboratory for Trace Element Research, Earth, Environmental and Geographic Sciences, University of British Columbia Okanagan, University Way, Kelowna, BC, Canada.

The release of weathered silver nanomaterials (Ag NMs) from commercial products creates a potential for toxic effects in environment due to their antimicrobial capabilities. However, current research focuses on the effects of pristine nanomaterials and the fate of these weathered Ag NMs in aquatic environment, such as wetlands, are largely unknown. Wetland ecosystems have an innate ability to transform a wide range of pollutants into harmless by-products mainly through their microbial communities which could be impaired by the release of Ag NMs. This project endeavours to examine the fate of both pristine and weathered Ag NMs through a mesocosm-scale wetland setup. Twenty-four batch-fed subsurface flow planted wetland mesocosms were developed for this study; twelve were intensified with artificial aeration and twelve were non-aerated. The experiment consisted of four design types including an ionic silver (positive control), a negative control, a pristine Ag NM and an artificially weathered Ag NM exposure, all conducted in triplicate. Following two separate in-situ exposures, the overall fate of silver within the mesocosms was determined through destructive sampling of the constructed wetland biofilm, plant roots,

and aboveground plant biomass. Overall, there was no discernible difference in microbial activity between the silver treatments and their respective controls. Total silver data from the deconstruction indicates that the highest concentrations of silver were located in the gravel-associated biofilm; in particular in the 30 – 60 cm layer. This research demonstrates the robustness of wetland mesocosms in the presence of Ag NMs at environmentally relevant concentrations. As the Ag NMs sequester in the biofilm, it is likely to transform into less toxic silver species, such as silver sulfide, which would result in reduced toxicity to downstream environmental receptors.

16. NUMERICAL STUDY OF VOLATILE ORGANIC COMPOUND REMOVAL BY THERMAL TREATMENT Qianli Xie[1], Kevin G. Mumford[1], and Bernard H. Kueper[1].
[1]Department of Civil Engineering, Queen's University.

Non-aqueous phase liquids (NAPLs) such as chlorinated solvents and petroleum products are contamination sources in the subsurface that can persist for centuries if not treated. Removing these sources of contamination is important for protecting groundwater and reducing health risks. In situ thermal treatment (ISTT) technologies have the potential to treat NAPL sources in months rather than years. To improve the effectiveness and reduce the cost of ISTT applications, two numerical models have been developed that focus on mass recovery at the laboratory and field scales. The laboratory-scale model can simulate the removal of single- or multi-component NAPLs for treatability tests. It has been validated against experiments and can help predict the effectiveness of ISTT under different conditions. The 2D field-scale model can simulate mass recovery by thermal conductive heating (TCH). Results indicate that mass and location of NAPL pools dictate the total heating time, suggesting that investigation costs could be offset by reduced heating time if they are focused on locating the largest NAPL pools and locating heaters accordingly.

17. SEDIMENT DYNAMICS AND THE GROWTH/DECAY OF BIOFILMS IN A MIXED PRIMARILY GRAVEL-COBBLE STREAM (THE SALMON RIVER, ONTARIO, CANADA) Max Robinson[1], Geof Hall[1] and Ana da Silva[1]. [1]Department of Civil Engineering, Queen's University.

Gravel-cobble streams are found throughout the world, and are common in areas that are moderately steep, as opposed to sand-bed streams with low gradients. It is becoming increasingly important to understand the flow hydrodynamics and sediment transport in these streams for their application to pressing issues such as flood hazard and mitigation, habitat restoration, and river morphology.

These gravel-cobble beds are studied in laboratories extensively, however, in contrast to the case of sand streams, only a few isolated field studies aimed at understanding their hydrodynamics and sediment transport mechanics have been carried out to date. This field study at the Kennedy Field Station hopes to considerably increase our understanding of sediment dynamics and the growth of biofilms in the stream.

The aim of this project is to create a working model of the flow and cobble transport. Research will be undertaken to help understand the influence of the rougher bed consisting of gravel, cobbles, and boulders

on the hydrodynamics of the stream. Topics include the vertical velocity distribution, the bed shear stress, and the flow conditions that cause cobbles to be dislodged and transported downstream. The secondary objective is to understand the growth and decay of biofilms in the stream and discover what this could mean for the stream's overall health.

