Session 1 – R3 Innovations (Reclamation, Remediation, Restoration)

The Use of Innovative High Resolution Site Characterization (HRSC) Technologies to Improve Contaminated Site Management

Ben Sweet, SCG Industries Limited, Saint John, NB

Despite the incredible advancement of remediation technologies many industry stakeholder's still face high levels of uncertainty concerning their project's budget, schedule and success. This gap between technological advancement and project success is detrimental to all industry stakeholders and the larger socio-economic environment. This gap exists in part because of the difficulty in proper selection, implementation and optimization of remediation technologies and risk management strategies. Successful strategy application is critically dependent on an accurate understanding of contaminated site dynamics and risk. Current progress in site remediation is being spearheaded by new technologies that enable site professionals to accurately select, implement and monitor the appropriate solution(s) for their site. High-resolution site characterization (HRSC) technologies have facilitated this advancement. HRSC technologies are diagnostic tools that provide the scale appropriate detail, data density and real-time imaging required to precisely execute cost-effective remediation and management plans. By advancing our ability to conceptualize the parameters controlling contaminated site dynamics these tools have enabled practitioners to maximize the performance of today's remediation technologies and management strategies. A brief introduction to these tools will be followed by a Atlantic Canadian case study.

Sediment fingerprinting as a method of determining sources of erosion in an agricultural watershed in Atlantic Canada

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Sediments adversely affect the quality of surface waters and are a major source of contaminants, such as nutrients and pesticides in agricultural watersheds. In many agricultural watersheds, it has been assumed that the majority of suspended sediment is coming from water erosion occurring in agricultural fields. This assumption was challenged by many recent studies, which showed that bank erosion contributes more than in-field water erosion in many watersheds. In Atlantic Canada, many potato fields are prone to some of the most serious water erosion in Canada due to the climate, topography and soil conditions, and the intensive management associated potato cropping. The objectives of the study are: (1) to determine the sources of sediment in an agricultural watershed (using Cs-137 radioactivity and other geochemical parameters), and (2) determine the proportion of each source in order to identify the sources with the greatest contribution. The study was carried out in the Black Brook Watershed (BBW), a small watershed in the potato belt of the province of New Brunswick in Atlantic Canada. Sediment fingerprinting technique was used to quantify the contributions of each source towards the suspended sediments collected at the eight locations. Our results show that the contributions of different sources varied a lot within the BBW watershed. However, there appear to be a trend with scale and a strong influence of land use. Bank

erosion was found to contribute substantially to suspended sediment in some locations, whereas the contribution of in-field water erosion showed strong impact at the local level.

A "Miner" Remediation – The Salvage of the MV Miner

Robert Jessome, George MacNeil, Sheldon Andrews, and Frank Potter, Nova Scotia Lands Inc., Sydney, NS

On September 20, 2011 the vessel MV Miner was under tow to a salvage yard in Turkey when it broke free of its tugboat and ran aground on Scaterie Island off the coast of Cape Breton Island. The ship ran aground on the rocky coast of this pristine wilderness island that was designated as a wildlife management area. Mired in a legal controversy that spanned many countries, the ship was left to slowly deteriorate. The Province of NS stepped in and removed oily bilge water and floatable debris. An ill-fated attempt by a New York salvage company in 2012 failed. Eventually Nova Scotia Lands Inc., an agency tasked with remediating provincial industrial properties was assigned the role of project manager. This presentation will describe the challenges and uniqueness of removing a large stranded vessel on a sensitive landscape. The discovery of 30,000 litres of fuel oil and 38 tonnes of asbestos added to an already difficult assignment.

Session 2 – Freshwater Habitat Restoration and Management

Results of the Re-Establishment of Fish Passage to the Petitcodiac River

John Bagnall[1] and Edmund Redfield[2]
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[2] Fort Folly Habitat Recovery / Petitcodiac Fish Recovery Coalition

In 1968, construction of a causeway between Moncton and Riverview, NB across the macro-tidal Petitcodiac River estuary, created a 20 km long upstream impoundment. The surface elevation of the impoundment was maintained by the barrier of the causeway and by opening and closing five spillway gates. Gate manipulation prevented tidal inflow into the "headpond". A fishway incorporated into the causeway to provide passage for at least 10 diadromous fish species proved to be ineffective. Mud carried in the sometimes 8+ m tides fell from suspension once the tide encountered the barrier of the causeway; choking the downstream channel, and further preventing the upstream migration of fish. The causeway and its often-closed gates delayed upstream and downstream fish passage and provided an opportunity for predators to decimate the fish accumulated around the structure.

