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Environmental Insurance for Brownfields (Case Studies)

Carl Spensieri, Berkley Canada

Across Canada, there is an increasing need to build infrastructure and dense residential communities on urban and industrial lands (brownfields). Learn how environmental insurance can be used as a tool to reduce the liability of acquiring, building on, and repurposing environmentally challenging properties. Using case studies, attendees will learn strategies to minimize environmental liabilities and achieve better outcomes.

Target Audience: Developers and real estate owners; municipal, city and provincial government agencies responsible for infrastructure; and environmental consultants and contractors.

Carl Spensieri

Carl Spensieri supports the Environmental Team at Berkley Canada, a niche specialty insurance carrier. Carl focuses on delivering better outcomes for clients by using his expertise to find creative risk transfer solutions for environmental risks. Prior to underwriting, Carl was an environmental engineer working with a Toronto based environmental consulting company. He has also worked at a Canadian law firm, within their environmental law group. Carl's areas of expertise include merger & acquisition due diligence; professional liability; environmental liability assessment and risk transfer; property transactions; and Canadian infrastructure projects. Carl holds a Masters of Applied Sciences and Engineering from the University of Toronto and a Bachelor of Laws from the University of London (UK). He is also a Professional Engineer (Ontario).

(The) Implications and Challenges Experienced at a Brownfield Development Project

Paul H Cheung and Peter Sutton, Terrapex

Decisions regarding whether to undertake brownfield development are typically made on an economic basis. However, this approach inherently biases the reuse of brownfield properties to development proposals designed to maximize the financial return on investment. Inherently, this is a disincentive to making use of underutilized lands to address societal ills such as homelessness and a lack of affordable housing.

This case study will outline the implications and challenges experienced at a brownfield development project where evaluating the viability of a proposed residential development was undertaken on the basis of the project to provide, within a certain timeframe, housing for individuals experiencing or at risk of homelessness, rather than the economic return of the project. The review will also highlight significant changes in how the development project progressed versus a typical development or even brownfield development proposal.

Paul H Cheung

Paul H. Cheung, MEnvSc, QPRA is an environmental risk assessor at Terrapex with over 10 years of environmental consulting experience. Specialising in risk assessment, vapour intrusion assessment, and risk management, Paul uses his technical skills to assist clients in navigating regulatory, municipal conveyance, and transactional due diligence processes. He has a keen interest in brownfield development strategy and regularly consults for a broad range of public, residential and commercial real estate, and industrial clients.

Paul is a Qualified Person in Risk Assessment (QP_{RA}) under O. Reg. 153/04 and was part of the project delivery team involved in addressing environmental, geotechnical, and hydrogeological items for the development, and oversaw the completion of two risk assessments to support the filing of Records of Site Condition (RSCs) per O. Reg. 153/04 for the project.

Remediation Contracting is Dead

Nicholas Doucette and Pete Craig, QM Environmental

Stand-alone remediation contracting for large-scale redevelopment projects is dead. Money, time, acceptance of risk management measures for sites and the ensnarement of all major earthworks projects in QP-based systems for environmental oversight conspire to make efficiently siloing off remediation works increasingly impractical. Vividly illustrated with examples from North America's largest waterfront redevelopment project, "Remediation Contracting is Dead" describes the convergence of civil and environmental works into an integrated development project, where contamination is managed as just one part of an overall whole... using one design, one spatial model for machine control, one soil tracking system, and one umbrella for environmental compliance. If consultants for large-scale brownfield redevelopment want to reduce cost, risk and schedule for their clients, they need to understand how integrated civil/environmental works can be delivered.

Running a stand-alone procurement process, digging an enormous hole, sending all soil to the same, high-priced disposal location, letting the site sit stagnant for extended periods to close off loose ends and then handing it over to a completely different contractor fits into very few modern redevelopment aspirations. Market risk (time to market) alone makes it infeasible.

When desired structures – from water-managing constructed ecosystems to hard civil infrastructure like roadways – are constructed in one sequence, with contamination and risk-management measures handled in a single build process as part of construction, schedules are dramatically compacted and costs reduced. Hand-offs between potentially incompatible teams are eliminated, as are expensive mobilizations and orientation/adaptation periods. Gaps in regulatory compliance are eliminated: All soil - not just contaminated soil - is managed in accordance with increasingly complex requirements. There is one sect of records. Synergies, like the re-use of marginally contaminated soils for beneficial purposes, pile on.

A new kind of contractor is emerging, one that leverages best current technologies from across specialties - from 3-D digital models, machine control and remote sensing to cloud-based document and data management - to simultaneously deliver both civil and environmental objectives. To capture the benefits, consultants and owners need to understand the capacity for integrated delivery and tailor integrated designs to maximize their returns on it.

Nicholas Doucette

Nicholas Doucette, P.Eng., QM's National Manager for Special Projects, is a passionate advocate for innovation in the pursuit of safer, more sustainable environmental remediation projects. He has applied his civil engineering education from the University of Waterloo and the Swiss Federal Institute of Technology to some of Canada's most important and challenging environmental projects, from the Sydney Tar Ponds in Nova Scotia to the Rock Bay site in Victoria, B.C. Nick's areas of expertise include: Large Scale Multi-Disciplinary Projects; Water Treatment; Project Documentation and Project Controls; Design-Build Delivery; and Project Management. He currently leads QM's Toronto Portlands Project portfolio, presently valued at over $140 million.

Tools to Reduce Vapour Intrusion Mitigation System Installation and Operating Costs for Brownfields

Paul Nicholson, Geosyntec Consultants

The presentation will focus on innovative methods that optimize the design of vapour intrusion mitigation systems that can reduce installation costs and reduce long-term operating costs, while still protective of human health. Historical mitigation methods are based on decades old radon research at residential size buildings, however, new tools for mitigation systems at larger buildings have been developed by Geosyntec which offer an optimized approach. The presentation will show simple additional methods for system testing and design that have shown up to a 12 times return on investment for larger buildings and long-term operations cost savings of $250,000.

Paul Nicholson

Paul Nicholson is an engineer and senior member of Geosyntec's vapour intrusion practice. He has over 15 years of experience in environmental consulting, vapour intrusion assessment, vapour intrusion mitigation design and construction. Paul's current focus is on the design and optimization of cost-effective sub-slab mitigation systems based on over a decade of research in this area.

Digging Deeper with 3D RaVE: Managing and Visualizing Impacted Excess Soils Using Three-dimensional, Rapid, Volume Estimation Technology

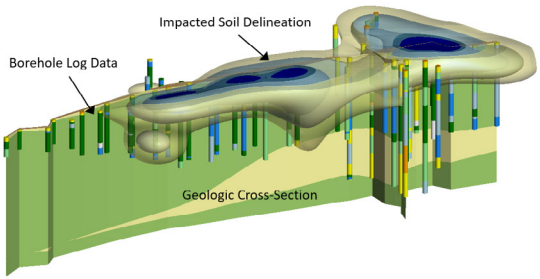
Brant Gill, Matrix Solutions Inc

The Ontario Ministry of the Environment's Regulation 406/19: On-Site and Excess Soil Management regulation (O. Reg. 406/19) has been implemented to promote the beneficial reuse of excavated soil rather than landfilling clean soils previously treated as "waste". Under the regulation, excess soils from a source site can no longer be directly discarded at landfills, but must first be assessed for potential beneficial reuse or directed to one or more off-site receiving sites.

Under the regulation, the beneficial reuse of soils requires a comprehensive understanding of often complex site conditions and detailed soil quality characterization to pair a source site to a suitable receiving site. Matrix has developed **3D-RaVE**, a three-dimensional rapid volume estimation tool, with visualization and quantitative capabilities, to interactively display site data and model impacted soil volume(s). This innovative approach facilitates stakeholder regulatory compliance with O. Reg 406/19 and can be used to develop or enhance site characterization, evaluate applicable remediation technologies, visualize and plan construction excavations, improve construction schedule management, and promote efficient and beneficial excess soil reuse and off-site soil management decisions.

Matrix' approach combines qualified person (QP) experience, specialized technical modelling skills, and a thorough understanding of regulatory requirements to employ the latest in advanced 3-D modelling systems. With 3D-RaVE, we can rapidly generate 3-D delineations of impacted soil, and estimate clean and contaminated soil volumes to improve the efficiency of remediation technologies and excess soil management. The approach can be applied to any suite of soil and groundwater analytes referencing the Ministry of Environment, Conservation and Parks' Site Condition Standards for environmental soil quality, or multiple and fully customizable and site-specific set of soil quality. **3D-RaVE** provides the QP with an improved characterization of impacted soil delineation, allowing for greater efficiency of excess soil management and planning, and evaluation of remedial options. This presentation will summarize and visually demonstrate Matrix' **3D-RaVE** tool application for impacted soil delineation, soil volume estimation, soil remediation, and 3D visualization.

3D-RaVE Display of Impacted Soil Delineation and Soil Sample Locations



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J Brant Gill

Mr. Brant Gill is a senior hydrogeologist at Matrix with 25 years of consulting experience within a diverse range of business sectors, including environmental site characterization, environmental management, municipal infrastructure, land development, excess soil management, transportation, water supply, aggregates, mining, and oil & gas. Brant has led public engagement information meetings, completed numerous environmental peer review assignments, and has served as expert witness for the Crown (Ontario) regarding contaminated site environmental impacts.

Mr. Gill works closely with clients, regulatory agencies, and engineering and environmental technical disciplines to resolve permitting requirements, assess surface water/groundwater interactions, develop beneficial soil reuse and excess soil management plans, estimate construction dewatering requirements, assess environmental impacts, and develop and implement effective sustainable riskbased environmental mitigation, management, and monitoring plans.

Anna Best

Ms. Anna Best completed her Master of Science in Land Resource Science Degree at the University of Guelph in 2013, specializing in non point-source groundwater contamination in glacial sediments. Anna effectively integrates her knowledge of hydrogeologic systems into comprehensive three-dimensional (3D) conceptualizations of the subsurface. At Matrix Solutions, Anna applies her experience in hydrogeology and geospatial analysis to support groundwater resource management projects in southern Ontario and Western Canada. Anna has transitioned her groundwater modelling experience into estimating excavated environmentally impacted soil and bedrock volumes in support of Excess Soil Management projects and preparing aggregate resource volume estimates. Anna has characterized contaminant impacts and the nature and distribution of aquifers in a variety of hydrogeologic settings.

Mycoremediation – Mushrooms For More Than Just Food

Oskar Pula, TRIUM Environmental Inc

For some of us mushrooms are a tasty food, but did you know that they also provide a viable remediation solution? Mycoremediation is a form of bioremediation where fungi are used to remediate soils. Research has proven that fungi can be a cheap, effective, and environmentally sound way for removing a variety of contaminants including heavy metals, organic pollutants, dyes, processing chemicals, petroleum fuels, polycyclic aromatic hydrocarbons, pharmaceuticals, pesticides, and herbicides. Some fungi are also effective in extremely cold or radioactive environments where traditional remediation methods prove too costly or are unusable.

Fungi are amongst the primary saprotrophic organisms (organisms that feed on nonliving organic matter) in an ecosystem, as they are efficient in the decomposition of matter. They use non-specific enzymes to break down pollutants, many of which are normally recalcitrant to bacterial degradation. They are resilient, require little external energy input, and are easy to support in treatment systems once established.

In this presentation, we will highlight the science of mycoremediation and present the exploratory efforts TRIUM has completed with our unique treatment approach called Naturo-EXF. Specifically, we have been exploring the use of this technology for treatment of polycyclic aromatic hydrocarbons (PAHs), which are complex organic compounds with fused, highly stable, polycyclic aromatic rings. PAH's are known for being difficult contaminants to treat and we will showcase treatment data that proves the non-selective destruction of high concentration PAH's in as little as 60 days.

Oskar Pula

Mr. Oskar Pula, M.Sc., PAg. is the General Manager, Contaminated Site Services at TRIUM Environmental Inc. He has over 11 years of environmental industry related experience conducting assessment and remediation programs at Oil and Gas and Brownfield sites across Western Canada. Mr. Pula received his Master's in Environment and Management from Royal Roads University with a thesis focused on drilling waste remediation using oyster mushrooms. Mr. Pula's expertise includes the design, management, and execution of projects and initiatives related to alternative and conventional remediation, research and development of proprietary/patented technologies, and overall operations management within TRIUM.

(The) Port Lands Flood Protection Project – How Advanced Petroleum Hydrocarbon Forensic Tools Can Be Used To Support Successful Bioremediation Programs

Don Forbes, Waterfront Toronto
Francine Kelly-Hooper, Stantec

The Port Lands Flood Protection and Enabling Infrastructure Project is being undertaken by Waterfront Toronto with the funding and support of the City of Toronto, the Province of Ontario and the Government of Canada. This project will alleviate flooding of 240 hectares of downtown Toronto during a regulatory flooding event and allow for the redevelopment of 142 hectares of Brownfields in Toronto's Port Lands. The project involves the excavation of 1.3 million cubic meters of contaminated fill and soil to create a new, naturalized river channel at the mouth of the Don River. In addition to the new river channel the project will create wetlands, aquatic, emergent and terrestrial habitat along the flanks of the new river, parkland above the river valley system and roads, public realm and utilities to support redevelopment. In order to optimize the environmental sustainability, technical feasibility and economic viability of this important city building project much of the contaminated soil excavated for the new river channel will be reused to raise grades in the surrounding parks, roads and development blocks. In addition to the implementation of risk management measures significant volumes of soil require remediation prior to reuse.

This presentation will explore the past environmental investigations and remediation technology pilot studies that have been undertaken in support of this project, how remediation programs are being implemented by Waterfront Toronto's Construction Manager and contractors and the challenges the program has faced in achieving objectives. The presentation will then pivot to provide a detailed discussion on the Petroleum Hydrocarbon (PHC) forensic tools that identified a wide range of PHC sources. These results distinguished PHC sources that could be readily bioremediated (e.g. diesel) from recalcitrant sources that would be difficult to bioremediate (e.g. asphalt). A key recommendation of this evaluation was to leave the recalcitrant asphalt sources in place due to their low bioavailablity and leachability risks. Lastly, recommendations on the physical tools that can be used to maximize bioremediation processes will be provided.

The objective of the presentation is to provide conference attendees with a real world example of how the application of advanced analytical and screening techniques can alleviate challenges in the bioremediation of hydrocarbons and ensure your project starts off, and stays on, the right path.

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Don Forbes

Don Forbes, Project Director, joined Waterfront Toronto in early 2018 to oversee the design and implementation of earthworks, soil management activities and soil remediation on the Port Lands Flood Protection and Enabling Infrastructure Project. Prior to joining Waterfront Toronto Don oversaw environmental investigation and management activities for Metrolinx in support of the GO Train expansion program, construction of Light Rail Transit and the development of new stations. While he was with Infrastructure Ontario he undertook the design and execution of the environmental site assessment and brownfields approvals program for the redevelopment of Toronto's West Don Lands as the 2015 Pan/Parapan Am Games Athletes' Village, River City, Corktown Common and Underpass Park.