18. THE USE OF CONSTANT HEAD TESTS FOR DETERMINING FRACTURE TRANSMISSIVITIES IN SPARSELY FRACTURED ROCK Matthew Howroyd[1] and Kent Novakowski[1]. [1]Department of Civil Engineering.

Subsurface flow and transport in bedrock is typically governed by the presence of fractures, which allow for the rapid migration of contaminants through convoluted pathways. The successful application of numerical models based on discrete-fracture formulations in the prediction of transport relies on accurate estimates of fracture transmissivity. A commonly used method for the measurement of fracture transmissivity is constant head testing using straddle-packer systems. These tests, however, measure a bulk transmissivity for the entire section tested, which is often >2m in length due to the difficulty and cost associated with smaller measurement scales. As a single 2m section often includes several fractures, it is frequently unclear how the bulk transmissivity relates to that of individual fractures. The primary goal of this study is to determine how constant head tests at a 2m scale can be used to create a discrete fracture network (DFN) that accurately describes flow and transport. To do this, core logs and transmissivity measurements from constant head tests at 0.1 and 0.5m intervals, which were conducted in a Silurian-aged dolostone in Southern Ontario, Canada, were first used to generate a DFN most likely to be representative of the natural setting. Predictions of the transport to 50m of a conservative tracer in this DFN were then compared to predictions from DFNs produced using various methods of determining individual fracture transmissivities from a 2m bulk value. Based on the comparison we seek to establish a method for proportioning larger-scale test results to obtain a representative DFN at a site.

19. PREDICTING THE EVOLUTION OF MEANDERING RIVERS Kerri Bascom[1] and Ana da Silva[1]. [1]Department of Civil Engineering, Queen's University.

Meandering rivers are highly dynamic systems, whose (water-induced) erosion can affect the infrastructure in the vicinity. These rivers evolve by way of lateral expansion and downstream migration, and the advancement or retreat of the riverbank can lead to subsurface instability and endangerment of infrastructure along the riverbank. Therefore, it is vital to understand the planimetric evolution of meandering rivers. In the literature there are numerical models that predict the migration of meandering rivers; however, they are time-intensive and require considerable computational power. The objective of this research is to examine the morphological change of meandering rivers at a spatial scale of one meander loop, and to create an approximative analytical MATLAB model that can provide an overall estimation of the expected migration of the river along with a visual of the progressive migration of the river channel centerline.

20. INFLUENCE OF CARBON DIOXIDE ON IN-SITU THERMAL TREATMENT TECHNOLOGY Zenith Wong[1], Kevin Mumford[1]. [1]Department of Civil Engineering, Queen's University.

In-situ thermal treatment (ISTT) technologies for the treatment of non-aqueous phase liquids (NAPLs) typically requires a large energy consumption to maintain high temperatures within the subsurface to vaporise contaminants for extraction. Additional energy is required during ISTT under conditions of higher groundwater flow, which can result in cooling in preferential pathways. Previous work has demonstrated the potential for dissolved carbon dioxide (CO2) to be introduced to a target treatment zone as an enhancement of ISTT, resulting in increased gas saturations below water-boiling temperatures, flow reductions in preferential pathways, and lower energy requirements.

Enhanced ISTT will be investigated using a series of laboratory experiments. Mass recovery will be investigated using one-dimensional 1L stainless steel cylinders packed with a tetrachloroethene (PCE) impacted medium sand. CO2-saturated water will be flushed through the cylinder prior to or during heating in an oven. The mass recovery and temperature of the system will be recorded to observe remediation effectiveness and NAPL-water co-boiling. Relative permeability effects will be investigated using a two-dimensional flow cell packed with different sized sands. A PCE source zone will be placed within the sand pack and CO2-saturated water will be flushed through the cell prior to or during heating by electrical resistance heating (ERH). The gas distribution and relative permeability within the porous media will be observed.

The goal of this research is to identify the potential effects of CO2 application on the performance of ISTT systems. It is anticipated that lower operating temperatures of ISTTs can be achieved, reducing overall energy consumption. This is expected to result from both the exsolution of gas at lower temperatures, and reductions in relative permeability to reduce cooling by groundwater flow in heterogeneous porous media to increase effectiveness of ISTT. It may also promote the reuse of CO2 emitted from ISTT operations to reduce greenhouse gas emissions.