On April 14, 2010 the causeway gates were permanently opened, restoring tidal flow to the river, and enabling unrestricted migratory fish passage. Since then, the Province of NB through its consultant, Amec Foster Wheeler, and the Petitcodiac Fish Recovery Coalition to operate a fish trap annually at the river's restored head-of-tide at Salisbury. Fish species composition and capture rates have been tracked. Several species have shown fluctuations in abundance; others have steadily increased, and others have remained extirpated or at very low levels. Despite the introduction of Atlantic salmon fry and pre-spawning adult salmon, no returning wild adult salmon have yet been captured in the trap, although evidence of wild spawning has been detected. Ongoing changes in

tidal height and substrate composition following gate opening may have an effect on the upstream migration of anadromous fish.

Restoration of Unnamed Tributary to the Madawaska River in Boucher, NB
Amber Yates, Parish Aquatic Services, Nashwaak, NB

Changes in hydrology due to developments in the watershed of an unnamed tributary to the Madawaska River and how existing road crossings may be affected by those changes were investigated. Altered hydrological conditions resulting from new land use (i.e., construction of new subdivisions) can cause flows that exceed the drainage capabilities of current infrastructure. The urbanization of watersheds typically shortens runoff times and increases flow intensity during rain events and spring snow melts. This project provided a geomorphic assessment of the watershed, specifically focusing on identifying sensitive areas of the stream responsible for causing flooding of the surrounding residential areas. Stream crossings were also assessed and replacement recommendations provided in anticipation of more intense flows from an urbanized watershed. Properly-sized stream crossings and channel/bank geometry were designed to function under increased flow conditions to reduce the risk of flooding in the community. Construction and completion of the project occurred in June of 2014.

Management of Submerged Aquatic Vegetation in Lake Banook
Marc Skinner[1] and Elizabeth Kennedy[2]
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An overgrowth of submerged aquatic vegetation (SAV) in Lake Banook, Dartmouth, began interfering with lake-based recreation in 2010. Through council, the community successfully engaged Halifax Regional Municipality (HRM) to undertake an initial assessment of the SAV in Lake Banook and to evaluate possible solutions based on cost, feasibility, effectiveness and risk. It was determined that the likely cause of the vegetation overgrowth in the lake was the enrichment of sediment from non-point source urban inputs which had been exacerbated by an extended lake level drawdown in the winter of 2009 that had disturbed the natural ecology of the lake. Solutions for the immediate management of the vegetation overgrowth were evaluated, and recommendations were made to avoid a similar drawdown scenario that may exacerbate overgrowth again. Long term protection of the existing lake quality would necessitate a reduction in the urban inputs to the lake; most importantly, reduction of sediment delivery into the lake, and opportunities for source control and sediment capture were evaluated. In advance of the initiation of short term management of SAV through a boat-based vegetation harvester, acoustic and underwater video data were used to map SAV and bathymetry in the Lake and provide a basis against which to monitor long-term SAV management. Harvesting was initiated and completed in August 2015.

Session 3 – Atlantic PIRI

Atlantic PIRI and Atlantic RBCA Update - Part One
Michel Poirier, NB Department of Environment and Local Government, and Stakeholder Working Group Co-Chair, Atlantic PIRI, Fredericton, NB

Since 1997, the Atlantic Partnership In RBCA Implementation (PIRI) has a mandate to establish Risk Based Corrective Action (RBCA) as the approach used to manage petroleum hydrocarbon impacted sites in Atlantic Canada. Atlantic PIRI works by bringing together Atlantic Provincial regulators and regional stakeholders in a collaborative approach to developing workable guidelines and science-based analytical tools. Atlantic RBCA is a process to help ensure the consistent and cost effective assessment and remediation of petroleum hydrocarbon impacted sites in the region. Affected properties are remediated and managed based on scientifically based principles and in relation to actual risks posed to human health and the environment.

The Atlantic RBCA tools and user guidance were updated in 2012, and included significant changes and improvements to the model and user guidance. This presentation highlights key regulatory developments since 2012 throughout the Atlantic region in the areas of impacted site management. Part two of this presentation will focus on recent developments of additional user guidance and vapour intrusion screening levels (VISLs). A website www.atlanticrbca.com is maintained and updated on a regular basis by Atlantic PIRI and provides new contaminated site information released by Atlantic Provincial regulators.