Francine Kelly-Hooper

Dr. Francine Kelly-Hooper is a Contaminant Scientist with over 20 years of experience in soil and sediment chemistry studies. Francine operated her research based consulting firm, Kelly Hooper Environmental, for 16 years and joined Stantec in 2018. She completed her PhD at the University of Waterloo in 2013, where she developed a new method for evaluating petroleum hydrocarbon sources in soils. Francine's continues to develop new approaches to beneficial reuse of contaminated soils as cost effective and environmentally sustainable alternatives to landfill disposal.

What You Need To Know about Digital Transformation

Vincent Lam, Matidor.com

Digital transformation is undoubtedly one of most researched topics amongst the 21st century. It is being defined as the using of digital technologies to improve business processes, culture and client experiences. For energy and environmental organizations, it means a new way to convert physical findings from the field, into digital, actionable insights, in order to maximize operational efficiency, team collaboration and cost savings. To many, it may seem like a matter of adding more apps and software into their already bloated technology stack - but is it really the case?

Ironically, organizations often suffer not because of the lack of apps, but of having too many uncoordinated "silo" systems and databases. Studies have shown that average companies deploy over 100 apps and software in different areas of operations, and still find themselves constantly catching up with competition. So the question remains - what are key considerations when bringing in your next piece of technology? How can you remain agile without massive re-investment, while technologies are changing ever so quickly? During this presentation, Vincent Lam from Matidor.com will walk through the most common mistakes made by companies when adopting new software, and will provide some guidance to the latest technology landscape and deployment best practices.

Vincent Lam

Vincent Lam is the CEO and co-founder of Matidor.com. A visionary and 3x founder, Vincent built and sold his first Point-of-Sale system during his university years, and later joined Google to lead projects with the Google Earth team. Vincent has over 20 years of experience commercializing software innovations for environmental and energy companies, including GIS, marketplaces and AR/VR platforms. Vincent holds an MBA from the University of Ottawa and a BASc in Computer Engineering from UBC.

Differences and Similarities in PFAS Risk in Europe and Quebec

Hugo Carronnier, Valgo
Gabriel Munoz, Université de Montréal

Since 2019, VALGO has conducted a wide range of research and development projects on diagnosis, modelling, analytical methods, risk measurement, as well as on the treatment of PFAS in Europe. The University of Montreal has also worked extensively on the PFAS problem in Quebec, carrying out numerous sampling campaigns, and greatly improving mass spectrometry analysis methods.

In 2021, the company carried out a complete diagnosis of the public water network of a major French city near Paris, in collaboration with Pr. Sauvé's team from the University of Montreal. The aim of this study was to determine the behavior of PFAS in the water network, from the drinking water catchment area, through the distribution network, to the wastewater treatment plant; but also to determine the potential carcinogenic risk induced by the consumption of contaminated water.

This presentation aims to present the behavior of PFAS in public drinking water networks, the threat of contamination, the risk for populations but also solutions to protect public health and the environment. But must importantly, this presentation will present the similarities and differences of the PFAS issue in Canada and in France like the emergence of new PFAS, o or country-specific variations in network contamination risks.

Hugo Carronnier

Hugo Carronnier is a project manager working with VALGO, a French company offering global strategies for environmental remediation of former industrial sites, and now established in seven countries including Canada. His work at VALGO is focused on the PFAS study, at every stage of the perfluoroalkyl issue, studying the environmental contamination, as well as the human exposure, the impact on health, or the environmental remediation strategies. He previously worked on technical scale projects with Landcare Research on the remediation of former and active mine sites (Waiuta, Bellvue, and Stockton, the largest active open pit mine of Oceania) located on the west coast of the southern island of New Zealand.

After a double degree education in pharmacy (Pharm D) and in human and environmental toxicology (MsC) he received his Pharmacy Doctorate, summa cum laude in 2021, for the thesis: Distribution and Impact study of per and poly fluoroalkyl substances in the Seine valley, after an industrial incident. This work is nominated for the national thesis award: GATOX 2022, which reward the best Pharm-D thesis specialized in toxicology.

Gabriel Munoz

Gabriel Munoz is a research associate in the Department of Chemistry at the Université de Montréal. He holds a chemical engineering degree and a PhD in environmental analytical chemistry (Université de Bordeaux, France). He joined Professor Sauvé's team as a post-doctoral fellow in 2016, focussing on the development and validation of analytical methods to quantify novel PFAS at federal contaminated sites. His current research topics include the environmental fate assessment of emerging organic pollutants using targeted and nontargeted mass spectrometry methods.

Electrochemical Degradation of PFAS Mass In Redundant Stocks of Afff Concentrate and First Flush Washwater – Pilot-Scale Field Demonstration

John Santacroce, Rachael Casson, Shangtao Laing and Rebecca Mora, AECOM

Introduction As state regulators globally ban or strictly administer the storage, handling and use of Aqueous Film Forming Foam (AFFF) because of they contain fluorosurfactants, users are implementing foam transition programs where fluorine free foams are replacing AFFF. These transition programs include the removal of AFFF and the generation of PFAS impacted decontamination wastewater. We have completed a field pilot using electrochemistry to destroy PFAS mass contained within the solutions generated as part of these foam transition programs.

Pilot Methodology A 3-month pilot trial has been completed at a facility in Australia. The pilot comprised the treatment of 13,200 liters (L) of redundant 'end-of-life' AFFF and 20,800 L of PFAS impacted first flush wash-water.

The EAOP pilot system is accommodated within a 20 foot container housing six(6) 40-liter(L) cylindrical reactors equipped with novel reactive membrane electrodes that are controlled by a PLC and capable of continuously circulating water 24hrs a day in an unmanned capacity. The EO reactors are assembled with recirculation pumps, off-gas control, chiller, and control panel, vapor emission control and a foam suppression system. Key operational parameters, such as current density and flow rate, are fully adjustable and can be preset for automated operation. The PLC has an internal datalogger to record operating conditions to fine tune optimisation. Telemetry has allowed our operators to monitor status and alert to any process alarms/shutdowns. The trial comprised a series of experiments under different treatment conditions and reactor configurations, including but not limited to different retention times / flow rates (20 to 105 L per minute [LPM]) and current supply (100 – 300 Amperes). The experimental L per m2, per hour (LMH) ranged between 200 and 1,530.

Time-course samples were collected and analyzed for PFAS (30 compounds), total oxidizable precursor assay (TOPA)-PFAS, select anions (fluoride, sulphate and perchlorate), Total Organic Carbon (TOC), Semi Volatile Organic Compounds (SVOCs) and metals. Total organic fluorine (TOF) data was also collected for mass balance evaluation.

Results Post-Treatment First Flush: After EO treatment, concentrations of perfluorooctanoic acid (PFOA) were reduced by between 77% and 99% and the sum of perfluorooctane sulfonate (PFOS) and perfluorohexane sulfonate (PFHxS) were reduced by between 95% to 100%. As a more reliable indicator of total PFAS mass, TOF data was used for mass balance calculations, and indicated that under ideal operational parameters 96% of the measurable and unmeasurable PFAS mass was reduced.

Post-Treatment Redundant End of Life AFFF Concentrate: Following EO, TOF data indicated that the combined measurable and unmeasurable PFAS mass was reduced by 76%. Regulated PFAS were not detected in the AFFF as it was a C6 pure foam. The experiment was prematurely ceased due to time constraints.

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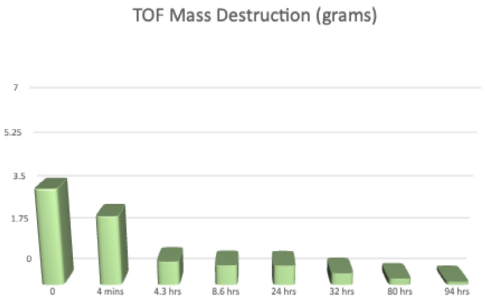
Figure 1: Preliminary PFAS First Flush Mass Destruction (grams)



Energy Consumption: On average, the EO system consumed 4.92 kWh of electricity per day, therefore the system is capable of being powered by solar energy (supplemented with a battery) for future applications.

Future Direction A second system has been designed and constructed in the US, and comprises technology enhancements: flow through capability and greater current density. The US pilot is underway.

Rachael Casson

Rachael serves as the Director of AECOM's International PFAS Program, focussing on innovation and technical excellence. She has over 22 years of consulting experience in contamination assessment and management. In 2008, Rachael recognized the emerging concern over PFAS with aviation and defence clients, positioning the AECOM team at the leading edge of the PFAS science. She has worked on over 100+ PFAS-related projects across the globe.

Rachael is part of the DE-FLUORO™ technical development team, an electrochemical process that destroys PFAS in solution. Her other research programs include: (1) Plant PFAS uptake study and (2) Evaluation of the transformation of PFAS Precursors into perfluoroalkyl acids (PFAAs) downgradient of known source zones.

John Santacroce

John supports AECOM's international PFAS Initiative as the North America Aviation PFAS Practice Lead and East Region Subject Technical Lead. He has over 22 years of consulting experience in environmental investigation and remediation projects. John began solving PFAS issues for clients in 2015 when he led the Preliminary Assessment and Site Inspection program for 19 Air National Guard Bases across the continental US. His experience includes dozens of PFAS projects for airports, the US Department of Defense, industrial clients, and state agencies. John is part of the DE-FLUORO™ team, an electrochemical process that destroys PFAS in solution.

Field-Scale Treatability Study - Soil Washing of PFAS-Contaminated Soils, Peterson Air Force Base, Colorado

Steve Becker, Brice Engineering
Paul Newman, ECT2

A field-scale treatability study was performed to evaluate the effectiveness of soil washing for the removal of PFAS from soils derived from Aqueous Film-Forming Foam (AFFF) release sites at Peterson Air Force Base. The study validated the efficacy of the soil washing technology at the field scale and generated site-specific treatment system design and operational parameters for optimum PFAS removal from soil. The study also demonstrated the ability to remove PFAS from liquids and additives used during the soil washing process.

Initially, approximately 500 cy of contaminated soil from a former AFFF spray test area was excavated and stockpiled. The soil was homogenized using heavy equipment (bucket mixing) to ensure relatively uniform particle size distribution and PFAS concentrations for processing through the soil washing plant. An Incremental Sampling Methodology (ISM) was used to establish pre-treatment concentrations of PFAS (e.g. 3.2 mg/kg PFOS) for use as a baseline to assess the effectiveness of the treatment. An on-site mobile lab monitored PFAS concentrations in process water at multiple points within the treatment train as well as in the various system outputs including organics, gravels, sands, and fines.

Brice treated ten batches of soil through a patented water-based, closed-loop treatment process that uses particle size and particle density segregation techniques to 'wash' PFAS from the various soil fractions and capture the mobilized PFAS in an effluent stream that was pretreated using settling and flocculation, followed by PFAS treatment with ECT2's regenerable ion exchange resin. At the client's request, Brice also dredged and successfully treated three batches of sediment from the base stormwater system, demonstrating the ability of the process to treat finer grain size and high-organic matter materials.

The field-scale treatability study demonstrated the ability of the soil washing treatment methodology to achieve PFAS removal efficiencies between 93 to over 99% for the coarse soil fraction, and between 82 and 89% in the fine soil fraction. Soil washing liquids with initial PFOS concentrations of 490 µg/L were effectively treated using regenerable IX media to below 70 ng/L.

Soil washing is an effective source control and management strategy. Full-scale application offers the potential, when combined with on-site IX media regeneration and regenerate destruction, for complete PFAS removal, zero waste generation, and beneficial reuse of soils.

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Steve Becker

Steve Becker, CEP: Steve Becker is a Certified Environmental Professional and soil scientist with over 30 years' experience in the construction and environmental industries, including more than 27 years as a project and/or program manager. Steve is the national PFAS Program Manager for Brice Environmental Services Corporation, and has experience with multi-media PFAS investigation and remediation, and. He is an Affiliate Professor of Emerging Contaminant for the University of Alaska Institute of Northern Engineering, and serves as a member of the ITRC PFAS and Emerging Contaminants Work Groups.

Paul Newman

Paul Newman is the Department of Defense Market Sector Leader for ECT2 (Emerging Compounds Treatment Technologies). ECT2 is an equipment company focused on developing and implementing treatment technologies for PFAS and other emerging, difficult-to-treat contaminants. Paul's focus is currently on supporting the DoD in pilot- and full-scale water treatment deployment, and pairing our regenerable ion exchange process with destruction technologies. He received his Bachelor's Degree in Geology from the University of Windsor and his Master's Degree from McGill University.

Pushing the Boundaries on Quantitative PFAS Analysis - a Global Leader

Katrina Zwambag, ALS Environmental

There are hundreds of chemicals that can be classed as PFAS (Per and poly-fluorinated Alkyl Substances). Accredited laboratories typically determine approximately 30 of these specific chemicals. ALS continues to be a global leader in support of the on-going investigation into PFAS impacts on the environment and the many compounds that are currently not actively measured in routine analysis. Traditional PFAS analysis only targets the key analytes and therefore may or may not greatly underestimate the presence of PFAS in the environment. US EPA continues to discuss the ongoing PFAS Action Plan to address these long-lasting 'forever chemicals'. Under the CWA Analytical Methods it was announced that in collaboration with the US Department of Defense a more extensive list of 40 compounds would be analytically developed in support of wastewater as well as surface water, groundwater, leachate, soil, sediment, biosolids, and fish tissue matrices. This includes the following compounds not routinely tested at accredited laboratories:

Abbreviation	Name – Acid/Neutral Form	CAS#
3:3 FTCA	2H, 2H, 3H, 3H-perfluorohexanoic acid	356-02-5
5:3 FTCA	2H, 2H, 3H, 3H-perfluorooctanoic acid	914637-49-3
7:3 FTCA	2H, 2H, 3H, 3H-perfluorodecanoic acid	812-70-4
NFDHA	Perfluoro-3,6-dioxaheptanoic acid	151772-58-6
PFEESA	Perfluoro(2-ethoxyethane)sulfonic acid	113507-82-7
PFMPA	Perfluoro-3-methoxypropanoic acid	377-73-1
PFMBA	Perfluoro-4-methoxybutanoic acid	863090-89-5

ALS Globally has been a market leader in the PFAS testing capabilities starting from the Australian Marketplace and actively explored and implemented in the North American region. ALS Waterloo is proud to release a new service offering in support of EPA's invested efforts in targeting the solutions needed to address PFAS in the environment and on-going PFAS studies and remediation. ALS will now offer an extended list of targets to reach a quantitative LCMSMS scan of 52 compounds.

This compound list and associated detection limits supports the rapid movement in the United States on control and ban of these contaminants in the environment. The extended suite can be obtained from the existing 60mL sample submission bottle for the regular suite of targets meeting all regulatory guidelines globally.