21. MILLENNIAL-SCALE LAKE-WATER PRODUCTION HISTORY OF A SMALL BOREAL LAKE IN NORTHEAST ONTARIO CANADA Cale A.C. Gushulak[1], Eduard G. Reinhardt[2], Peter R. Leavitt[3,4], and Brian F. Cumming[1]. [1]Paleoecological Environmental Assessment and Research Laboratory (PEARL), Department of Biology, Queen's University. [2]School of Geography and Earth Sciences, McMaster University, Hamilton, Canada. [3]Institute of Environmental Change and Society, University of Regina, Regina, Canada. [4]Institute of Global Food Security, Queen's University Belfast, Belfast, United Kingdom.

Lake eutrophication is of great interest to managers, stake holders, governments, scientists, and the public. The recent occurrence of harmful algal blooms in previously unaffected lakes is therefore of great concern. Recent research suggests anthropogenic climate warming as a major factor in lake eutrophication and the proliferation of algal blooms. It is difficult, however, to make predictions regarding lake response to climate change without background monitoring data, which is lacking over long time scales. To combat this challenge, millennial-scale changes in geochemistry, diatom algae, and sedimentary pigments

preserved in lake sediments were used to investigate the effects of regional climate and local landscape on lake-water production in a small, boreal lake in northeastern Ontario. A ~2.3 m sediment core was carbon dated resulting in a continuous chronology extending back to ~6300 cal yr BP (calendar years before present). Published pollen data from the region suggests a warm and wet climate ~6000–4000 cal yr BP, a transitional cooler and dryer climate ~4000–2000 cal yr BP, and modern cold and wet conditions after ~2000 cal yr BP. Geochemical and biological proxies indicated that lake-water production was highest during the warmest period and decreased steadily through time to a minimum at ~1000 cal yr BP. Evidence of landscape disturbance and anthropogenic climate effects such as pronounced anoxia and colonial cyanobacterial blooms were briefly detected at ~1880–1920 CE. A sustained diatom assemblage change that co-occurs with the cyanobacterial blooms suggests a prolonged anthropogenic alteration of the lake independent of landscape alterations.

22. EVALUATING DOM IN COMMERCIAL BACTERIA GROWTH METHODS VIA TEMPORALLY-EXTENDED TWO-DIMENSIONAL SYNCHRONOUS FLUORESCENCE SCAN David Blair[1], Stephen Brown[2,3] and Pascale Champagne[1,4]. [1]Department of Civil Engineering, Queen's University. [2]Department of Chemistry, Queen's University. [3]School of Environmental Studies, Queen's University. [4]Department of Chemical Engineering, Queen's University.

Rapid bacteria quantification and detection of dissolved organic matter (DOM) in partially treated wastewater has the potential to change process controls and the operation of municipal wastewater treatment plants (WWTPs). The research method detects *E. coli* and coliform using a fluorophore-bound defined-substrate growth medium and a commercial diode array fluorescent spectrophotometer. The detection and quantification of bacteria is poorly established in organically-complex wastewater. This research provides operators a microbiological and DOM assessment of engineered conventional and naturalized treatment systems in near-real time. Novel signal processing of temporally-extended two-dimensional synchronous fluorescence data reveals chemical and physical parameters impacting correct quantification of bacteria in WWTPs. Additionally, fluorescent regions associated with DOM are detectable through spectral signal impacts, previously unexplored by this instrument. The technology, parameter correlations, and spectra signal isolation methods, contribute to the operational improvement at WWTPs, provides practical knowledge for operators, and reduce public health risk with engineered systems.

23. CAN MICROPLASTICS ACT AS A MEDIUM TO CONCENTRATE WATERBORNE MICROCYSTIN? Eden K. Hataley[1], Xavier Oritz Almirall[1,2] , Chelsea M. Rochman[3], and Diane M. Orihel[1,4]. [1]School of Environmental Studies, Queen's University. [2]Ontario Ministry of the Environment, Conservation and Parks. [3]Department of Ecology and Evolutionary Biology, University of Toronto. [4]Department of Biology, Queen's University.