Atlantic PIRI and Atlantic RBCA Update - Part Two
Tania Noble, Stantec Consulting Ltd., and Technical Working Group Co-Chair, Atlantic PIRI, Fredericton, NB

In 2006, Atlantic PIRI published the *Guidance for Soil Vapour and Indoor Air Monitoring Assessment* to provide technical assistance to Responsible Parties and Site Professionals when assessing potential risk of vapour intrusion into buildings. In 2012, this document was re-released as a stand-alone document that included an errata that addressed changes associated with Atlantic RBCA Version 3, but it was not updated to reflect new information and research that has been published since 2006. Site Professionals and Regulators in Atlantic Canada had also suggested that screening levels for indoor air, subslab, and soil vapour monitoring results would simplify the reporting and review of vapour intrusion monitoring programs.

The new *Guidance for Vapour Intrusion Assessments* is a simplified guidance document for Site Professionals and Regulators that outlines the Atlantic RBCA approach to assessing the potential for unacceptable exposures via indoor inhalation of vapours originating from volatile contaminants in subsurface soil and groundwater. It introduces Vapour Intrusion Screening Levels (VISLs) that can be used to screen for potential unacceptable risks associated with the indoor air inhalation pathway. It also incorporates the findings of scientific studies which have found petroleum hydrocarbon

vapours do not migrate 30 m. This presentation provides an overview of the guidance and VISLs that can be used at contaminated sites in Atlantic Canada.

Atlantic RBCA Version 3 Example Application: Calculating Changing Compound Concentrations in Groundwater Between a Source Area and a Surface Water Receptor
Cameron Ells, Cameron Consulting Incorporated, Halifax, NS

Assessment, remediation, management, and reclamation projects sometimes have to take into account the potential for site conditions to impact adjacent or close by water bodies. Atlantic RBCA Version 3 has a capacity for calculating changes in compound concentrations in groundwater between the source area and a surface water receptor some distance away. This can be expressed as Site Specific Target Levels (SSTLs). This can provide the decision maker with an opinion such that compound concentrations in intermediate monitor wells should be less than X mg/litre, in order for the impact of those compounds on the surface water receptor to be less than Y mg/litre. This presentation uses screen shots from an example Atlantic RBCA evaluation. It may be a technical refresher for some people, and an interesting learning experience for some others.

Session 4 – Vegetation

The Southern Twayblade at the Halifax Stanfield International Airport
S. Hicks, Halifax International Airport Authority, Enfield, NS

In 2001 the Halifax International Airport Authority (HIAA) discovered a rare plant, the Southern Twayblade (*Listera australis* or *Neottia australis*), while carrying out Environmental Impact Assessment work for the construction of a new taxiway at the Halifax Stanfield International Airport (HSIA). The HIAA adjusted the location of the taxiway and has been monitoring and protecting the colony of rare orchids ever since. In 2014 the status of this plant was changed to "secure" in NS due to greater numbers of them being found throughout the province. As the species is still considered rare in some jurisdictions, HIAA decided to have a scientific paper prepared to document lessons learned on the preservation of this wetland orchid.

Improving the quality of choke cherry seedlings for reclamation
Joanne E. MacDonald, J. Dale Simpson, and Elizabeth A. Mills, Natural Resources Canada, Canadian Forest Service – Atlantic Forestry Centre, Fredericton, NB

Choke cherry (*Prunus virginiana* L.) is important in restoring ecological function during reclamation of disturbed forest landscapes across Canada. It has an extensive root system that readily suckers, thus quickly creating dense thickets. Consequently, choke cherry provides rapid site occupancy that reestablishes nutrient cycling, prevents erosion, and provides food and habitat for wildlife. Although choke cherry reproduces well naturally, it has proven difficult to produce high quality seedlings in nursery culture due to (i) prolonged seed germination and (ii) poor root development. This reduction in seedling quality reduces survival after planting. Our overall research goal is to produce high quality choke cherry seedlings. The first objective was to synchronize seed germination with the aim of producing germinant uniformity, the first step toward quality seedlings. A combination of 2 weeks of warm, moist conditions followed by 20 weeks of cold, moist conditions was most effective for breaking seed dormancy, after which seed germinated

uniformly. The second objective was to increase germinant root-system development, the second step toward quality seedlings. Applying a plant growth regulator to germinants at the 0.5 mL/L rate increased number and length of roots compared with control. Vigorous rooting at this stage establishes the framework for further root development later in culture.