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In order to continue obtaining a deeper knowledge of PFAS compounds and their fate, analytical laboratories need to continue to pursue the full scope of analytes. ALS Waterloo's extended suite offers analysis of PFECHS which is found in aviation hydraulic oils as well as fluorotelomer carboxylic acids 3:3 FTCA and 5:3 FTCA that are major components in legacy landfill leachates. The following targets not listed above are included in the extended list:

Abbreviation	Name – Acid/Neutral Form
PFECHS	n-Decafluoro-4-(pentafluoroethyl)cyclohexanesulfonate
FHUEA	n—2H-perfluoro-2-octenoic acid (6:2)
FOUEA	n—2H-perfluoro-2-decenoic acid (8:2)
FDUEA	2H-Perfluoro-2-dodecenoic acid
6:2 FTCA	n-2-perfluorohexyl ethanoic acid (6:2)
8:2 FTCA	n-2-perfluorooctyl ethanoic acid (8:2)
10:2 FTCA	n-2-perfluorodecyl ethanoic acid (10:2)

ALS has always concluded that there is a need to expand analytical suites to cover other PFAS that may arise from weathering that might include some oxidation and hydrolysis and, ideally, to have better models for predicting environmental endpoints. Without measuring all of these compounds the potential for ongoing contamination, as these compounds go through weathering processes, is a large liability. Case Studies will be reviewed to show the impact of the never before measured target analytes on Canadian Sites. Questions will be answered: How prevalent are they? How will this change the on-going scope of PFAS remediation and site characterization? Further product breakdown scenarios will be discussed and explored to highlight where these new compounds fit in the biodegradation of AFFF.

Katrina Zwambag

Katrina Zwambag is the Business Manager at the ALS Waterloo laboratory. Her previous role as the LCMS Manager involved extensive work in the research and method development of PFAS compounds. Previously Katrina's responsibilities were focused on coordination of the LCMS department, method validations, quality control and maintenance of instrumentation. In her 13 year laboratory career Katrina has held a variety of positions, including analyst, instrument operator, supervisor, team lead and manager, providing her with a well-rounded skillset which she has utilized to find improvements and efficiencies throughout the lab. Katrina has a certificate in Biotechnology from Mohawk College and has completed the ALS iLEAD leadership and Management designation.Abstracts text

Bioaugmentation – A Canadian Perspective

Sandra Dworatzek, Phil Dennis, Corey Scales and Jeff Roberts, SiREM

Bioremediation of chlorinated solvents including perchloroethene (PCE) and trichloroethene (TCE) in groundwater is a proven and cost effective remedial approach, particularly in the United States. Despite Canadian expertise with in-situ bioremediation (EISB) including biostimulation and bioaugmentation, EISB has taken longer to be accepted and utilized. Barriers to implementation have included the regulatory approval process and perceptions that the geological and climatic conditions in Canada may be unsuitable for successful bioremediation.

In Canada, geological and geochemical conditions; which include low groundwater temperatures and the preponderance of low permeability matrices and fractured rock geology pose challenges for EISB. The increased use of the EISB over the past 5 years, particularly in southern Ontario is providing insights into the implementation of bioremediation projects and how to optimize approaches for successful in situ remediation of chlorinated solvents and other recalcitrant compounds in contaminated groundwater in Canada.

Groundwater temperatures defined as cold (i.e., below 10 °C) are commonly found north of 45 degrees latitude. Understanding the feasibility of bioremediation of chlorinated ethenes and the practical limits of bioremediation of chlorinated ethenes under cold conditions is important. Examples of successful bioremediation at sites in Alaska, Denmark and Canada, will be presented with a focus on degradation half-lives, concentrations of dechlorinating bacteria (Dehalococcoides) and remediation outcomes.

Low permeability strata are common in some of the most highly industrialized areas of Canada; notably in Southern Ontario and Quebec. Originally conceived as an oil and gas extraction technology, hydraulic fracturing can also be used to improve distribution of bioremediation amendments thereby improving bioremediation outcomes. Examples of successful implementation of hydraulic fracturing and other approaches for bioremediation in clay strata and fractured rock environments will be discussed.

Case studies for anaerobic bioremediation for a growing list of recalcitrant compounds, including chlorinated solvents and petroleum hydrocarbons will be presented.

Sandra Dworatzek

Ms. Dworatzek is a Principal Scientist at SiREM and has been with the company for twenty years. Ms. Dworatzek is an environmental microbiologist with advanced technical experience in bioaugmentation cultures and laboratory treatability studies. SiREM maintains state-of-the-art treatability, molecular testing and microbial culture production facilities in Guelph, Ontario, Canada and Knoxville, TN. She currently oversees maintenance and culturing of microbial cultures that have been widely used to improve the rate and extent of bioremediation of chlorinated solvents in groundwater, as well as promoting the development of new bioaugmentation cultures for a wide range of environmental contaminants, including 1,4-dioxane, 1,2,3-trichloropropane, benzene, toluene and xylene. She provides senior technical oversight for laboratory treatability studies for a wide range of environmental contaminants, including halogenated organics (e.g., solvents, pesticides, etc.) and inorganics, both alone and in complex mixtures using a wide range of standard and innovative technologies (Bioremediation, ISCO, ISCR, natural attenuation etc.).

In-Situ Chemical Injection to Treat Chlorinated Solvents in Groundwater

Takako Matsueda, SLR Consulting

Background And Objectives A dry cleaner operated at a shopping centre in BC between the 1960s and 1980s. Tetrachloroethylene (PCE) and degradation products were identified in soil, groundwater and soil vapour at concentrations above the BC Contaminated Sites Regulation (CSR) standards on-site and off-site to the north and west beneath roads, residences and a school.

In the 1990s and 2010s, remedial excavations removed approximately 6,000 m3 of PCE-impacted soil in the source area on-site and off-site to north. However, post remedial investigations identified contaminated soil, groundwater and soil vapour remaining on- and off-site.

In 2015 following the excavations, a groundwater treatment system was installed on-site to extract and treat groundwater to prevent further migration of the groundwater plume off-site.

In 2019 and 2021, an in-situ chemical injection program of BOS 100® was implemented to treat PCE in groundwater. The objectives were to replace the groundwater treatment system and reduce PCE concentrations to complete a human health and ecological risk assessment for the site and support revitalization of the site. The goal is to ultimately obtain risk-based Certificates of Compliance from the BC Ministry of Environment for the site and off-site affected areas.

In-Situ Chemical Injection Program – Approach, Activities and Challenges In 2019, a pilot scale injection program was conducted in the groundwater "hot spot" on-site. In 2021, based on the success of the pilot program, a large scale injection program was implemented which consisted of approximately 105 injection points on-site to depths of 19 m on a 3 m grid and 16 injection points off-site to depths of 21 m on a 10 m grid.

Due to the presence of dense silt till and heaving sands at the site, each injection point was pre-drilled using a sonic rig and then backfilled with a grout mixture. The injections were completed by advancing direct push drilling technology (Geoprobe®) through the pre-drilled boreholes and injecting a suspension (i.e. BOS 100® mixed with water) at set vertical intervals throughout the subsurface.

Challenges included refusal of the direct push in the pre-drilled boreholes, injection tooling clogging and daylighting of the suspension through the top of the pre-drilled boreholes. The issues were resolved by adjusting the diameter of pre-drilled boreholes, changing the backfill material of pre-drilled boreholes and adjusting injection pressures. At some locations, the suspension was reallocated to adjacent injection points.

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Results And Next Steps In September 2021, after the injection program, the groundwater treatment system was shut down. In October 2021, on- and off-site groundwater wells were sampled. The concentrations of PCE at most wells within the injection area decreased but increased in select wells. The increases may be attributed to the shut down of the groundwater treatment system. It should be noted that during the pilot program, the initial reduction in PCE concentrations was slow but increased after approximately 6 months.

The plan is to continue groundwater sampling on a quarterly basis until the groundwater plume is stable or shrinking then complete a risk assessment and apply for risk-based Certificates of Compliance.

Takako Matsueda

Takako Matsueda is an Environmental Engineer with SLR Consulting (Canada) Ltd. and is a professional engineer licensed with Engineers and Geoscientists of BC (EGBC) and an Approved Professional with BC ENV. She received her B.A.Sc. in Bio-Resource Engineering from the University of British Columbia. She has over 20 years of experience in the environmental consulting industry. Her experience includes managing multiple complex contaminated site investigation and remediation projects in BC.

Metals & Organic contaminant Removal Using Novel Iron Media for *Ex situ* Groundwater Remediation and Industrial Wastewater Treatment

Jean Paré, Chemco Inc.
Yu Yang, Phillip Palumbo, Carolyn Somerville, Hyunshik Chang and Madan Tandukar, Höganäs Environment Solutions

Selenate removal is a great challenge in both groundwater remediation & industrial wastewater treatment. A novel porous iron media (named Cleanit®-LC Plus, LC+) was invented and is manufactured by Höganäs, which has a high reactivity and treatment capacity for selenium (Se) removal. Several laboratory and pilot-scale studies have been conducted for selenate removal. Batch studies showed that the maximum removal capacities of LC+ were 2.70 ± 0.12, 4.90 ± 0.03, 4.74 ± 0.22, and 5.00 ± 0.00 mg Se/g media, for selenate, selenite, selenosulfate, and selenocyanate, respectively. Lab column test on groundwater sample from west coast of the U.S. showed selenate removal from 35.4 ± 3.5 µg/L to 4.0 ± 2 µg/L with an empty bed contact time (EBCT) of 30 min. Another independent pilot column study was performed on industrial wastewater from a battery recycling facility. The selenium concentration was 3.1 ± 1.0 mg/L, which was removed to about 1.6 ± 0.79 mg/L below the treatment target of 2 mg Se/L (EBCT, 20 min). The capacity of LC+ media for selenium was about 3.2 mg Se/g media.

Additional inorganic contaminants (e.g., arsenic, cadmium, lead, antimony, molybdenum and zinc) present in groundwater or industrial wastewater can also be removed ex situ via sorption & reduction processes.

For instance, Pb was removed from 133 ± 14.1 to 18 ± 2.1 mg/L, showing a capacity of 282 mg Pb/g LC+ media. Organic contaminant such as cVOC can be destroyed rather than sorbed using this type of media when a pump & treat system is in operation. The unique composition of the media (99 % iron) allows it to have a sustainable lifecycle as it could be remelted for re-use in other iron powder application or re-activated depending of the type contaminant treated. This limit the cost of disposal for hazardous material and promote a more sustainable environmental approach to the filtration of these type of contaminants.

In summary, this novel iron media demonstrated a significant potential for organic and inorganic contaminant removal for ***ex situ*** groundwater remediation and industrial wastewater treatment. Full scale implentation case study demonstrating the system performance and cost will be given during the presentation.

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Dr. Yu Yang

Dr. Yu Yang (PE, PMP) is currently employed at Höganäs Environment Solutions as a Manager for Process Development, where he focuses on water and industrial wastewater treatment. He obtained his Ph.D in Civil and Environmental Engineering from the University of Missouri in 2012. Before joining Höganäs Environment Solutions in 2015, Dr. Yang worked at Arizona State University and Marquette University as a postdoctoral associate. Dr. Yang has published more than 33 peer-reviewed journal papers, one book chapter, and has one granted patent. The total number of citations of his publication is over 1,300, with a h-index of 18. He has presented on more than 40 professional conferences, and reviewed more than 50 scientific articles for 20 professional journals. Dr. Yang has also evaluated grants and fellowships as an external reviewer for the Natural Sciences and Engineering Research Council of Canada, the National Science Center of Poland, and U.S. NSF Graduate Research Fellowships Program. He serves as a board member for Environmental Justice and equity board at NC Department of Environmental Quality.

Jean Paré

Jean Paré, P.Eng., has a degree in Chemical Engineering from Laval University. He has been involved for the last 25 years in the evaluation, development, design, and promotion of both conventional and innovative environmental technologies. As Vice President with Chemco Inc., his responsibilities include the remediation design, technico-economical analysis and technology supply for chemical oxidation and reduction, soil washing, and enhanced bioremediation. Last year, he worked with over 400 sites applying his expertise to various types of organic and inorganic contaminants in soil and groundwater. He is also involved with many environmental organizations such as CLRA, CBN, ESAA, BCEIA and Reseau-Environnement where he is an active technical committee member and regular technical speaker.

Boat Harbour Sludge Thickness Mapping and Volume Calculations

Tim Bachiu, WSP Golder

The remediation and restoration of Boat Harbour (A'se'k) presents significant engineering, environmental, and stakeholder challenges. This 160-hectare former tidal estuary, located less than 1 km south of the Pictou Landing First Nation, has been receiving pulp effluent since it was isolated from the Northumberland Strait and converted into an industrial stabilization basin in 1967. Recently, the Province of Nova Scotia has committed to the remediation and restoration of Boat Harbour to convert the Harbour back to a functional tidal estuary. The specific objective of this phase of work was to accurately measure the in place volume and distribution of contaminated sludge which has accumulated within the Harbour and neighboring Aerated Stabilization Basin (ASB) over the last 50 plus years. Accurately understanding the volume and distribution of the contaminated sludge at the site is essential for the design of the remedial dredging and sediment management program to restore Boat Harbour to its natural state.

The approach was to employ corroborating techniques to identify the top and bottom elevations of the contaminated sludge. A unique and innovative approach using in-situ Laser Induced Fluorescence (LIF) and Electric Conductivity (EC) profiling was employed to accurately identify the distribution and thickness of contaminated sludge across the Harbour and ASB. The real-time high resolution data collected in-situ was coupled with more traditional physical sampling techniques to provide further confidence in the in-situ methods Barges constructed specifically for the project were used to collect over 600 discrete LIF/EC profiles in the two water bodies. The collected LIF/EC profiles were corroborated by gravity core, percussion coring and vibracoring methods from 60 duplicate stations. The data collection occurred over a two field programs in 2019 and 2021. Weather conditions and the full-scale deployment of a novel characterization technique presented numerous challenges to the expedient collection of high quality, spatially accurate data. Bathymetric surveys using single and multi-beam echo sounding were completed to define the top of the sludge surface.

The bathymetric surface and the LIF/EC profiles were combined to generate surfaces representing the top and the bottom of the contaminated sludge. Based on these derived surfaces the volume of contaminated sludge was calculated. This information was critical to the design of the remedial dredging and disposal programs. The knowledge gained through this study is transferable to a broader context of sludge and sediment characterizations as part of other reclamation efforts involving organic sludge characterization, removal, and disposal.

Tim Bachiu

Tim Bachiu is a geoscientist based in Nova Scotia. His areas of expertise include site characterization, hydrogeology, geochemistry and mapping. As a project manager he utilizes the expansive expertise of WSP-Golder to develop specialized project teams that are supplemented by technical and local knowledge groups to address unique challenges in the field of environmental management.

No Quick Fixes to Gas Well Problem — Case Study — Big Creek Valley, Ontario

Louis-Charles Boutin, Steve Shikaze, Cam Baker
Matrix Solutions Inc
Laura Weaver, Morwick G360 Groundwater Research Institute

The first heartbeat of oil and natural gas production in North America started in Ontario with oil in 1858 followed by natural gas in the early 1900s. In Big Creek valley, Ontario there are hundreds of active, inactive (i.e., suspended and/or legacy wells of unknown status), plugged (i.e., abandoned) petroleum wells. Regulations on well abandonments have changed significantly over the last century, and therefore, abandoned wells are not uniformly plugged. The abandoned wells are potential pathways for gas migration such as methane (CH4) and hydrogen sulphide (H2S). The origin of sulphur-rich waters was previously investigated (Jackson et al. 2020) in Norfolk County.