The potent liver toxins microcystins (MCs) and microplastics (MPs) are both emerging environmental contaminants now recognized as being widely distributed across the globe. MCs are a diverse group of monocyclic heptapeptide hepatotoxins produced by several genera of freshwater cyanobacteria. MPs are defined as small particles of plastic less than 5 mm in diameter. MPs may impact ecosystems by adhering

to and/or being ingested by organisms, which may cause harmful physical effects. Additionally, MPs may be a source of hazardous chemicals via their additive ingredients and/or sorption of environmental contaminants. The exchange of contaminants between MPs and ambient waters is influenced by the physicochemical properties of MPs, the nature of the contaminant, and environmental conditions. Studies have demonstrated the ability of MPs to act as a medium to concentrate hydrophobic (non-polar) contaminants in aquatic environments, driven by their characteristic surface hydrophobicity. This research has not been extended to MCs. MCs are relatively hydrophilic (polar) molecules, implying that their affinity for MPs is negligible; however, many MC congeners contain hydrophobic (non-polar) amino acid residues. Inherent in this lies the question: Can microplastics act as a medium to concentrate waterborne microcystin? To address this question, we developed a laboratory-based experiment to measure the rate and concentration at which a mixture of four MC congeners (MC-LA, -LR, -YR, and -RR) sorb to one of four types of plastic resin pellets (low-density polyethylene, polystyrene, polyethylene terephthalate, and polyvinyl chloride). Our preliminary experiment indicates that MPs can act as a medium to concentrate waterborne MCs, dependent on type of plastic and MC congener. This research seeks to understand if and how two dominant environmental issues – namely, microplastic pollution and cyanobacterial harmful algal blooms – interact in a freshwater environment.

24. THE SPATIOTEMPORAL DISTRIBUTION, PHYLOGENETIC AND ANTIBIOGRAM PROFILE ASSOCIATED WITH E. COLI CONTAMINATED GROUNDWATER SOURCES IN SOUTHEASTERN ONTARIO

Madeleine Kelly[1], Stephen Brown[1,2] , Paul D. Hynds[1,3], Anna Majury[1,4]. [1]School of Environmental Studies, Queen's University. [2]Department of Chemistry, Queen's University. [3]Technological Institute Dublin, Dublin, Ireland. [4]Public Health Ontario Laboratories, Kingston, Ontario, Canada.

Fecal contamination of drinking water represents a threat to public health in Ontario and Canada, and particularly in rural communities reliant on private well water. Private well water supplies in Canada are unregulated, with supplies frequently impacted by anthropogenic activities including agricultural runoff and septic system leakage. Consequently, these sources may serve as a reservoir for antimicrobial resistant organisms (AROs) and antimicrobial resistant genes (ARGs). Objectives: The purpose of the current study is four-fold: a) assess private well water supplies for the prevalence of fecal contamination based on the detection of *E. coli*, b) describe the phylogenetic profile and source of private well water *E. coli* isolates, c) assess levels of antimicrobial resistance using diffusion-based methods, and d) determine the impact of season, geology and previous host on the distribution and prevalence of AROs and ARGs. The antimicrobial susceptibility panel was designed to include both human and veterinary antimicrobial agents currently in use in Canada. Methods: Private well water convenience samples are currently being collected over a full hydrogeological year and seasonally categorized, with the final data set comprising approximately 150 isolates from 50 wells, per season. Results: To date, 129 isolates from 52 southeastern Ontario private wells have been collected and characterized by phylogenetic origin. The phylogroup distribution consists of 33% A, 30% B1, 20% B2, 1% C, 11% D, 4% E, and 1% G. Results of statistical analyses indicate an association between phylogroup type and 10-day cumulative antecedent rainfall ($p = 0.030$. Significant associations were also found between phylogroup and geological setting. Conclusions: Study results will further current understanding of the presence, frequency and concentration of

antimicrobial resistant *E. coli* in southeastern Ontario groundwater. Determining potential drivers of antimicrobial resistant *E. coli* in well water will better inform surveillance, modeling and predictions of human health risk. Furthermore, it will initiate discussion regarding the potential implications of antimicrobial resistant *E. coli* in private well water, such as water quality testing methodologies, regulation and policy.

25. DRIVERS OF HEALTH BEHAVIOURS AMONG PRIVATE WELL USERS IN ONTARIO: A CROSS-SECTIONAL SURVEY OF AWARENESS, PERCEPTION, ATTITUDE AND EXPERIENCE

Sarah Lavallee[1], Paul D. Hynds[1,2], Corinne Schuster-Wallace[3], Stephen Brown[1], Sarah Dickson- Anderson[4], Anna Majury[1,5]. [1]Queen's University, Kingston, ON. [2]Technological University Dublin, Dublin, Ireland. [3]University of Saskatchewan, Saskatoon, SK. [4]McMaster University, Hamilton, ON. [5]Public Health Ontario, Kingston, ON.