Salt Tolerance of Three Native Willow Species

John E. Major, Alex Mosseler, John Malcolm, Moira Campbell, and Shane Heartz, Natural Resources Canada, Canadian Forest Service, Atlantic Forestry Centre, Fredericton, NB

In North America, much of the initial interest in willows for biomass production and land reclamation focused on the use of willow clones and species imported from Europe, where interest in willow biomass production has a longer history. Canada has a rich diversity of native willows and alone has some 76 native willows, which are widely distributed across Canada, adapted to a large range of site conditions. They grow fast and are generally easily propagated vegetatively from unrooted stem sections (cuttings). Salt tolerance is an issue on a variety of sites requiring reclamation including mine sites and oil sands development. Our objective was to assess genetic variation in 5 clones from each of 3 willow species, tested previously for survival and vigor on a range of sites, for survival, yield and components of yield at 3 different salinity levels. We used controlled ebb and flow benches to provide the 3 salinity levels twice a day for 15 minutes each time. The willow species tested were *Salix eriocephala* (ERI), *S. discolor* (DIS) and *S. interior* (INT). We also compared these species to a highly breed European willow that has been widely used in North America, *S. viminalis* (VIM). Preliminary results show that VIM was the least tolerant clone. The most saline tolerant species and clones belonged to INT, followed by DIS and ERI. There was significant genetic variation within each species. Results will be presented and discussed.

Session 5 – Remediation Risks and Decision-Making

Soil Vapour-Based Risk Assessment Overview and Cost Analysis Versus Excavation

Jeff Earle and Kristin Banks, Dillon Consulting Limited, Fredericton, NB

An overview of the Atlantic PIRI RBCA approach to risk assessment with respect to the management of petroleum hydrocarbon impacted properties. The topic will focus on the application of soil vapour based risk assessment, and the value of soil vapour data collected directly vs. modeled output based on soil data. In addition, the authors will present the outcomes of several case studies where soil vapour assessments were executed in the Atlantic Provinces, and will contrast the cost of soil vapour based risk assessment with the cost of soil excavation followed by offsite disposal. The intent of the discussion will be to examine the economic value of soil vapour assessment as well as the impact of this approach as it relates to sustainable remediation.

Mass Flux-Informed Remediation Decision Making at One of Canada's Most Polluted Sites

Tony R. Walker [1,2] and N. Devin MacAskill [3]
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[3] Verschuren Centre, Cape Breton University, Sydney, NS

In recent years, there have been significant developments in contaminant mass flux techniques that focus on understanding "mobile" versus "immobile" contaminant mass. Flux-informed remediation decision-making uses this information to develop remediation end point goals aimed at reducing off-site exposure and risk. We reviewed results of numerous flux studies, including our own mass flux study during remediation of one of Canada's most polluted sites at the Sydney Tar Ponds (STPs).

According to an Environmental Impact Statement, the STPs were thought to be the major source of PAH contamination in Sydney Harbour. However, during three years of remediation monitoring we found that only 17-97 kg/year of total PAH in surface water was discharged from the STPs and groundwater was responsible for negligible quantities of material (0.002-0.005 kg/year). An independent surface water PAH flux study conducted by CRA (2011) during the first year of remediation, estimated 119 kg/year (which compared favourably to our 97 kg/year estimate during the same period). The estimated mass efflux of PAHs from the STPs during remediation is in stark contrast to ~3000 kg loading thought necessary to cause a short term increase in harbour sediment PAH concentrations. Our mass flux estimates during remediation was also much lower than 777 kg/year of PAHs discharged from the STPs in 2001, when at the same time, government studies demonstrated on-going reduction in PAH concentrations in harbour sediments. Flux results were corroborated in a separate forensic assessment study using PAH fingerprint techniques which found a common source of PAHs for urban soils, marine and aquatic sediments in and around Sydney. Coal combustion (from historical coking) and coal transhipment (from current facilities), are likely the principal source of PAHs in these media and *not* the STPs. Specific PAH forensic assessment results will be discussed in a separate platform presentation at this conference.