Norfolk County owns a parcel of land on which a well is currently discharging sulphur-rich waters at ground surface and potentially in the subsurface. The sulphurrich waters present a significant risk to local ecosystems and human health. This issue has been ongoing for several years and more recently, the explosion that occurred in September 2021 in Wheatley, Ontario brought more media attention to the issue of gas migration from abandoned petroleum wells in southern Ontario.

This presentation will provide an overview of the hydrogeological understanding that was advanced in 2020-21, through the analyses of well records held by the Oil, Gas and Salt Resources Library (OGSR), integration of sitespecific information from local residents, review of regional geological maps of the bedrock, field investigations, and the construction and application of a numerical model of groundwater flow. More specifically, the study allowed the interpretation of an artesian zone in Big Creek valley due to groundwater pressures within the Dundee Formation aquifer. It also helped to understand the radius of influence from historical well plugging activities, estimate the relative risk between petroleum wells, and assess the potential impacts of different remedial scenarios that were identified through a workshop with the Norfolk County technical project team.

Louis-Charles Boutin

Mr. Louis-Charles Boutin is a principal groundwater engineer working at Matrix Solutions Inc. He graduated from École Polytechnique de Montréal in 2003, and received the Undergraduate Student Report Award from the Canadian Geotechnical Society for his work on simulating artificial recharge and recovery to an unconfined aquifer. As a coauthor, he received the Thomas C. Keefer Medal from the Canadian Society for Civil Engineering in 2004, for a technical article on carbon monoxide migration associated with blasting operations. From early on in his career, Mr. Boutin has been involved in municipal water supply projects in Québec, before joining Matrix where he has been working for the last 15 years, mainly in industrial groundwater supply projects and environmental risk assessments in North America. During his career, he has been involved in several hydrogeological assessments, where he developed and applied a variety of numerical and analytical groundwater flow and contaminant transport models.

Acknowledgements We would like to acknowledge employees and residents from the Norfolk County, who contributed significantly by sharing historical and groundwater knowledge on the area of interest.

References Jackson, R.E. et al., Investigating the Origin of Elevated H2S in Groundwater Discharge from Abandoned Gas Wells, Norfolk County, Ontario. Presentation at the Geoconvention 2020.

Remediation of Wetland Used by First Nation for Plant Harvesting

Muntazir Pardhan, Dillon Consulting Limited

Four areas within traditional lands of the Mohawks of the Bay of Quinte (MBQ) in the Township of Tyendinaga, Ontario were found to be significantly contaminated with metals, PAHs, and petroleum hydrocarbons. These lands are of great importance to the First Nation community as they are used for fishing and harvesting of plants (e.g., sweet flag) used by community members for medicinal purposes. In 2019, to support the transfer of lands to MBQ, Dillon was retained to complete the final stages of the FSCAP 10-Step process (remediation and closure) by preparing a Remedial Action Plan and remedial design based on source removal. The discovery of contamination encroaching on a previously unidentified wetland required alternative remedial approaches to remediate and risk manage the lands while balancing the need for ongoing traditional use by MBQ.

This presentation reviews the unique considerations and challenges faced following the discovery of contamination in a previously unidentified wetland that served as a key source of traditional medicine for the community. The problems within the wetland were further aggravated by high water levels and species at risk which introduced additional constraints to a final remedy. A phased approach was adopted that included source removal of impacts adjacent to the wetland from targeted areas and the completion of a risk evaluation and functional assessment of the wetland for successful management of the remaining impacted areas of the wetland. Further field data collection was necessary to address data gaps and included soil/sediment sampling and analysis of medicinal plants located in the wetland. Stakeholder collaboration (MBQ and Indigenous Services Canada) and the implementation of an environmental monitoring program during construction was critical to the success of the phased approach for the remediation and risk management of the wetland. In addition, in collaboration with MBQ, the planned excavation of impacted soil in heavily forested area was curtailed as risks were evaluated and a mitigation plan was incorporated into the design.

Muntazir Pardhan

Muntazir is a Partner at Dillon Consulting Limited in London, ON and has over 20 years of experience in Environmental Consulting. He has a Bachelors of Civil and Environmental Engineering from Western University and is licenced as a Professional Engineer in the province of Ontario. Muntazir specializes in phased environmental site assessments and remediation projects with Indigenous Communities across Canada. He also manages large scale phased environmental site assessments for infrastructure projects and monitoring of active and closed landfills.

(The) Importance of a Good 3D Conceptual Site Model in Remediation of a Chlorinated VOC Impacted Groundwater Site in Eastern Ontario.

Jonathan Coakley, Stantec Consulting

The key to designing a successful in-situ remedial injection program to remediate plume(s) of contaminated groundwater is highly dependent on good site characterization and formulation of conceptual site model (CSM) reflective of actual site conditions. A good CSM will enable injections of remedial agents and amendments to be targeted in an effective and cost-efficient manner to those contaminated areas that require treatment. A good CSM will have the aquifer stratigraphy and contaminant distribution characterized and mapped on a meter-scale resolution. The pitfalls of designing a remedial program based on a very generalized CSM is that the injection treatment zone locations and elevations may not be reflective of the actual zones and depths of highest groundwater and/or soil contamination, thereby potentially limiting performance of the injections and prolonging clean up timelines. This presentation highlights Stantec's experience in utilizing high quality aquifer characterization data (including soil and groundwater analytical/instrument data from tightly spaced monitoring wells and/or multi-level wells for lateral and vertical delineation and membrane interface probe (MIP) surveys) synthesized and visualized in a spatially accurate 3D CSM to target contaminated groundwater plumes in an upcoming in-situ remedial program.

Utilizing high quality aquifer characterization data and 3D visualization tools, Stantec has significantly evolved the understanding of contaminant distribution at a chlorinated VOC (cVOC) impacted groundwater site in eastern Ontario where groundwater has been monitored for over forty years. Early in 2021 Stantec conducted extensive review, analysis, and digitization of historical site data which included 75 borehole geology logs, 19 soil vapour logs, and soil and/or groundwater chemistry from 45 monitoring well locations. These multiple data sets were synthesized into one spatially accurate 3D CSM model using the Leapfrog Works 3D software platform.

Findings from the 3D CSM based on historical site-specific data identified a cluster of elevated organic soil vapour readings at the base of the shallow aquifer, immediately above the modelled location of the silt aquitard. Based on findings of the 3D CSM, Stantec hypothesized that the identified area of elevated organic soil vapour readings at the base of the shallow aquifer may contain high cVOC concentrations (relative to cVOCs concentrations found throughout the site). To test this hypothesis, Stantec used a multi-pronged approach including a MIP survey (instrumented to detect total cVOCs in soil and/or groundwater) along with downhole soil sampling and groundwater monitoring well installation. Following the assessment, the data were incorporated into an updated 3D CSM for the site.

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The shallow aquifer assessment program identified significant concentrations of cVOCs within the shallow aquifer in areas and at elevations not previously thought to contain significant source(s) of cVOCs at the site. Planning is now underway to design a targeted remedial injection program based on the results of the shallow aquifer assessment program and visualization within the 3D CSM.

In this presentation, we will review the construction of the 3D CSM using historical data, how it was used to plan additional assessment work, how the new results were incorporated into 3D CSM and how the updated 3D CSM was used to communicate the findings and recommendation to the client for the purposes of planning and designing future remedial injections at the site.

Jonathan Coakley

Dr. Jonathan Coakley is an environmental scientist and engineer, with over 20 years of experience in research, policy development, and management of contaminated land investigation and remediation projects. His research career focused on exposure assessment and risk analysis for contaminants in the environment, specifically persistent organic pollutants (POPs), including legacy contaminants like dioxins and furans, and emerging contaminants like perfluoroalkyl substances (PFAS) and brominated flame retardants (BFRs). Jonathan has been based in New Zealand since 2000, where he held technical and project management roles in the public and private sectors. He recently returned to his hometown of Hamilton, Ontario, where he now works for Stantec on a range of contaminated land investigation and remediation projects.

(A) Multidisciplinary Approach to Remediate Tetrachloroethylene Impacted Groundwater Beneath a Building

Kerry-Anne Pumphrey, BlueFrog Environmental Consulting Inc

In-situ remediation usually involves hydrogeology and chemistry, however, sometimes our built environment throws us a curve ball that requires other specialities such as geotechnical and structural engineering plus some microbes to help remediate a site. Tetrachloroethylene (PCE) concentrations were identified in groundwater in excess of the Ontario regulatory site condition standards beneath a three storey commercial building with a basement and rear parking lot construed circa 1950s. The property owner wished to renovate the building to allow for a commercial use on the ground floor and residential use on the upper two floors. Remediation of PCE impacted groundwater was required to allow for this redevelopment. An in-situ chemical reduction (ISCR) program was designed that consisted of temporary well point injections of ZVI and permanent wells for injection of EHC-L (electron donor), in the basement of the building and in the parking lot. During the initial phase of ZVI injections, ZVI was observed to be daylighting through existing basement floor cracks and in adjacent monitoring wells. In order to address and prevent ZVI daylighting, a denser slurry was injected during a subsequent injection event. EHC-L was injected into the permanent injection wells as well during this second ZVI injection event. During this second event, cracking in the drywall was observed on the walls on the ground floor above the injection area. Injection work ceased and a geotechnical investigation was conducted to assess the cause of the cracking. Based on the results of the investigation, engineered supports were installed to support a structural column that was identified to be a concern. The injections were modified to allow for low pressure injections of EHC-L into dedicated injection wells. The prescribed quantity of EHC-L was successfully injected during the first low pressure injection; however, subsequent injections were not nearly as successful, and the required quantity of EHC-L could not be delivered into the subsurface. A subsequent round of performance groundwater monitoring and sampling was completed 62 days after the EHC-L injection and the analytical data indicated that a cis-1,2-dichloroethylene stall may be occurring. Based on this information, attempting another injection of EHC-L under gravity feed would not drive the dechlorination process forward at the rate that the client would like. In order to inject enough amendment into the ground with adequate subsurface distribution, pressurized injections of ideally 30 psi are needed. Based on the geotechnical limitations of the site, “safe” injection pressures were determined throughout the site based on distances from the various types of foundations. In addition to re-introducing pressure, Dehalococcoides sp. was added to ECH-L. Groundwater monitoring and sampling was completed at 90 and 120 days post injection. At 120 days post injection, selected groundwater samples were submitted for volatile fatty acid (VFA) and Gene-Trac analysis. The VFA analysis indicated that the EHC-L was consumed more quickly than anticipated and the electron donor was changed to a longer lasting one for the next round of injections scheduled in February 2022.

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Kerry-Anne Pumphrey

Kerry-Anne Pumphrey is a senior scientist at BlueFrog Environmental Consulting Inc. and has 19 years of experience in managing contaminated sites across Canada. She has extensive experience with subsurface impacts caused by petroleum hydrocarbons, chlorinated solvents, heavy metals, and road salts. Kerry-Anne's extensive contaminated sites experience has involved hydrogeological modelling to assist in determining the fate and transport of groundwater contaminants. She has experience in using statistical data analysis to assess plume stability and to support long-term monitoring programs. In addition to contaminated sites work, Kerry-Anne has assisted with geotechnical assessments and has managed physical hydrogeological assessments in support of construction projects/property redevelopment throughout Ontario. Kerry-Anne is on the Board of Directors for Women Geoscientists in Canada and is a member of the Ontario Environmental Industry Associations' Excess Soils Sub-Committee.

Underwater Noise Impacts from Remediation Dredging: Best Practices and Mitigation Alternatives

Jonathan Vallarta, SLR Consulting

Mitigating the impacts of human activities on Canada's marine environment is vital to protecting our freshwater aquatic species and their habitats. Noise has long been identified as an environmental impact during the remediation of contaminated soils and sediments. However, when these remedial activities occur in water, there is a much higher probability of a noise impact, as sound travels 4.4 times faster in water than in air. Dredging is a commonly used remedial method for contaminated sediment removal and research has shown that even at low intensities, continuous noise activities from dredging can lead to cumulative noise impacts on sensitive freshwater aquatic species.

The impacts of underwater noise can affect individual species or entire populations differently, but underwater noise has been linked to a wide range of impacts on fish species, including disrupting their normal behaviour; change or loss of their habitat; masking sounds; changes in their physiology and/or stress levels, and permanent injury or even death. Canada currently does not have any federal statutes specifically designed to address underwater noise; instead, Fisheries and Oceans Canada regulate the impacts of underwater noise by specific groups of aquatic species, including fish. Best practices recommend noise thresholds of 150 dB re 1µPa of root mean square pressure for adverse behavioral effects on fish; and 187 dB re 1µPa^2·sec of cumulative sound exposure level for physical injury on fish.

There are several mitigation initiatives that address the problem of underwater noise associated with dredging. Pre-remedial activities may include the use of a sound transmission loss modeling study to generate exclusion zones, action protocols, and seasonal restrictions to prevent the ensonification of sensitive fish species and habitats. Mitigation during remediation can include such activities as the proper maintenance of the propellor blades, damped engine mounting and vessel speed reduction. To mitigate the noise propagation through water, air bubble screens may be used. To avoid exceeding noise thresholds, passive acoustic monitoring is recommended for the entire time dredging operations are being undertaken.

SLR's underwater noise specialist with expertise in noise propagation modeling and passive acoustic monitoring will share some mitigation alternatives and best practices to establish baseline noise levels and conduct passive monitoring during remedial dredging activities in or near water.

Jonathan Vallarta

Dr. Vallarta has eighteen years of underwater acoustics experience in a wide range of positions including teaching, design, project management, acoustic consulting, and collaborative research. He has considerable experience teaching training courses in underwater noise fundamentals and monitoring techniques. In 2018, his experience was recognized as a Mexican guest panelist and advisor at the United Nations in New York. He has a particular interest in marine conservation issues, especially in reference to threatened species, noise pollution and mitigation.

Excess Soils and O.Reg. 406/19 – The Contractors' Perspective

Mike Gawel, Vertex Environmental Inc.

The MECP released Ontario Regulation 406/19 and Soil Rules (O.Reg. 406/19) in December 2019, with the first Phase effective as of January 1, 2021, the second Phase coming into force on January 1, 2022 and, finally, the landfill ban expected to come into effect on January 1, 2025. The intent of this new Regulation like any other is multifaceted, however, a key takeaway is the overriding philosophy that soil should be considered a re-useable resource, not a waste.

One of the obstacles in rolling out any new Regulation is getting the word out, not only to the industry it directly impacts, but also to the general public. Various interest groups within the industry have slowly began to pop up (e.g. QPCO), while other existing groups are doing what they can to increase awareness on the new regulation (e.g. RCCAO – Residential and Civil Construction Alliance of Ontario).