Background: Unlike municipal water supplies, well owners are the primary agents responsible for managing their drinking water, including source maintenance, resource protection, and water testing. A previous Ontarian study found that just 11-12% of well owners complied with provincial water testing guidance during any year between 2008 and 2012. This finding suggests significant gaps in knowledge and/or tools for stewardship, representing a major concern due to the ubiquity of contaminant sources in rural areas (e.g. agricultural run-off, septic tanks, etc.). The current study sought to identify and assess the gaps associated with private well water stewardship; namely, knowledge, attitudes and practices (KAP), to contribute to improved health behaviours among rural Ontarian residents.

Methods: A province-wide online survey was undertaken over the 4-month period May to August 2018. The survey was designed to quantify information among Ontario's well owners based on their awareness, perceptions and behaviours in relation to their personal source and local sources of contamination.

Results: The survey was completed by 1030 respondents (99% CI 4.02%). Preliminary findings indicate that previous experiences (i.e. residential presence during well construction, previous case(s) of acute gastrointestinal illness within household) significantly influence both owner awareness ($p < 0.001$, $p = 0.038$, respectively) and perception of local groundwater contamination risk ($p = 0.017$, $p < 0.001$, respectively). Additionally, increased awareness ($p = 0.018$) and positive attitudes ($p = 0.006$) towards personal well water supplies were associated with increased likelihoods of testing.

Conclusion: Findings illustrate that experiences influence both respondent awareness and risk perception, with increased levels of awareness and positive attitudes enabling health behaviours. Results will provide public health agencies with a framework for designing strategies and policies for increasing awareness and addressing the drivers of, and barriers to, protective actions among well users in Ontario, and further afield.

26. CULTIVATION OF ACCLIMATED AND NON-ACCLIMATED MICROALGA STRAIN CHLORELLA VULGARIS ON DIFFERENT CENTRATE WASTEWATER

FOR NUTRIENT REMOVAL AND BIOMASS PRODUCTION Gisell Pazmino-Sosa[1], Sergey Gladkiy[1], Pascale Champagne[1]. [1]Department of Civil Engineering, Queen´s University.

Microalgae-based wastewater treatment has been identified as a sustainable technology to treat municipal effluents while producing biomass. Microalgae species have been isolated from wastewater environments showing their capacity to grow in these polluted environments. From the conventional wastewater treatment, after the anaerobic sludge digestion, an effluent called centrate (CW) is produced. CW has been identified as an excellent microalgae growth medium because of its high nutrient concentrations. In CW, ammonia is the main nitrogen form and at concentrations higher than 100 mg L-1, is toxic to aquatic microorganisms, including microalgae. This study investigated a 16-week acclimation process for isolated microalgal strain Chlorella vulgaris to CW with 128.67 ± 11.29 mg L-1 ammonia and 19.75 ± 1.06 mg L-1 total phosphorus concentrations. Then, acclimated strain and non-acclimated strain were cultivated in 30%, 50% and 100% CW to evaluate their growth performance and nutrient removal. Statistical analysis suggested that microalga acclimation was achieved 45 days after cultivation on CW. With respect to biomass production, the highest yield was achieved when 50%CW was employed (675 ± 8.66 mg L-1). In contrast, non-acclimated cultures resulted in 452 ± 2.78 mg L-1 in 30%CW and no growth in 100%CW. The highest ammonia and total phosphorus removals were obtained when acclimated C. Vulgaris was cultivated in 50%CW (86% and 89%, respectively), while for non-acclimated culture, 30%CW showed highest removal values. These results reflect the influence of an acclimation process on microalgae metabolism and their ability to remove nutrients using CW as a cultivation medium.

27. MICROBIAL GROWTH INVOLVED IN PHARMACEUTICALS REMOVAL FROM WATER BY BIOFILTRATION USING A BIOBED-BASED BIOFILTER

[1,2]Virgilio R. Góngora-Echeverría[1,2], Pascale Champagne[1,2,3], Amandine Dumas[1]. [1]Department of Civil Engineering, Queen´s University. [2]Beaty Water Research Centre, Kingston, ON, Canada. [3]Institut National des Sciences Appliquées, Lyon, France.