PAHs in Sydney Harbour Sediments: Using PAH Fingerprinting to Assess the Sydney Tar Ponds as the Primary Source of Impacts

Devin MacAskill; Verschuren Centre, Cape Breton University, Sydney, NS

Polycyclic aromatic hydrocarbons (PAHs) were the primary contaminant of concern at the remediated Sydney Tar Ponds (STP), located in Muggah Creek, Sydney, Nova Scotia. PAHs have also been identified in environmental media in the local area surrounding the STP such as surface water sediments, shallow soil and marine sediments. PAHs in marine sediments in Sydney Harbour have historically been considered to be a result of effluents from the STP and for this reason, preventing sediment releases during the remediation project was a primary component of the environmental protection plan. The purpose of this research was to develop PAH Fingerprints for soil and sediment samples from the STP and the surrounding areas. The PAH Fingerprints were analyzed using several qualitative and statistical techniques to identify common sources of PAHS.

Results indicate a common source of PAHs for Upstream Sediments, Urban Background Soils, as well as Harbour Sediments and Coal Sediments found within Sydney Harbour. Based on historical activity at these sites, coal handling is likely the source of PAHs in these samples, specifically, sediments throughout Sydney Harbour. Fingerprints in the STP Sediments do not correlate with other samples, indicating a different source of PAHs, unrelated to the PAHs found in Sydney Harbour Sediments.

Session 6 – Fredericton's Picaroons Roundhouse Project

Environmental Contamination in Real Estate

Andrew Langille, Spectra Energy, Fredericton, NB

Unless a parcel of land is and has been essentially untouched, it has the potential to be environmentally contaminated. Assessment of real estate for past activities on and adjacent to the subject area is key in determination if environmental risk may be present. Past activities including but not limited to homes, farming, factories, auto repairs and service, sawmills and forestry related, railway, fuel storage and distribution, dry cleaning, small engine repair and service, dumps and landfills (legal and illegal), and commercial and industrial activities both large and small all may pose environmental risk to real estate.

Both soil and groundwater on affected lands (real estate) can become contaminated and thereby be "environmental issues". Geological, hydrogeological and environmental site assessments are all key steps in determining if a parcel of real estate is contaminated. Once discovered and assessed, the contaminated soil and/or groundwater on a site can, in many cases, be remediated. Detailed environmental site assessments lead to the design and development of remediation plans which might include but are not limited to: sparging, excavation, storage (on and off site), on and off site treatment, bioremediation, groundwater and vapour recovery and treatment, and encapsulation. Since environmentally contaminated real estate inherently affects its monetary value, all aspects of site investigation from initial walk over to final clean up and remediation must be taken into consideration when a real estate appraisal is considered.

Brownfield Roundhouse to Award Winning Brews- The Picaroons Roundhouse Project

Sean Dunbar, Picaroons Brewing Co., Fredericton, NB

In 2013, Northampton Brewing entered into an agreement with the City of Fredericton for the redevelopment of the "Gibson Roundhouse". With a history dating back to the late 1800's of an industrial complex consisting of the railway round house, a tannery and a rail line, and prone to the natural havoc wreaked by the frequent Spring flooding courtesy of the adjacent St. John River, why would an established microbrewery chose this difficult site to become its Head Office and consolidated brewery complex? Picaroons Brewing Co. has taken that challenge and with the target date for opening in late October, 2015; the excitement grows for both microbrew lovers and locals watching an eyesore and environmental liability transform before their eyes.

The City of Fredericton describes the project as "a critical hub for tourism on the Northside, a key element of the City's overall tourism strategy." Microbrew lovers are looking forward to more great

names such as “Kelp on the Way”, “Plaid to the Bone”, “Timber Hog” and seasonal treats such as “Maple Cream Ale” and “Winter Warmer”.

$100 and a Vision, Plus Beer: The Social Value of Land Reclamation
Morgan J. Lanigan, Acre Architects Inc., Saint John, NB

Up until 2013, the site of the new Picaroons Brewery in Fredericton had, for all intents and purposes, been written-off by many as a site having no remaining value – nothing but a crumbling eyesore with innumerable challenges and liabilities, from flooding to soil contamination. Energized with $100, a vision, and a lot of beer, in steps the Northampton Brewing Company with Acre Architects. Now the community is abuzz with excitement and potential. This result is no accident.