There are many groups within the industry that already have been or will be directly impacted by the new Regulation. This talk will focus on a Contractor's Perspective of O.Reg. 406/19, and more specifically on:

- An overview of the evolution of Regulations in Ontario
- How Ontario plans to implement O.Reg. 406/19 (and what contractor's think of this)
- Why this regulation is coming and why it is important
    - What the implications might be on contractors:
    - How it may impact their day-to-day operations
    - How to understand, communicate and mitigate liability
    - How to work within the limits
- What opportunities might be out there for future business(es)

This talk will key-in on the contractors' perspective of the new O.Reg. 406/19 and how it might impact the environmental industry.

Mike Gawel

Mr. Gawel is a Principal at Vertex Environmental Inc., Director of Field Operations and Project Manager. Mr. Gawel has more than 18 years' experience in the Environmental Field as a contractor, working across Canada, the Middle East and South America, specializing in Site Assessment and Remediation. Mike has been involved with the design and implementation of more than 200 remediation programs since the early 2000s involving ex-situ remediation, PRBs, carbon adsorption, in-situ chemical oxidation and reduction, aerobic and anaerobic biodegradation, etc. in soil, groundwater and bedrock for a variety of contaminants, including petroleum hydrocarbons, chlorinated solvents, metals and other compounds. He has a Bachelor's degree in Biology/Chemistry and is currently an EP and C.Tech in Ontario.

Through the Lens of Recent Environmental Decisions and Legislation: The Ever-Changing Practice of Environmental Law— Parts 1 & 2

Willms & Shier Environmental Lawyers

Environmental law did not escape the ever-changing year that was 2021.

Part 1 - While the pandemic led to shutdowns and delays, Courts and Tribunals across Canada went virtual and decided several notable environmental civil and regulatory disputes.

Part 2 - Governments moved forward with the review, development and amendments of key environmental legislation.

During this 2 part presentation, John Georgakopoulos, Jacquelyn Stevens, Matthew Gardner, and Anand Srivastava will provide highlights that speak to environmental risks and liability during changing and uncertain times.

Speakers

John Georgakopoulos

John Georgakopoulos B.Sc. (Hons.), M.Sc., LL.B., is a Partner at Willms & Shier Environmental Lawyers LLP and is a Certified Specialist in Environmental Law by the Law Society of Ontario. John resolves complex environmental legal issues for clients, uniquely drawing on his technical knowledge as a former senior environmental scientist with Ontario's environmental regulator. John has particular expertise advising property developers, REITs, industrial manufacturers, and municipalities about managing environmental risks and liabilities associated with brownfields and contaminated sites. John provides strategic advice to help protect clients against corporate and personal environmental liabilities including civil claims, regulatory orders, prosecutions and fines. John is called to the Bar in Alberta and Ontario.

Jacquelyn Stevens

Jacquelyn Stevens B.Sc. (Hons.), M.Sc., M.S.E.L., LL.B., is a Partner at Willms & Shier Environmental Lawyers LLP and is a Certified Specialist in Environmental Law by the Law Society of Ontario. Jacquie has significant expertise representing a wide range of clients in environmental civil litigation, defence of prosecutions by environmental regulators, and at administrative appeals and hearings. Jacquie also provides effective advice and solutions for environmental due diligence and compliance, brownfields/contaminated site remediation, and environmental approvals for air, odour, noise and waste. Jacquie advises on cross-boundary migration of contamination and remediation options and has significant expertise involving contamination issues at dry cleaning operations and gas stations. Jacquie is called to the Bar in Alberta and Ontario.

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Matthew Gardner

Matthew Gardner B.Sc. (Hons.), LL.B., is a Partner at Willms & Shier Environmental Lawyers LLP and is a Certified Specialist in Environmental Law by the Law Society of Ontario. Matthew practices environmental law and environmental litigation. He provides advice and solutions about environmental due diligence and compliance to a wide range of clients including industrial corporations, the construction and land development sectors and municipalities. Matthew also provides advice and solutions about contaminated land issues, environmental risk management, environmental transactional due diligence and regulatory compliance. Matthew regularly appears before the Courts and administrative tribunals. He also assists clients under inspection or investigation by federal, provincial and municipal environmental regulators, and defends clients against environmental regulatory prosecutions. Matthew is called to the Bar in Alberta and Ontario.

Anand Srivastava

Anand Srivastava, B.Sc. (Hons.), J.D., is an Associate at Willms & Shier Environmental Lawyers LLP. Anand's practice focuses on environmental legal advice and environmental litigation. With prior education and experience in environmental toxicology, He assists clients to facilitate practical solutions to complex environmental legal issues. He works with a wide variety of clients on issues relating to environmental regulatory compliance with federal, provincial and municipal laws, contaminated sites, environmental due diligence, and exposure to environmental risks and liabilities. He prosecutes and defends environmental civil lawsuits and environmental regulatory prosecutions, orders and appeals. Anand is called to the Bar in Alberta and Ontario.

2020 Remediation Process Guide and CER Remediation Operating Practices Update

Holly Kingston and Adele Houston, Canada Energy Regulator

The Canada Energy Regulator (CER) regulates inter-provincial and international pipelines, international power lines, offshore renewables, the export and import of energy, and tolls and tariffs, as well as oil and gas activities on frontier lands. In October 2020, the CER released the "2020 Remediation Process Guide" (the Guide), which came into force January 1, 2021, and provides the framework for companies to demonstrate they are effectively anticipating, preventing, managing and mitigating adverse effects of contamination related to their facilities. The Guide provides information on the CER process for the submission of remediation process documents and guidance on how to maintain compliance with requirements. The Guide is an update of the first National Energy Board (NEB) Remediation Process Guide that was published in May 2011. Discussion in this presentation will include both background and requirements of the remediation process, Guide contents, and revisions to the Guide from the 2011 version. Updates on the CER Remediation operating practices to be included in the discussion are the public posting of Notices of Contamination and annual updates submitted since August 2018, the collection of information for the Online Event Reporting System, and guidance on reporting third party contamination.

Holly Kingston

Holly Kingston is a Group Leader for remediation within the Field Operations Oversight business unit of the Canada Energy Regulator (CER). She holds a degree in Earth Sciences with a specialization in Geochemistry and a Master degree in Soil Science – Microbiology. Holly has worked in the contaminated sites industry since 2008. She started as an environmental consultant, working in BC, Ontario, Alberta, and Saskatchewan characterizing contaminated sites and conducting risk assessments. In 2016, she joined the CER and has been happily working as an Inspection Officer with a focus on oversight of contaminated site remediation and risk management in the pipeline and powerline industries ever since.

Adele Houston

Adele Houston is a Technical Leader in the Environmental Protection team within the Field Operations Oversight business unit at the Canada Energy Regulator (CER). After working as a risk assessment specialist for 18 years, she joined the CER in 2020 becoming part of the CER's remediation process working group and providing oversight for the remediation and risk management of contaminated sites.

Bioremediation 4.0: What Procaryotic Microbes Can Really Accomplish and the Roll Quorum Sensing and Signaling (QSS) Plays

Kent Armstrong, TerraStryke Products LLC

Purpose Bioremediation 4.0 recognizes the historic importance of planktonic bacteria but reaches beyond by adapting innovative biostimulation strategies, which prioritize supporting the indigenous microbial populations' ecosystem, rather than the individual planktonic bacteria identified to support specific tasks. This new strategy is designed to support growth of microbial densities such that autoinducing signals reach threshold levels to allow intra- and inter-specie communication and the collective abandonment of a planktonic life for a more productive, collective world, as sessile microbes in a biofilm.

Process As densities grow, the collective secretion of biosurfactant-like-compounds also increase to allow expedited solubilization of residual mass contaminants (sorbed, stringer, ganglia), along with peptides and polysaccharides used to develop 'biofilms'. Within biofilms, consortia of bacteria harmoniously realize rates of performance and sustainability beyond planktonic microbes of the same population. For 4.5 billion years procaryotic bacteria, under anaerobic conditions, have collectively communicated, built protective structures that allow enhanced electron transmissivity, expedited horizontal gene transfer, created nutrient sinks, and through endogenous decay, sustained decades of energy utilization. Within a biofilm individuals assume different roles, express genetic material differently, and work collectively to maximize performance. Genetic information is shared 10-100x faster than in bulk water. Water moves >10x faster in biofilm. Biofilm predominates biological life and operates within every ecosystem on the Earth. We as environmental specialists must stop believing our systems operate different from every other biological process on the planet.

The 'treatment zone' is not static but a vibrant ecosystem under stress due to the contamination present. Baseline bulk water analysis classically indicates populations are lacking; bioremediation won't succeed, but the bacteria are there. In response to stressed conditions, microbes adopt a starvation strategy and become Ultramicrobactria (UMB). When the ecosystem is supported and restored, UMB and their single strand of acclimated DNA re-emerge.

Summary Procaryotic bacteria may be limited to a single strand of DNA and no nucleus, but they aren't loners, solitary or, 'dumb'. Ask an infectious disease expert who for years recognize these beings are incredibly capable of achieving growth and behavioural patterns that defy modern medicine and mitigation technologies, realizing their value not as an individual but rather, as a consortium of intra-inter-specie microbes collectively maximizing the utilization of available protons/electrons.

Conclusion Change is occurring in the remediation industry; there is existing QSS awareness that we must catch up with. We at TerraStryke strive to be pioneers in promoting Bioremediation 4.0 and the need to focus on the holistic ecosystem based on the concept of collective communication and information, electron, and resource sharing amongst the consortium of bacteria, not planktonic.

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Goal Spur environmental remediation/monitoring industries to move forward with that the wastewater, medical, dental, and oil production industries have realized for decades: the individual planktonic microbe and what they do is not the concern; rather, it's what planktonic microbes accomplish when QSS is supported, and they reside in a collectively constructed housing referred to as a 'biofilm'.

Kent Armstrong

A Graduate of California State University Long Beach, 'The Beach'; B.S. Terrestrial Ecology (Zoology), minor in Philosophy/Religious Studies, with Graduate Studies in Palynology (fossil pollen) and Paleoecology.

Numerous jobs as a butcher, human anatomy instructor, ravioli maker, warehouse and parts dispatch operator...real work began with the Los Angeles County Sanitation District as Plant Laboratory Chemist and then as a Treatment Plant Operator.

Over the next 35 years, Kent would work for and aid both government and corporate businesses with remediation strategies as a contractor, consultant, and general nice guy.

The culmination of these experiences afforded Kent the opportunity to participate in a wide variety of environmental investigation, remediation, and management projects combining numerous methods of physical, chemical, and biological strategies. . .

It also, 20+ years ago, introduced him to his patent partner, Richard Schaffner. Together, it led from a far-fetched concept to the formation, in 2008, of TerraStryke Products LLC.

Since then we have efforted the development of sustainable biostimulation additives designed to leverage existing site conditions and enhance indigenous microbial populations to realize safe, low-impact and cost-effective destruction of organic soil and groundwater contaminants, mimicking that which Mother Nature has done in every other ecosystem on the planet.

Combined Remedies Approach Tackles Large DNAPL Solvent Site

Mike Mazzarese, AST Environmental, Inc.

This U.S. site had been substantially contaminated since the 1950s. Compromised drainage pipes were assumed to be the source of chlorinated solvent contamination in both the saturated and unsaturated zones. High density remedial design characterization (RDC) activities pinpointed a zone of concern between 2.5 meters (m) and 14 m below the ground surface. Sampling revealed TCE concentrations as high as 730 mg/L in groundwater and 5,350 mg/kg in soils.

In 2013, AST Environmental executed a RDC that consisted of: surface geophysics, collection of 186 soil samples from 26 boring locations, and 31 groundwater samples. The intelligence gathered was used to design a permeable reactive barrier (PRB) to reduce the off-site contaminant migration of contamination, an unsaturated soil mixing program that treated over 2,150 cubic meters of source level TCE impacted soil, and an injection program to treat DNAPL level impacts in the saturated zone upgradient of the unsaturated source area.

The PRB injection took place in 2014. Activated carbon impregnated with reactive iron was selected due to the concentrations present, longevity, and the need to limit daughter product generation downgradient of the PRB. The technology selected for the in-situ soil mixing phase of the project was sodium permanganate. This technology was selected based on longevity in the subsurface and that no activation or catalyst would be needed. In 2019 it was clear that upgradient contaminant mass was present in the saturated zone at concentrations requiring a more robust in-situ treatment approach. A modified version of the activated carbon based technology implemented for the PRB was selected. An electron donor, nutrients, and bacteria were injected along with the iron impregnated activated carbon in the Spring of 2020.

Significant reductions in unsaturated and saturated soils and in groundwater have been observed to date. Groundwater TCE concentrations have been reduced 98-100% and TCE soil concentrations have decreased 97% on average.

Mike Mazzarese

Mike has been involved with in-situ remediation for fifteen years having worked within the remediation compound and environmental consulting community his entire professional career. His role as Senior Engineer at AST involves project assessment and design, field implementation oversight, and post project data analysis. Mike is a graduate of Penn State University holding an MS degree in Environmental Engineering. He has previously worked for Vironex, Regenesis and URS.

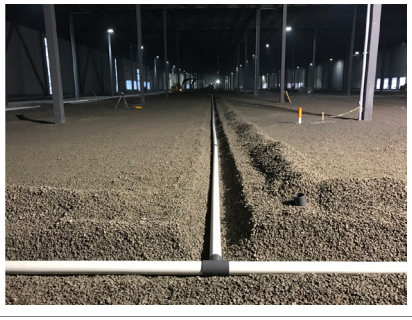
Large Scale Sub-Slab Vapour Intrusion System (A Case Study)

Devin Rosnak, Ground Force Environmental Corp
Frank Schlaefli, Pinchin Ltd

The objective of an SVIMS is to address/mitigate the migration of impacted soil vapour entering the overlying building(s) by generating an adequate negative pressure field underneath the floor slab relative to the pressure in the occupied areas above the floor. SVIMS for new constructions typically consists of the installation of a vapour collection pipping network below a sealed chemical-resistant vapour membrane system. The SVIMS can then be vented passively relying on a stack effect and pressure differential of the building or actively through a blower network which produces a negative pressure beneath the building floor.

Pinchin Ltd. (Pinchin) was engaged to complete the design of a large-scale SVIMS in Ontario, Canada for a proposed building that was planned to be constructed in the area where a potential for VI was present. Pinchin completed a preliminary feasibility evaluation that included feasibility and cost analysis of multiple SVIMS alternatives. Following the preliminary evaluation and the selection of the appropriate SVIMS, Pinchin prepared the design package that included design calculations, detailed design drawings prepared in consultation with the client's design-build team, and specifications for SVIMS installation. In addition, Pinchin prepared the field inspection forms, developed the QA/QC protocols for inspecting the SVIMS installation and warranty purposes, completed a final performance evaluation of the SVIMS, system commissioning and associated operations, maintenance and monitoring plans.