Emerging contaminants (ECs) are synthetic or naturally occurring chemicals (e.g., pesticides, pharmaceuticals) or any microorganisms that are not commonly monitored in the environment. ECs can enter the environment causing adverse ecological and/or human health effects. The Ontario Ministry of the Environment (2011) reported 27 pharmaceutical and endocrine disruptors presence in water resources in Ontario (Canada). Biobeds are efficient systems for ECs treatment (e.g., pesticides). Microorganisms and organic substrate mixture are the main factors.

This research aimed to study microbial behavior during a biofiltration process for the removal of pharmaceuticals from water (10 mg/L for all pharmaceuticals) using local organic substrates as biomixture in a 3-level biobed-based biofilter at laboratory scale. Temperature, pH, and moisture in the biomixture were monitored every sampling day. Results showed that bacteria grow faster than fungi. ECs presence inhibits microbial growth during the first 72 hours. Microbial growth without ECs presence was observed at 24 and 48 hours for bacteria and fungi respectively. A cyclic growth for bacteria and typical for fungi was observed. Moisture content, pH and temperature of the biomixture had a significant effect on bacteria and fungi growth ($P<0.05$); moisture content (73% and 68%) for bacteria and fungi, plus temperature (20.5°C) for fungi had the greatest effect. White-root fungi related to degradation of

pesticides and pharmaceuticals were observed in the system. A better understanding of the ECs residuals in the biofilter will help to link the microbial growth with biodegradation of these contaminants as part of a simple eco-engineered treatment system.

Oral Presentation Abstracts

1. REAL-TIME HIGH-RESOLUTION FORECASTING OF THE COASTAL OCEAN DURING A HURRICANE Alexander Rey[1], Pascale Champagne[1], Ana da Silva[1], Yves Filion[1], and Ryan Mulligan[1]. [1]Department of Civil Engineering, Queen's University.

The coastal ocean experiences dynamic changes during severe weather events such as hurricanes, and forecasting these conditions is challenging. While existing forecast models offer considerable guidance, they provide relatively low resolution in shallow coastal areas and do not typically provide wind- and wave-driven currents. This limits their application for nearshore research, such as deploying sensors at specific field sites prior to a storm event. To address these challenges and provide high-resolution (100 m) coastal forecasts for the DUring Nearshore Event eXperiment (DUNEX) research community, a real-time (RT) modelling system was developed. The RT model runs every 6-hours using Delft3D-SWAN to provide a 36-hour forecast of the significant wave height, depth-averaged current velocity, and water levels from combined tide and storm surge for an ideal test site in coastal North Carolina, USA. The domain includes the shelf and coast of the Outer Banks, tidal inlets, and the large back-barrier Albemarle-Pamlico estuarine system. Detailed conditions from large-scale forecasts are provided by the National Oceanic and Atmospheric Administration (NOAA) and used as model inputs including atmospheric conditions (winds, pressure, precipitation) at 3 km resolution, ocean wave boundary conditions, and water level boundary conditions. The real-time model results are communicated via a website with past and present forecasts shown together with observations at 10 sites in the ocean and estuary. This allows the effects of changes to the forecast hurricane track and intensity to be visualized and the model performance to be validated in real-time, thereby communicating the accuracy of the model. The performance of the RT model for Hurricane Dorian in September 2019 is statistically assessed by examining differences between observations, forecasts runs, and a hindcast run with the best available input data.

2. ADDING TO THE ENGINEER'S TOOLBOX: ACHIEVING FIRST NATIONS DRINKING WATER INFRASTRUCTURE RESILIENCE WITH A NEXT-GENERATION DESIGN DECISION SUPPORT TOOL Corinna Dally Starna[1], Yves Filion[2], Stephen Brown[1,3]. [1]School of Environmental Studies, Queen's University. [2]Department of Civil Engineering, Queen's University. [3]Department of Chemistry, Queen's University.

Drinking water (DW) advisories on First Nations reserves have increased despite large infrastructure investments and over two decades of dedicated government plans, programs, and policies. Various explanations are offered from within and outside the academy. Absent appear to be perspectives exploring water system design decision-making grounded in the resilience needs of the broader community, a "bottom-up" approach advocated by the Risk and Resilience Measurement Committee of the American

Society of Civil Engineers (2019). To date, there does not appear to be a design decision aid to assist designers in the early stages of the water system design process to consider resilience based performance objectives consistent with community needs.