Land reclamation, in and of itself, is not a goal but merely a means to an end. *Purpose* makes land reclamation meaningful and, to be meaningful, the purpose must support and elevate our values. Urban design, adaptive re-use of heritage buildings, walkability, community, and character are among our shared values that easily compliment land reclamation. We celebrate the projects that get it right but it is surprising how rarely – despite their impact – these values are considered in the vast majority of projects. We are, after all, what we create. The Picaroons Brewery project is a prime example of how balancing the trifecta of purpose, meaning, and values can build energy and excitement to achieve more than any one component in isolation.

Session 7 – NB Power's Mactaquac Project

Mactaquac Project Update
George Porter, New Brunswick Power

As presented at the 6th annual conference, this project seeks to assess alternative futures for the prematurely aging Mactaquac Hydropower station. Mactaquac Hydroelectric Generating Station is expected to reach the end of its service life in 2030. NB Power has identified three possible options for the station, each with broad implications for people and the natural environment. NB Power will seek input from experts, First Nations and all New Brunswickers before selecting a preferred option in 2016. Option 1 would mean building a new powerhouse and spillway and decommission existing concrete structures. This option would leave the earthen dam intact. Option 2 would mean building a new spillway, maintaining the earthen dam, and decommission existing concrete structures. Option 3 would mean draining the head pond and removing the powerhouse, spillways, and the earthen dam from service, allowing nature to bring the river back to a natural flow.

Much relevant technical information has been gathered, and both the First Nations and public engagements are very active. This ongoing work is to facilitate the selection of a preferred option for submission to regulators for approvals. While engagement on three works-in-progress rather than one specific final design has its challenges, it does allow more opportunity for input to be effective. The project has direct implications for the future of Mactaquac, and indirect implications for other future infrastructure and resource projects with substantial and complex social, environmental, economic, and technical considerations.

The Mactaquac Project First Nations Liaison Field Monitor Role
Austin Paul, NB Power, Fredericton, NB

The position of First Nations Liaison (field monitor) was created to respond to interests expressed from First Nations communities to foster inclusion and involvement in terms of studies related to the Mactaquac project, to reduce the likelihood that project work would infringe on First Nations interests, identify opportunities to improve studies as they relate to First Nations' culture and knowledge, participate in all aspects of field work associated with the Mactaquac project. The duties associated with this position include: maintaining daily logs and compiling bi-weekly reports to be shared with First Nations communities, assist in facilitating community-based open houses associated with the Mactaquac project, ensuring that First Nations concerns and interests are identified and addressed appropriately, the implementation of communication plans for sharing project specific information with the local First Nation communities and the development of a field guide outlining New Brunswick pre-contact artifacts and traditional plant medicines. This presentation is designed to provide a glimpse of the field work involved in the Mactaquac Project and the project's First Nations Liaison's involvement therein.

The Mactaquac Project River Restoration Option
Don Smal, AMEC Foster Wheeler, Fredericton, NB

As presented at 6th ARC, this project explores the technical challenges associated with removal of the Mactaquac Generating Station and potential impacts to shoreline infrastructure. Since the beginning of 2015, a team of consultants lead by Hatch Limited has been conducting engineering to determine methods and costs associated with dam removal - Option 3. Areas reviewed include draw down of the reservoir headpond, decommissioning of concrete structures and earth dam, mitigation to shoreline infrastructure, protection during drawdown, and restoration of the water course area.

The Mactaquac Aquatic Ecosystem Study (MAES)
A.Curry [1], T. Linnansaari [1], W. Monk [1], G. Yamazaki[1], A. Bielecki [2], and G. Porter [2]
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The Mactaquac Aquatic Ecosystem Study (MAES) is a partnership with NB Power that provides the aquatic environmental science in support of the Mactaquac Project. The MAES will support a pending decision to either rebuild or remove the dam, which would be the largest planned dam removal to date. It is a highly integrated research program planned for the next 20+ years and designed to explore the potential consequences for the river and its reservoir. The study is describing the spatial and temporal characteristics of the river ecosystem's structure and function. This information will be used to explore the potential consequences of the proposed manipulations, i.e., what are the environmental challenges and opportunities for either replacing or removing the dam. We are establishing baseline environmental conditions, developing appropriate indices for environmental monitoring, and predicting the flow, sediment, and temperature regimes which

control future habitats in the river. The research also describes the consequences of dam rebuilding for species at risk, fish passage, and managing flows to protect the river ecosystem's goods and services. The challenges addressed and environmental sciences solutions derived from the MAES will be a landmark achievement for the future of EIAs in Canada.