Ground Force/GFL was awarded the contract for the installation of the SVIMS. The SVIMS covered the entire building footprint measuring 25,000 m^2 (270,000 sq ft). The SVIMS consisted of a vapour membrane, vapour collection system and vapour venting system. The vapour membrane was manufactured by E. Pro locally in Hamilton, Ontario, and consisted of a base layer HDPE membrane, followed by a 60 mil (1.2 mm) thick layer of spray-on chemical resistant membrane, followed by the protective HDPE layer, which would normally be bonded to the concrete to be poured directly above. The vapour membrane had to accommodate numerous utility penetrations that required sealing around these penetrations. This system was selected not only for its vapour performance but also for its strength and resistance against punctures. The vapour collection system of the SVIMS consisted of nearly 2,000 linear m (21,500 linear ft) of slotted soil vapour collection pipe embedded in a layer of gravel. The vapour venting system of the SVIMS consisted of six soil vapour extraction points connected to 6 inline fans venting to the atmosphere at the roof.



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One of the largest challenges was adhering to a dynamic schedule and working in concert with the gravel supply contractors, utility contractors, and coordinating the timing of installation before the numerous concrete pours the project underwent. This project was completed in 3 months and is known as one of the largest commercial SVIMSs in Canada.

After the SVIMS commissioning, Pinchin has been completing on-going monitoring of the indoor air quality and no exceedances to the applicable indoor criteria has been identified. The indoor air results conclude that the SVIMS is performing as designed and the risk to human health via the vapour inhalation pathway has been mitigated at the Site.

Devin Rosnak

Devin graduated from Trent University with Honours in Bachelor of Science Environmental & Resource Science program, and since has over 15 years of technical sales and client management experience in the environmental industry. In addition to client management and sales services, Devin has experience in Project Management of remedial programs. As the Business Development Manager at Ground Force Environmental Corp (GFL), Devin's experience and expertise is managing project relationships relating to Brownfield Development, and Contaminated Sites Remediation. His understanding and extensive list of industry contacts has been a valuable asset in assisting end user stakeholders connect with the resources and contacts needed to move complex projects forward.

Frank Schlaefli

Frank Schlaefli is Pinchin's National Soil Vapour Practice Specialist and a Team Lead with the Environmental Due Diligence & Remediation group based in Mississauga. He has over 14 years of experience in environmental assessment and remediation of contaminated sites. Frank graduated from the University of Agrarian La Molina -Peru in 2007 with a Bachelor of Science in Environmental Engineering. At Pinchin, Frank provides technical, business and client development initiatives through knowledge-based services in the area of soil vapour mitigation for existing and new construction buildings. Frank enjoys the problem-solving aspect of the work which is one of the key skills required in the assessment and design of the soil vapour mitigation systems.

Leveraging the Synergies of Molecular Biological Tools and CSIA for MNA and Enhanced Bioremediation Assessment

Phil Dennis, Sandra Dworatzek and Brent Pautler, SiREM
Anko Fischer and Kevin Kuntze, Isodetect

Assessing natural attenuation potential, progress and degradation rates is critical for decision making regarding the feasibility of both enhanced bioremediation remedies and monitored natural attenuation (MNA) remedies for sites with chlorinated solvents, petroleum hydrocarbons, 1,4-dioxane, and other contaminants. While numerous tests are employed in evaluating remediation processes the combination of compound-specific isotope analysis (CSIA) and molecular tools can be particularly useful. CSIA indicates the extent of degradation and quantifies bond breaking processes over non-degradative losses such as sorption. CSIA also has the potential for estimating long-term degradation rates. Molecular tools, including quantitative polymerase chain reaction (qPCR) tests and next generation sequencing (NGS) quantify key biodegradative microorganisms, functional genes and whole microbial communities, providing insights into whether observed degradation can be explained by biotic processes. CSIA and molecular tools are tertiary lines of evidence in MNA protocols, and provide compelling data to answer the questions (1) Has degradation occurred and to what extent? and (2) Which microbes are responsible for any observed biodegradation?

This presentation will provide examples of where CSIA and molecular genetic data were collected from several sites undergoing enhanced bioremediation and MNA assessments. The CSIA data (mainly for carbon: $^{13}C/^{12}C$ as $\boldsymbol{\delta}^{13}C$) was used to determine if contaminant degradation processes were evident, or absent, based on enrichment of the heavy isotope in the remaining undegraded contaminant fraction. Corresponding molecular genetic data, including qPCR was used to determine if biodegradative microbes were present at sufficient quantities to meaningfully impact contaminant degradation. In several cases, CSIA and molecular genetic testing data indicated natural attenuation processes were occurring and clarified complex biotic and abiotic remediation processes. At an Alaska site, trichloroethene to ***cis***-1,2-dichloroethene (cDCE) degradation was conclusively confirmed by CSIA but further cDCE degradation by reductive or oxidative processes was inconclusive. By correlating the extent of ^{13}C-enrichment in cDCE with the proportion of dechlorinators, as determined by molecular tools, the case for natural attenuation of cDCE was more compelling. At an enhanced bioremediation site in Kansas, biodegradation of 1,1,1-TCA was confirmed even at locations where concentrations were increasing due to increased mass flux. At a site in Denmark a complex combination of reductive dechlorination abiotic degradation by iron sulfides and aerobic bioremediation was indicated by CSIA and molecular data.

Overall, the combination of CSIA and molecular tools allows conclusions to be drawn on enhanced and natural attenuation processes that are not easily arrived at by using other analytical methods.

Phil Dennis

Phil Dennis is Principal Scientist at SiREM where he has worked for over 20 years. Phil holds a Masters of Applied Science, Civil Engineering University of Toronto, and Honours Bachelor of Science, Molecular Biology and Genetics from the University of Guelph. Phil has almost 30 years of experience in research and development and management of molecular biology, microbiology, and environmental remediation laboratories. Phil currently manages molecular genetic testing services and is innovation lead for SiREM's research and development program and leads multiple research and development projects.

(The) Multitude of Uses for Plant Growth Promoting Bacteria in Soil Remediation and Site Management

Elizabeth W. Murray, Earthmaster Environmental Strategies Inc

Plant growth promoting rhizobacteria (PGPR) help plants to grow in stressful conditions, facilitating seed germination and plant growth in contaminated and/or poor quality soil. Contaminated soil is often remediated by excavating it and disposing in a landfill facility. Treating the soil using nature-based methods is a sustainable way of remediating the contamination to conserve the soil, reduce the carbon emissions associated with hauling to a landfill or treating using other energy intensive methods, and reduce industry dependence on landfills. Earthmaster's PEPSystems® bacteria/plant phytotechnology adds PGPR to seeds and plants, then uses the hyper-accumulation properties of the plants for salt and trace metal uptake, and the carbon consuming properties of the bacteria to breakdown petroleum hydrocarbons to non-toxic components. This system also facilitates plant growth in reclamation applications, where contamination may be left in place as a strategy for risk based site management and where soils may have naturally elevated parameters such as salinity.

This talk will review results from both laboratory and field trials to assess the applications of PGPR for phytoremediation of salt and/or hydrocarbon contaminated soil. An industrial site case study from two sites in Northern Alberta and a case study from a site in Southern Alberta will be presented detailing the use of phytoremediation to biodegrade fraction F2 hydrocarbons (up to 3,100 mg/kg) and fraction F3 hydrocarbons (up to 2,400 mg/kg). Trials involving the use of PGPR for re-vegetation in soil containing elevated salinity and extremely poor quality soil will also be discussed. These case studies look at an agricultural site in Saskatchewan with chlorides up to 12,000 mg/kg and a commercial site in Alberta looking to install PGPR treated grass as a method of controlling salt accumulation from effluent release. The positive effect of PGPR on native grass plug growth and establishment, the growth of white spruce and paper birch trees in laboratory and field trials for forested area revegetation applications, and the establishment of native species on roadway green spaces will be discussed as a strategy for site management.

Elizabeth Murray

Elizabeth W. Murray, Ph.D., P.Biol., R.P.Bio. – Elizabeth Murray is a senior scientist with Earthmaster Environmental Strategies in Calgary, Alberta. She is a graduate of Lakehead University in Thunder Bay, Ontario and Queen's University in Kingston, Ontario. She has a Ph.D. in human genetics and she has worked for more than 20 years in medical related research and in plant based biotechnology, developing biologics as treatments for human diseases. Elizabeth has worked in environmental sciences for 10 years and plays a lead role in the analysis and reporting of phytoremediation research and results. She also manages the research and development of Earthmaster's PEPSystems® technologies.

Coauthors: Michael Quesnel, Ben Poltorak, Bruce Greenberg, Kent Cryer, Adam Dunn and Perry D. Gerwing

Partitioning and Storage of Per-and Polyfluoroalkyl Substances Considering Precursors and Multi-Bilayer Supramolecular Assemblies in Unsaturated and Saturated Zones of Fire Training Areas

Ian Ross, Tetra Tech

Background There are current uncertainties regarding why AFFF impacted soils and concrete surfaces retain a significant mass of PFAS which continues to leach for decades following cessation of AFFF use. Multiple site investigations where assessment of per- and polyfluoroalkyl substances (PFAS) at fire training areas using advanced characterization tools, such as the total oxidiseable precursor (TOP) assay, have determined that high concentrations of PFAS, including elevated concentrations of cationic and zwitterionic precursors are present in superficial soil and vadose zone. As PFAS have been described to self-assemble into supramolecular forms in bilayer films, this phenomenon is considerd to be reposnsible for their retardation and storgae in source zones.

Approach. A detailed literature review of publications considering the behavior of fluorosurfactants was performed to shed light on their partitioning behavior. Self assembly phenomena exhibited by amphiphillic fluorosurfactants at higher concentrations, driven by entropic forces was assessed as the potential driving mechanism behind the observed sorption. PFAS are known to self-assemble to form large supramolecular assemblies, at interfaces and via nucleation. Self-Assembled PFAS (SA-PFAS) structures have been described to be similar to crystalline solids and have been shown to grow to form 500 micron sized supramolecular assemblies over a 4-month period. These assemblies have been demonstrated to form at solid-liquid interfaces at concentrations some 5 orders of magnitude lower that PFAS critical micelle concentrations (CMC). From examination of the physical chemistry of PFAS it is considered that when they are dispensed in AFFF they coat solid surfaces with SA-PFAS, via the repeat formation of Langmuir-Blodgett films and that this mechanism is potentially responsible for storage of PFAS at interfaces in the vadose zone. In the saturated zone at FTAs relatively high concentrations (mg/L) of dissolved PFAS will concentrate at solid-liquid interfaces leading to the potential for SA-PFAS to form. The supramolecular assemblies formed by SA-PFAS are considered to be an important reservoir of PFAS at FTAs, as they can potentially comprise millions of quasi-crystalline bilayers, which slowly release PFAS. The resence of these structures needs to be consideried when planning site investigations and their beaviuor will be important when assessing remedial options.

Ian Ross

Ian Ross, Ph.D., is a Technical Director and Global PFAS Practice Lead at Tetra Tech.

Ian has focused solely on PFAS management in a global rile for the last 8 years after first evaluating solutions to manage PFOS in 2005. Ian works for Tetra Tech as a technical expert for assessment of contaminated land sites and PFAS decontamination. Ian has published over 30 articles, academic publications and book chapters on PFAS analysis, site investigation and remediation, including a recent book entitled Emerging Contaminants Handbook. He was the first to apply the total oxidizable precursor (TOP) assay commercially and has acted as expert witness for governments looking to manage PFAS.

Assessment, Remediation, Capping and Closure of a Former Construction & Debris (C&D) Landfill Site, Harrietsfield Nova Scotia

Rob McCullough, AECOM Canada Ltd.
Wilf Kaiser and Donnie Burke, Nova Scotia Lands Inc.

Background/Objectives: The objective of this paper is to discuss a project AECOM has completed with NS Lands Inc. to remediate a long-standing public concern with respect to the development of and the impact from a C&D landfill site located adjacent to a residential location near Halifax, Nova Scotia. The paper discusses the existing environmental conditions both onsite and offsite in part resulting from the existence of a former Construction & Debris Landfill. The study included the review of several years of monitoring data and site works, a field assessment program to examine waste locations, types and characteristics as well as to study and understand site geological, geochemical and hydrogeological conditions for the purpose of providing to the crown a recommendation for an effective site closure strategy within the Nova Scotia Contaminated Site regulations pursuant to the Nova Scotia Environment Act. Construction debris taken in by the site was ground up into fragments, stored in piles and placed in a partially lined containment cell. Once the cell was complete, the cap soil material overtime became desiccated and allowed precipitation to infiltrate the cell and dissolve and transport a chemical species through the cell into the fractured rock. This species, it would appear, played a part in dissolving uranium from the parent rock and likely impacted the groundwater to some extent and thus nearby production wells. Well water treatment systems and supply of bottled water to the community is currently being undertaken. This area has had a significant history of poor-quality groundwater prior to any development at the site although it is likely the site has contributed to the problem.

Following the closure approach determination, project work included leachate removal from the cell and the onsite treatment of the liquid concurrent with the design and tender specification development for the site closure. Subsequent project initiation for site remediation involved the collection and sorting of waste for diversion/recycling, the disposal both on site in the cell and off site at approved waste facilities, the site reclamation, regrading, drainage control, leachate management and capping of the landfill cell with an impermeable synthetic turf.

This paper presents an overview of the property, the site investigation, data review, closure assessment and engineering required for the development of a sensible but scientifically effective and publicly acceptable closure plan for the landfill site. It discusses how the Province involved the public, especially the nearby stakeholders in the process outcome and will outline how the province was successful in involving federal agencies to secure funding both Provincial and Federal for the successful closure of a landfill project through the federal/provincial governments greening initiatives and within the mandate of the greenhouse gas reduction and climate change resiliency objectives.

Rob McCullough

Rob is a Senior Technical Lead in AECOM's Halifax office and a Senior Remediation Scientist in the Geoscience – Division - Environmental Practice in Canada. Rob has 38 years of experience in management, co-ordination and facilitation of large emergency response and remediation projects in Canada both in the south and across the Northwest Territories and Nunavut. Rob was the Technical Director and the Senior Technical Lead for this Landfill Closure Project.

"How much is enough"
Design Factors for In-situ Chemical Remediation

Jevins Waddell and Oskar Pula, TRIUM Environmental Inc

When designing in-situ remediation projects using chemical reagents, the burning question remains: "how much is enough". There are many experts in this field and many have a method or model that they lean toward in designing these programs. Which one is going to give the highest degree of certainty? Does the perfect one exist? We know that not all contaminants are equal nor are the chemicals used to treat them, so coupled with application and site specific factors, this can makes the selection process very tricky. As a result, benchscale tests are often conducted, but do we really know what this is telling us? Can this small scale model reflect real world situations? Is the result "certain" and what happens if it isn't?

This presentation will showcase several models for evaluating chemical dosing and discuss some methodologies of benchscale testing. We will use case studies to show how calculated dosings outperformed, met targets or underperformed in different circumstances and try to explain the possible complimentary or complicating factors. The site examples will ultimately demonstrate how managing uncertainy in highly variable environments is possible, but how each situation often requires a unique solution.