My research objective is to systematically assess the conditions and circumstances under which dysfunctions can cascade into events that affect the functionality, resilience, and sustainability of First Nations on-reserve water systems and thus First Nations communities. I hypothesize that a design decision support tool informed by integrated ecosystem assessment and community-based approaches will lead to greater water infrastructure resilience. I will employ mixed methods (qualitative/quantitative) and tools associated with the engineering, environmental, and social sciences while adhering to core values of Indigenous community-based participatory research and Ownership-Control Access-Possession principles in recognition of Indigenous Peoples' rights to inclusion and equity. The outcome will be data to inform next-generation resilience-based water design standards, which will ultimately achieve greater drinking water system resilience.

3. MODELLING WAVES AND STORM SURGE IN THE GULF OF MAINE AND BAY OF FUNDY SYSTEM Cody McLaughlin[1], Ryan P. Mulligan[1], and Brent Law[2]. [1]Department of Civil Engineering, Queen's University. [2]Fisheries and Oceans Canada.

Powerful storms such as hurricanes and tropical storms pose a serious threat to human society. These events can generate large waves and storm surge when traveling over water. The Gulf of Maine and Bay of Fundy system, connected to the Atlantic Ocean, is a marine area that has natural resonance causing a dynamic environment with a tidal range of up to 16 m. Storms, with increasing intensity due to climate change, in this tidal environment yield a serious problem for coastal protection of low-lying coastal settlements. Maritime Provinces, such as Nova Scotia and New Brunswick, are at risk of flooding due to dyke systems that may not be at appropriate elevations needed to prevent flooding from strong storms. A well-timed powerful storm could create a storm surge during spring tide that would overcome these dyke systems, causing extensive damage to local infrastructure and human life. In order preserve the at risk coastal regions, a better understanding of storm surge in this area is needed.

In this study, Tropical Storm Andrea (2013) is investigated using the coupled hydrodynamic-wave model Delft3D-SWAN to provide a better understanding of the response to the storm as it passed directly over the Gulf of Maine and Bay of Fundy. Model results are validated using available data for water level elevations and wave parameters. Results indicate that TS Andrea generated significant wave heights up to approximately 4 m (Figure 1) and storm surge elevations reach approximately 0.8 m in coastal areas at the head of the Bay of Fundy. Future work includes investigating more intense hurricanes as they travel through this large coastal system and examining how storm surge differs when combined with different (spring and neap) tidal conditions.

4. FROM SOCK TO STREAM – CHARACTERIZATION OF RELEASED SILVER NANOMATERIALS FROM COMMERCIAL PRODUCTS AFTER SIMULATED WEARING David Patch[1], Vincent Gagnon[1], Iris Koch[1] Denis O'Carroll[2] and Kela Weber[1]. [1]

Environmental Sciences Group, Department of Chemistry and Chemical Engineering, Royal Military College of Canada, Kingston, Ontario, Canada. [2]School of Civil and Environmental Engineering, University of New South Wales, Sydney, Australia.

Engineered nanomaterials are artificially created objects that have at least one dimension between 1-100 nm. As a result of their small size and associated higher surface-to-volume ratio, they can exhibit physicochemical properties different from their bulk material counterparts. Textiles are often functionalized with silver nanomaterials (AgNMs) to take advantage of silver's antibacterial properties, which prevent odour in textiles during use. Recent research has shown that AgNMs are released from textiles during their active life cycle, which can pose a risk to microbial communities present in environmental systems. The presence of complex matrices and the potential for post-release transformation demand a full suite of analysis techniques.

The experimental set-up involved the physical stretching of commercially available silver-treated textiles with a 3D printed apparatus adapted from techniques used in the textile manufacturing industry. Following physical pre-treatment, textiles were washed in a detergent solution at parameters closely mimicking typical laundry conditions. Wash water samples were analyzed through a combined suite of characterization techniques including: single-particle inductively coupled plasma mass spectrometry (sp-ICP-MS) size fractionation via filtering, scanning electron microscopy (SEM), x-ray fluorescence, and x-ray absorption near edge structure (XANES). Simulated human weathering resulted in changes to the amount and speciation of silver being released. Information on the release characteristics of silver from textiles allows for more accurate understanding of potential environmental impacts as these silver nanomaterials can end up in environmental systems like streams, rivers, and lakes.