Session 8 – Wetland Restoration

Looking Back Over 10 Years of Tidal Wetland Restoration in Nova Scotia.

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Since 2005, efforts have been made to compensate for the loss of tidal wetland habitat in Nova Scotia through ecological restoration activities. Over the past decade nearly a dozen tidal wetland projects, complete with comprehensive long-term ecological monitoring programs based on the GPAC Monitoring Program, have been undertaken in NS. These projects have ranged from replacing tidally restrictive culverts (i.e., Cheverie Creek, Lawrencetown Lake), to the breaching of agricultural or impoundment dykes (i.e., St. Croix River, Walton River) and have also included the design and construction of tidal channels and pannes (i.e., Antigonish Landing North). This presentation will provide a look back over ten years of tidal wetland restoration projects in NS highlighting successes in the field, advancements in restoration design, lessons learned and challenges encountered. Given this retrospect, what does the next decade hold for tidal wetland restoration?

Community Patterns after 5 Years of Salt Marsh Restoration in the Upper Bay of Fundy

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[2] Ducks Unlimited Canada (DUC), Amherst, NS

Given the ecosystem services provided by salt marshes, there is increasing interest in restoring them. In 2009-2010, DUC and partners started one such restoration project in two adjacent farmland cells (impacted East and impacted West) in Aulac, NB. In October 2010, the dikes of these cells were breached, either with an engineered breach (with rock weir) or two smaller breaches to mimic a natural process. Plant and invertebrate densities in the impacted sites (cells), as well as in two nearby established salt marshes (termed reference sites), were monitored yearly since summer 2010. Salt water cordgrass *Spartina alterniflora* (the primary bioengineer species of salt marshes) appeared 2 years after the breaching, and initially spread through rhizomes and then in years 4 and 5 mainly by production of seedlings. Freshwater cordgrass *S. pectinata*, present before the breaching, survived in a stressed state until year 5, when it disappeared from within the impacted sites. Salt marsh hay *Spartina patens* (the dominant grass in the high zone of marshes) and typical salt marsh invertebrates are just starting to colonize the impacted sites. Although still significantly different as of last year (2014, $p = 0.001$), the community structure in impacted sites is approaching that of the reference sites. It is important to continue to study the ecological succession in large-scale salt

marsh restoration projects in our climate, as most previous salt marsh restoration has been conducted in warmer geographic regions.

Development of Salt Pools in Restored Salt Marshes in the Bay of Fundy

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Salt pools are an essential microhabitat in salt marshes, used by marine and aquatic animals such as minnows, waterfowl and invertebrates. In a salt marsh restoration project in Fort Beauséjour, NB, we monitored the animal community and physical characteristics of salt pools in two replicate restoration sites and two reference sites over 5 years (2011-2015); restoration began with the breaching of agricultural dikes in autumn of 2010. Due to sediment dynamics and infilling the salt pools themselves are not yet stable; yet we have found that the minnow community reestablished itself quickly, approaching the reference condition within 2 years. Vegetation and other aquatic animals have lagged behind, likely because of lower movement capabilities as well as lack of permanency of the pools. The infaunal community at the bottom of the pools continues to reflect a mudflat community, rather than the reference condition. We will continue to monitor community dynamics until the sites are fully restored. We are also using LIDAR data of the sites (conducted in 2009, 2012 and 2014) to examine connectivity of the established salt pools and determine the impact this has on pool abiotics and the biotic community. Temperature will also be examined as a potential limiting factor for biota.

Session 9 – Mine Reclamation at the Sydney Coalfield

Geochemical Assessment of Reclaimed Mine Waste Rock Piles in the Sydney Coalfield

Christopher Power, Murugan Ramasamy, Devin MacAskill and Martin Mkandawire, Cape Breton University, Sydney, Nova Scotia

At several former mining sites in the Sydney Coalfield, engineered cover systems have been installed over reclaimed waste rock piles (WRPs) to prevent or control the generation of acid mine drainage (AMD). To assess and predict the long-term WRP performance, a multi-phase, multi-discipline monitoring program has been implemented. An essential component of this program is a geochemical assessment of the WRP to understand and predict AMD generation and the long-term effects on the receiving environment. This work presents the methodology used to develop geochemical conceptual models for two WRPs with contrasting cover systems: Lingan (soil cover) and Scotchtown Summit (engineered cover with a HDPE liner). The field performance monitoring data (e.g., atmospheric, pore-gas and pore-water) were coupled with site background information (e.g., geologic, geochemical, hydrologic). Key aspects of the geochemical model include: (i) water and oxygen flux from the atmosphere, (ii) waste rock acidity and contaminants of concern within the waste rock, (iii) contaminant loading to the receiving environment. As a result, the developed conceptual models can provide an initial assessment of the longevity of AMD, effects on the receiving environment and WRP performance at both sites. Ongoing work includes the

development of a reactive transport model that will be used to simulate the long-term performance of WRP and associated cover systems.