Jevins Waddell

Mr. Jevins Waddell, P.Tech.(Eng.), is a Principal of TRIUM Environmental Inc. He has over 19 years of environmental industry experience in consulting and contracting with a focus on alternative remediation approaches and projects. He is also focused on the research, development, and commercialization of environmental technologies through independent and collaborative initiatives. His experience includes projects throughout Canada, South Korea, China, and Yemen.

Oskar Pula

Mr. Oskar Pula, M.Sc., PAg. is the General Manager, Contaminated Site Services at TRIUM Environmental Inc. He has over 11 years of environmental industry related experience conducting assessment and remediation programs at Oil and Gas and Brownfield sites across Western Canada. Mr. Pula received his Master's in Environment and Management from Royal Roads University with a thesis focused on drilling waste remediation using oyster mushrooms. Mr. Pula's expertise includes the design, management, and execution of projects and initiatives related to alternative and conventional remediation, research and development of proprietary/ patented technologies, and overall operations management within TRIUM.

In-Situ Permeable Reactive Barrier Remediation Optimization using High Resolution Site Characterization Tools – A Case Study

Patrick O'Neill, Vertex Environmental Inc

Off-site liability and risk mitigation from subsurface impacts have become a key focus of the environmental industry. A common remedial technology to address off-site liability and risk mitigation involves the installation of a Permeable Reactive Barrier (PRB). Reasons for this resurgence in PRB popularity can be traced back to improvements in remedial amendments and technologies, sustainability and major improvements towards efficient, detailed Site characterization. Previous PRB installations largely relied on site wide information or information collected sporadically along the alignment to make decisions on design and installation details. Relying on limited information to design and install a robust PRB may lead to unintentional "holes" in the PRB or overdesigned and higher costs for the stakeholders involved.

Optimizing these remedial designs to achieve the project objectives and balance the costs of the project can be a challenging proposition without sufficient data along the PRB alignment. High Resolution Site Characterization (HRSC) tools have been developed, deployed and used on many sites in Canada and around the world. The ability to capture thousands of data points relating to contaminant presence, type, magnitude and distribution in the subsurface as well as detailed measurements of subsurface permeability heterogeneities from a single probe point is invaluable for robust PRB design. The data collected by the HRSC tools, coupled with targeted analytical data, can allow the PRB design to be optimized for an effective and cost-efficient solution.

This presentation reviews two case studies where HRSC tools were deployed and compared to targeted analytical data to design and implement PRBs. Furthermore, this presentation will discuss the potential information data gaps that would have arisen if just traditional methods were used to collect data for the PRB designs. Additionally, the final optimized designs that were completed are compared to the theoretical PRB that would have been designed if data from the HRSC tools were not included to highlight potential pitfalls and optimization strategies for these in-situ remediation programs.

Patrick O'Neill

Patrick O'Neill, M.A.Sc., P.Eng. is a project manager at Vertex Environmental Inc. and has over 12 years of experience in environmental engineering. Patrick manages the high-resolution site characterization division and has years of experience designing and implementing high resolution site characterization programs targeting chlorinated solvents and petroleum hydrocarbons. Mr. O'Neill holds a Master's degree from the University of Waterloo where he studied groundwater modeling of the Grand River watershed and how climate change scenarios will affect the watershed.

Prairie NSZD: A Comparison of NSZD Rates Across Eight Sites Using New High-Data density Technology

Steven Mamet, N Higgs and, S Siciliano
Environmental Material Science, Inc

Natural source zone depletion (NSZD) has emerged as a practical alternative for restoration of light non-aqueous phase liquid (LNAPL) sites that are in the later stages of their remediation lifecycle. Site owners and managers are increasingly adopting this as a viable approach towards site closure. This has driven demand for high-density data to better characterise patterns and processes underlying NSZD at daily to seasonal timescales. At EMS we have developed an economical and robust sensor suite ("Soil Sense") that facilitates construction of networks within and surrounding LNAPL plumes. These networks allow high-resolution spatial and temporal quantification of LNAPL plume dynamics (extent and persistence) as well as biological processes associated with natural attenuation (e.g., methanogenesis, methanotrophy). Here we present an analysis of NSZD from eight sites across Saskatchewan and Alberta. The data were collected at 30-minute intervals and include gas flux (CO_2, O_2, CH_4), pressure, air and soil temperatures, relative humidity, and petroleum hydrocarbon vapour concentrations. NSZD rates varied as a function of site and LNAPL plume characteristics. The high-temporal resolution data generated robust estimates of plume areal extent, volume, and mass, NSZD rates, and time to closure. Moreover, while NSZD rates slowed during soil freeze-up, they were non-zero, which affords users a more nuanced and robust picture of natural attenuation at their site over seasons to years.

Steven Mamet

Steven is a quantitative ecologist with a focus on microbial ecology. He has spent the last 20 years studying environmental and ecological change natural and disturbed environments. Using a diverse suite of research approaches from citizen science to machine learning, Steven has developed a deep toolkit for analyzing and visualizing pattern and process along environmental gradients.

Temporary Mobile Water and Wastewater Treatment Systems for Environmental Remediation: A Contractor's Perspective

Nishil Mohammed, GFL Environmental

Water contamination can occur due to a wide variety of activities including industrial, municipal, agricultural, residential, and commercial applications. Often technologies used for remediation of the contaminated water are unique to the site-specific contaminants of concern (COC) being treated. Hence, custom-designed water/wastewater treatment systems (WTS) encompassing different technologies need to be utilized for each specific site. Temporary and mobile WTS are the most viable option for successful on-site remediation of contaminated water, especially in the case of projects that are time-sensitive and have a limited land footprint for the installation of WTS. A significant advantage of these WTS is that the process design can be easily tailored depending on the flow rate and level of treatment required as per the discharge guidelines to be met or reuse water quality criteria. Temporary and mobile WTS have been deployed worldwide to treat water contaminated with suspended solids and other COCs such as total/dissolved metals, volatile/semi-volatile organic compounds, polyaromatic hydrocarbons, petroleum hydrocarbons, emerging contaminants and many others. There are several advantages to using these systems for projects such as construction dewatering, brownfield land development, stormwater pond management, Per- and polyfluorinated substances (PFAS) contaminated groundwater remediation and industrial spill/process/wastewater collection pond remediation. Ground Force Environmental Corporation (GFEC), A GFL Company, is an experienced environmental remediation contractor, has successfully commissioned and operated several temporary and mobile WTS at environmental remediation sites across Canada for both public and private sector clients.

This conference paper will provide a brief overview of one such project where GFEC helped a high-profile client at a confidential site with the design, construction, and operation of a temporary and mobile WTS. The objective was to treat 250,000 m^3 of contaminated water from excavation and dredging operations at a site where environmental remediation was ongoing. The challenge was to treat the water contaminated with total suspended solids (TSS) and heavy metal ions including copper and zinc to meet the stringent Provincial Water Quality Objectives (PWQO) before being discharged to the lake. The major components of the GFEC operated treatment process consisted of an inlet tank, sand filters, a pH adjustment tank, flocculation mix tank, disc filter, activated carbon vessels, acid tank, equalization tank and discharge pump to a submerged diffuser in the lake. GFEC was able to optimize the chemicals such as sodium hydroxide, sulfuric acid and polymers as required to used in the treatment process, In addition to this, GFEC performed the effluent sampling and compliance monitoring for reporting to the Ministry of Environment and Climate Change (MOECC). During the entire course of the project, GFEC successfully operated the WTS at a flow rate of 500 US-GPM for 24 hours a day seven days a week while simultaneously meeting the stringent guidelines as per PWQO that allowed the discharge of treated water to the lake. The operational constraints and various other challenges faced by environmental remediation contractors such as GFEC while executing challenging projects like this will also be discussed in this conference paper.

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Nishil Mohammed

Dr. Nishil Mohammed is a water/wastewater specialist having experience working with various stakeholders in the environmental industry, such as consulting, contracting and R&D organizations in Canada, the United States, and India. He is currently working as a project manager with Ground Force Environmental and leads the water and wastewater treatment projects for the Technologies Division. He manages the design, build, and operation of groundwater, stormwater, and industrial wastewater treatment systems for private and public sector clients. Most of his work has been problem-solving to achieve the treatment goals for industrial wastewater and construction dewatering discharge/re-use using advanced knowledge obtained from the laboratory, bench-scale, and pilot-scale treatability testing studies. In addition, he is knowledgeable about the provincial and local water quality guidelines required to be met before the discharge of treated water. He is also an inventor of two patented water treatment technologies and author of 10+ journal/conference publications.

Use of Risk Assessment to Develop Remediation Goals

Karen Bechard, Meggen Janes and Ashkan Arefi
Geosyntec Consultants, Inc

Regulatory remediation goals are to remove or manage contamination in order to reduce risks to humans and ecological receptors to acceptable levels. Risk assessments (RA): 1) evaluate the potential risks to human health and ecological receptors associated with impacted media at a Site, and 2) develop site specific standards/guidelines that are protective of these risks. As a result, a RA is indubitably entwined with the development of remediation goals that are protective of current and future receptors. Remediation goals are typically met by: 1) remediation down to the generic standards level (Tier 1); 2) remediation down to standards developed on a site-specific basis (Tier 2 or Tier 3); and/or 3) inclusion of institutional or engineered controls to manage the potential risk (Tier 2 or Tier 3 with risk management measures). This presentation compares how RA can be used to develop remediation goals under several regulatory regimes in Canada. It will highlight how this can provide relief from using the conservative generic standards/guidelines for remediation since it allows the use of site-specific clean-up targets. This can result in significant cost savings. The challenges encountered with different remediation approaches and meeting site-specific standards/guidelines will be explored. Case studies will be provided to illustrate the application and benefit of understanding the RA framework in the process and cost-benefit of the coupled RA and remediation strategy.

Karen Bechard

Karen Bechard is a Risk Assessor (QPRAOntario) and toxicologist based in Ontario with more than 12 years of experience in the environmental consulting industry. Her areas of expertise include human health and ecological risk assessment and toxicological review, evaluation of risk management measures (RMM) and data quality assessments. Her risk assessment portfolio includes many projects under Ontario Regulation (O.Reg.153/04), as well as risk assessment projects in other jurisdictions (United Sates [CERCLA/RCRA], Australia, elsewhere in Canada). Ms Bechard is regularly consulted on in the capacity of toxicologist when reviewing potential impacts to environmental receptors at points of compliance. Ms. Bechard is also involved in many research and development projects focused on treatability options of groundwater/wastewater/pit water contaminants. Participation in the conceptual design of many treatability studies for water, sediments, and mine tailings through to pilot and full-scale systems has provided a solid understanding of data collection and data quality needs. Ms. Bechard is also an integral team member in the characterization of natural carbon sources and selenium and nitrate reduction in mining bioremediation treatment systems.

De Beers Victor Mine Demolition Project – Remote and Challenging Locations

Enrique Bayata, Priestly Demolition Inc

The De Beers Victor Mine demolition project is part of the decommissioning plan of the former open pit diamond mine by the De Beers group of Canada. The full scope included the demolition of 55 buildings including the processing plant, primary crusher, mechanical shop, construction camps, mining offices, water storage tanks, maintenance shops, pumping modules, pit perimeter power lines, transfer station and reclaim station. The work site was located in the James Bay Lowlands of Northern Ontario, approximately 90km west of the coastal community of Attawapiskat First Nation. One of the main challenges was the remote location of the site with no access roads and the closest urban center 515 kms away, the site developed as a "fly-in/fly-out project". As part of the mobilization and demobilization to and from site, a Hercules plane program was developed to fly the necessary machines, material and attachments. Machines had to be disassembled and adapted to fit into the Hercules plane. A total of 34 loads (each approximately 40,000 pounds) were flown to and from the site during the two phases of this program. In addition to the equipment and materials, a 2-week rotation shift, 7 days a week, 12 hour days schedule was developed that required all personnel and supplies to be flown in on -chartered flights. To reduce the manpower that had to be flown in, Priestly hired and trained workers locally providing skill development and job opportunities to a predominantly indigenous community. Additionally, there were zero recordable incidents in 88,571 man hours. One of the priorities of the project was to have minimal environmental impact. To salvage as much material as possible, PDI developed a plan where all salvage materials were taken to a lay-down area where they were stored, processed and prepared to be shipped out via ice-road at a later date. Most of the demolition was carried out by heavy equipment and supported by a team of torch persons and fire watch personnel who cut and processed the heavy steel for shipment off site. The largest portion of the job was the demolition of the process plant. A 4,500 sq m, 28 meters tall building with a variety of mining equipment inside. Another challenge faced was the extreme cold temperatures, its effect on the workers and the steel structures. The main heating system of the building was disconnected ahead of the demolition. Therefore, PDI managed to create a budget-friendly solution by reusing small heat cannons that were refitted from the mining site allowing the torching crews and machines to do bursts of work inside the plant so that no one was in the cold for an extended period of time.

The end goal of the project was to return the site to a functioning ecosystem, site closure objectives and site rehabilitation. PDI was awarded the World Demolition Award 2021 for this project.

Enrique Bayata

Enrique Bayata is an experienced demolition professional that has worked for the last two decades across North America in the demolition and remediation industry. In 2019, he joined Priestly Demolition and is currently the General Manager of West Coast Operations. Enrique enjoys helping clients find innovative solutions in challenging projects and creating long-lasting partnerships. He has been part of several multi-million dollar projects including the 2021 World Demolition Award winner - The De Beers Victor Mine Demolition Project.

A native of Mexico City, Mexico he attended University of Cincinnati where he graduated with a Bachelor's degree and two Master's degrees. He swam internationally for the Mexico National Team and the University of Cincinnati. He currently lives in Calgary, AB with his wife Sara.

First to Field Mass Mixing In-Situ Stabilization/ Solidification Remediation in Uncharted Waters of Kendall Bay

Dogus Meric, Chris Robb and Phil Hutson
Geosyntec Consultants, Inc

Background/Objectives Once home to the largest manufactured gas plant (MGP) in the southern hemisphere, the former MGP site was remediated and developed for medium density residential use almost two decades ago. With an area of the shoreline declared a "Remediation Site" by NSW EPA, Jemena subsequently prepared a Voluntary Management Proposal for remediation of sediments within the adjacent Kendall Bay impacted with hydrocarbons (polycyclic aromatic hydrocarbons, total recoverable hydrocarbons, and BTEX) by former MGP operations. The adjacent residential land use presented challenges for developing a remedial approach that addressed the impacted sediments while minimizing impacts to adjacent residents. For this reason, in-situ stabilization/solidification (ISS) of impacted sediments and subsequent capping was selected as the preferred remedial approach for the site, rather than traditional dredging. This method allows management of nuisance odour and minimization of truck traffic. This presentation provides an overview of the technical and design approach to move this project from a laboratory bench-scale treatability study to full-scale field application in an expedited manner, and presents invaluable lessons learned in overcoming many unexpected technical challenges.

Approach/Activities A multi-stage laboratory treatability study was performed to identify the optimum mix design evaluating a range of cementitious reagent dosages, grout modifiers, and enhancers to achieve the performance criteria for the remedy. Following the treatability study, a two-phase pilot study was designed and implemented to assess the constructability, construction approach, and field verification of the remedy effectiveness. Based on the comprehensive site-specific data collected during laboratory treatability and field pilot studies, Geosyntec developed a tiered validation plan using a multiple lines of evidence framework to allow pass/fail determination within 2 to 7 days from field mixing and received regulatory approval. In addition, Geosyntec performed the detailed design of the full-scale remediation. The additional design elements consisted of quantitatively establishing a soft sediment buffer zone to mitigate excess surface water ingress to the mixing zone, and associated means and methods to reduce mixing energy. The full-scale ISS remediation was commenced in early 2020. Geosyntec oversaw the ISS works, provided on-site support to address unexpected challenges encountered in the field in real-time by collectively developing technical solutions to fine tune the ISS implementation and validation process to meet project schedule. Full-scale ISS remediation was completed in November 2020.

Results/Lessons Learned It is understood this project is the first field implementation of ISS remediation of subaqueous sediments using mass mixing techniques. Geosyntec team demonstrated that ISS can be successfully implemented in subaqueous sediments, breaking new ground in the use of innovative sediment remediation technology. The project was completed two months ahead of schedule and under budget in the midst of COVID-19 restrictions and lock-downs. Upon completion, the project received two Australasian Land and Groundwater Association Industry Excellence awards, two Australian Institute of Project Management awards, and Edison award in 2021.

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Dogus Meric

Dogus Meric is a Senior Environmental Engineer based in Chicago Illinois with more than 12 years of experience focused on the management and remediation of contaminated sediment sites and developing tailored environmental solutions into brownfield and waterfront development efforts in North America and Australia. Dogus' expertise focuses on delivering effective, implementable, and yet economical solutions that are tailored to achieve client's objectives and stakeholder/regulatory acceptance. He develops and leads multidisciplinary teams to solve complex problems from early planning to design, construction, and closure. He has pioneered new sediment remediation technologies such as in-situ stabilization/solidification (ISS) of subaqueous sediments and thin-layer sediment capping. Dogus is the co-author of ASTM International standard guidance document on corrective action objectives on sediment sites. Dogus also served on the Wisconsin Department of Natural Resource (WDNR) External Advisory Group for contaminated sediments. He has authored numerous articles in peer-reviewed scientific journals and presented his work in national and international conferences. He was an invited speaker at American Chemical Society Fall meeting in 2017 to present his work on the use of thin-layer reactive cap applications in sediment sites. In 2021, Kendall Bay sediment remediation and Wollongong Gasworks remediation projects that he managed received a total of six of awards from reputable organization.

Randle Reef Sediment Remediation Project Stage 2 – Methodologies Utilized for Contaminated Sediment Dredging, Thin Layer/Isolation Capping, and Water Treatment

Wayne Harris, Milestone Environmental Contracting Inc
Marc Laliberté, Veolia Water Technologies

Located in the southwest corner of Hamilton Harbour, in the Port of Hamilton, the Randle Reef site is approximately 60 hectares (120 football fields) in size. The site contains approximately 615,000 cubic metres of sediment contaminated with polycyclic aromatic hydrocarbons (PAH) and other toxic chemicals – the largest PAH-contaminated sediment site on the Canadian Great Lakes. Impacted by historic operations this site has a legacy of a variety of past industrial processes dating back to the 1800s. There were multiple sources of contamination including coal gasification, petroleum refining, steel making, municipal waste, sewage and overland drainage. Environment and Climate Change Canada (ECCC) serves as the project lead and Public Services Procurement Canada (PSPC) provides technical and construction management, and procurement services. Setting: Active port; average total PAH concentration near 5,000 ppm with peaks over 73,000 ppm; Depth of Water: ranges from ~4 m to ~ 12 m; Sediment Depth: ranges from ~0.1 m to >3 m. This project included the design of a remediation plan that included constructing a 6.2 hectare Engineered Containment Facility (ECF) over the highly contaminated sediment (Stage 1) and using a combination of hydraulic and mechanical dredging to remove approximately 450,000 m3 of contaminated sediment and placing within the ECF (Stage 2). The ECF is made of double steel sheet pile walls with the outer walls driven to depths of up to 24 metres into the underlying sediment. The inner wall is sealed creating an impermeable barrier. The dredging of the contaminated sediments also involved the treating and dewatering the ECF to balance the water input into the ECF. This involved the design/build of a water treatment plant that would match the input of the dredging and balance the water level within the ECF. Dredging was followed by Thin Layer Capping of marginally contaminated sediment and Isolation Capping of the Stelco Intake/outfall channel sediments. Following the dredging the ECF will then be covered by a multi-layered environmental cap accompanied with consolidation and dewatering of the sediments (Stage 3).

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Wayne Harris

Wayne Harris, C.Tech., is an Environmental Technician and Project Manager with 25 years of experience in a variety of environmental and heavy civil disciplines. A Certified Technician with the Ontario Association of Certified Engineering Technicians and Technologists, Wayne has direct experience managing and supervising projects for soil and groundwater remediation, brownfield remediation, marine remediation, site decommissioning, landfill construction and closure, heavy civil construction projects. Wayne`s past experience includes working environments sites such as brownfields, landfills, oil and gas, forestry, pulp and paper, marine, mining, industrial and commercial, power generation and transportation. Wayne obtained a diploma in Terrain and Water Resources from Sir Sandford Fleming College in 1994 which followed with ten years working as a site technician, in a consulting role, for soil surveys, Phase 1 and 2 contaminated sites investigations, soil and water remediation projects, and soil, surface water and groundwater studies. In 2004, Wayne began working in a contracting role for contaminated sites remediation, including heavy civil construction, in varying positions such as site superintendent, general superintendent, project manager and operations manager.

Marc Laliberté

Marc Laliberté is a water specialist with a background in process engineering and chemistry. He has 40 years of experience in mining, metallurgical and general industrial projects. He is a specialist in the treatment of industrial wastewater, treatment of feed water, water management including using reuse, recycling, storage and similar approaches as appropriate and water quality (chemistry) and quantity problems. His work in the last decade has focused on integrating biological and physico-chemical treatment chains.

Redevelopment On or Near Oil and Gas Wellsites in Alberta – A Minefield of Safety, Environmental, and Planning Considerations

Michael Lupart, Trace Associates Inc

There are over 450,000 oil and gas wellsites across Alberta. Thousands of abandoned and active wellsites are located in Cities and urban areas. The objective of this presentation is to explore safety, environmental and planning considerations as it relates to redevelopment in proximity to these wellsites. For landowners, developers, consultants, and municipalities, there are many considerations with negative impacts to the costs and timelines of redevelopment.

Significant Health and Safety Risks Minimal environmental cleanup has been completed on historical wellsites. Facilities like tanks, pits, and pipelines may be left in place causing significant redevelopment hazards. Contamination can be hazardous to workers and future occupants. Wellheads, particularly older wellheads, have the potential to leak or spill.

Litigious Sites: Responsibility is Unclear In some cases, the landowner is responsible for all costs and liability associated with historical wellsites. It can be an expensive and lengthy process to determine who is responsible.

Expensive Environmental Cleanup Costs Environmental cleanup costs on historical wellsites are typically hundreds of thousands of dollars, and it is not uncommon to quickly progress to millions.

Unknown Development Timelines, Multiple Regulators, and Stakeholders Wellsites can take years or decades to get regulatory closure if a problem is encountered. This may require coordination between multiple municipal, provincial, and even federal regulators. Each stakeholder has their own list of requirements and guidelines. If a problem is encountered at a historical wellsite during development, it can be years before redevelopment activities can proceed.

Lingering Exposure Even After Development Even after the former wellsite is redeveloped, there is still risk. Who pays?

This presentation will review how to quantify, reduce or mitigate these risks. This presentation will also provide examples of successful redevelopments surrounding wellsites.

Michael Lupart

Mr. Michael Lupart is a Partner, Senior Environmental Scientist, and Division Manager, Calgary, with Trace Associates Inc. (Trace), and has been working in the environmental industry since 2005. At Trace, Michael is a member of the Senior Leadership Team and leads the Calgary office. Michael oversees work as the Principal-in-Charge for a variety of market sectors and clients. He is responsible for senior technical oversight, client liaison, and successful project execution within the real estate, government, oil and gas, and industrial sectors.

Saskatchewan Non-Uranium Abandoned Mines Clean-up Program

Dale Kristoff and Brent Zelensky
Saskatchewan Ministry of Environment

The issue of abandoned mine sites in northern Saskatchewan is long-standing, and Saskatchewan Ministry of Environment is committed to its long-term efforts to reduce the overall number of contaminated sites and effectively manage abandoned mines on Crown Land.

The Ministry of Environment has the mandate and regulatory authority for protecting the environment, including ensuring the decommissioning and reclamation of environmentally impacted sites.

Over the years, a variety of programs and initiatives have been completed on the abandoned mines in northern Saskatchewan.

Highlights of the work include:

- A three-year assessment and risk evaluation program in 2000, identified 33 abandoned gold or base metal mines in northern Saskatchewan; they were assessed for potential public health/safety and environmental impacts.
- In 2006, a site characterization, risk assessment and preliminary decommissioning plan with a cost estimate was completed for the Western Nuclear Mine Site.
- In 2013, the ministry contracted a qualitative risk assessment and preliminary cost estimate for reclamation of five sites to satisfy the liability accounting requirements. It also provided an estimate of the work and costs required to obtain the detailed information to further estimate the liability with greater certainty associated with these five sites.
- In 2015, the program continued with the detailed site characterization, quantitative risk assessment and remediation plan cost estimates for five of the non-uranium abandoned mines in northern Saskatchewan.
- In 2018, the ministry issued a publics Request for Proposals (RFP) regarding abandoned non-uranium mine clean-up. The RFP asked for Qualified Professional submissions for a multi-year plan for reclamation of six abandoned non-uranium mining sites with cost estimates. The six abandoned mine sites prioritized for remediation were: Western Nuclear, Box, Rottenstone, Anglo-Rouyn, Newcor and Vista.
- In 2021, The ministry completed remediation activities at the Newcor site near Creighton. The project was completed as part of the ministry's commitment to address abandoned mine sites on Crown land and reduce the overall number of contaminated sites in the Province.

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The history of abandoned mines in northern Saskatchewan will be discussed with a specific focus on the non-uranium abandoned mines and the remediation work recently completed at the Newcor Mine near Creighton, Saskatchewan. Presenters will provide insights into the unique characteristics of the site and working in northern Saskatchewan, and discussions on corrective action plan details, including engineered cover design, mine shaft cover design, shoreline protection, risk-based endpoints, and regulatory considerations.

Dale Kristoff

Dale Kristoff is currently the Manager of the Hazardous Materials and Impacted Sites Section with the Saskatchewan Ministry of Environment. He has have worked as an Environmental Protection Officer and Provincial Hazardous Materials Coordinator for the province for more than 15 years. In addition to regulating impacted sites, the section is responsible for delivery of the hazardous materials and waste dangerous goods storage program, the emergency response spill program and the abandoned non-uranium mine program for the province. Prior to working for the government, Dale was principal in a small consultant firm specializing in a variety of work in northern Saskatchewan including the assessment and characterization of abandoned mines.

Brent Zelensky

Brent Zelensky is a Senior Environmental Protection Officer with Saskatchewan Ministry of Environment's Environmental Protection Branch. He has 20 years of experience and expertise in contaminated sites, specializing in site assessment, remediation, hazmat spill response, and regulatory affairs. Brent project manages a portfolio of abandoned mines and handles the Orphan Impacted Sites Fund for the Government of Saskatchewan. He is also a member of the province's Environmental Emergency Response Team. Zelensky is a Professional Agrologist who's training includes a Water Resources Engineering Technology Diploma, a Bachelor's degree in Environmental Science, and NFPA Hazmat Technician and Specialist certificates.

Thermal Remediation of Soils Impacted with Explosives, PCB's and PAH's at the Former Ravenna Army Ammunition Plant Superfund Site - Portage and Trumbull Counties, Ohio

Chad Belenky, Iron Creek Group

Iron Creek Group (Iron Creek) provides clients around the world with innovative and cost-effective mobile thermal remediation technologies to positively address soil impacts. Using the patented Enhanced Thermal Conduction process, Iron Creek was able to successfully treat more than 6,000 tonnes of soil impacted with Explosives (TNT & RDX), PCB's and PAH's at the Former Ravenna Army Ammunition Plant Superfund Site located at Camp James A. Garfield, Portage and Trumbull Counties, Ohio.

Load Lines 1-4 & 12 Soil Remediation – Former Ravenna Army Ammunition Plant Superfund Site - Camp James A. Garfield, Portage and Trumbull Counties, Ohio

The former Ravenna Army Ammunition Plant (RVAAP) Superfund Site, currently named Camp James A. Garfield (CJAG), is located in northeastern Ohio within Portage and Trumbull counties, approximately 75 kilometers southeast of the City of Cleveland. The former RVAAP was a load, assemble, and pack facility built to produce large caliber artillery projectiles and bombs to support several international conflicts including World War II, The Korean War and The Vietnam War. Throughout its operational life, the RVAAP facility was also used for munitions rehabilitation and demilitarizing operations with each Load Line handling millions of munitions items. The 21,683 acre facility is currently an active military installation licensed to the Ohio Army National Guard for use as a military training site.

Over the decades of RVAAP operations the soil in several production areas (Load Lines) within the facility became impacted with contaminants including polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), explosives (TNT & RDX) and metals. Remedial action was required at RVAAP to ensure Facility Wide Cleanup Goals established for the protection of human health of fulltime military personnel working at the site along with the National Guard Trainee could be met.

Utilizing Iron Creek's Enhanced Thermal Conduction (ETC) technology, soil impacts from 24 separate locations within the facility were excavated and thermally treated to remove the contaminants of concern. Thermally treated soils were then utilized to backfill the 24 excavation areas to facilitate reclamation and revegetation. Although many challenges were encountered and routinely addressed during the remediation program at RVAAP the thermal remediation activities were safely completed during the Fall/Winter of 2020/21 and at the height of the first wave of the COVID-19 pandemic.

This presentation will provide an overview of the remedial action completed at the RVAAP Superfund site while highlighting the successes as well as the lessons learned when conducting remedial operations on an active military installation. The presentation will also outline how the versatility of the Enhanced Thermal Conduction process provided a reliable, timely and effective solution to remediate these unique and challenging soil impacts onsite, at the source location.

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Chad Belenky

Chad Belenky is the President of Iron Creek Group and is responsible for the overall management of the business. Chad has been active in the environmental field since 1996 working on government, commercial, and resource industry sites throughout North America. With more than 25 years of experience managing a diverse portfolio of projects, he brings a broad range of experience to Iron Creek. This includes extensive background in both soil and groundwater remediation, all phases of site reclamation, civil earthworks, property transfer activities and project management.