Use of a Conceptual Model In Advance of Numerical Simulations to Demonstrate an Understanding of Loading from a Reclaimed Waste Rock Pile

C. Bradley and G. Meiers, O'Kane Consultants Inc., Fredericton, NB
D. Mayich, David Mayich Consulting, Sydney, NS
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A conceptual model is often used as an initial step in demonstrating an understanding of site conditions to inform on long-term impacts from waste storage facilities. This understanding provides the basis for additional work, including numerical simulations should they be required, and identifies appropriate objectives. In conjunction with numerical simulations, a representative conceptual model establishes a high degree of confidence in simulated results. A conceptual model also serves as a delivery mechanism for conveying information to site personnel or management who may not have the technical knowledge or time required to interpret results. Although developing a conceptual model may seem like an unnecessary step, it is an instrumental skill which needs to be cultivated.

The Victoria Junction waste rock pile was reclaimed with an engineered cover system that includes a geomembrane layer and is presented as a case study. The waste rock pile is located near Sydney, NS, and was reclaimed in 2006. This case study details the conceptual model and methodology employed, and highlights the importance of implementing a monitoring program to ensure sufficient information is collected to adequately inform the conceptual model. It is also demonstrated that through a strong conceptual model the use of numerical simulations may not be required to further enhance our understanding of performance. The conceptual model identified that long-term acid loading from the waste rock pile will be limited to levels that allow for closure objectives to be achieved. Consideration may be required in long-term planning given that the longevity of geomembranes are in the order of 500 to 1,000 years and that stored and potential acidity will remain for ~200,000 years. Net present value and a representative conceptual model were also used to demonstrate the financial and environmental benefit of the reclaimed waste rock pile compared to the collection and treatment of basal seepage in perpetuity.

Variably Saturated Flow Modelling to Evaluate the Performance a Soil Cover System at the Lingan Coal Waste Rock Pile in the Sydney Coalfield

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Oxygen and water ingress into waste rock piles (WRPs) increases the risk of acid mine drainage (AMD), which eventually affects the WRP's geochemical and geotechnical stability. Understanding the physical and hydrological properties of the WRP helps to predict flow and solute transport which is critical for effective management of the WRP. We have used two-dimensional finite element FEFLOW modelling to investigate the mechanisms that produce subsurface flow and vertical percolation through the soil cover system at the Lingan WRP. The cover system consists of a till growth medium, 50 cm in thickness, applied directly over the waste rock. A database was developed with moisture, groundwater conditions and internal waste rock dynamics and used to

develop a flow model that successfully modeled flow for the unsaturated and saturated zones of the WRP. This presentation will, among other things, present the modelling procedure outlining opportunities and challenges involved in the model calibration and sensitivity of parameters. For example, the simulated results show that the cover responds rapidly to precipitation, converting approximately 20% of the input to subsurface flow. Such simulations help to better understand the long-term response of a typical waste rock pile and its associated cover system.

Session 10 – Wetland Restoration, Continued

Wildcat Brook Shale Pit Restoration

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East Coast Aquatics Inc. (ECA), working with the Bluenose Coastal Action Foundation, is undertaking the restoration of an abandoned pyritic shale pit near Bridgewater, NS. Acid rock drainage from the disused pit directly enters Wildcat Brook and is characterized by low pH, acute toxicity associated with precipitation events and elevated dissolved metal concentrations. Wildcat Brook is a tributary to Hebb Lake, part of the protected watershed area providing drinking water to the Town of Bridgewater as well as critical habitat of the globally endangered Atlantic Whitefish (*Coregonus huntsmani*).

Restoration of the pit seeks to create wetland conditions to limit the exposure of pyritic rock to oxygen with the provision of both organic substrate and a vegetation community to increase the surface water pH and bind soluble metals. Restoration activities commenced in July 2015 with the creation of surface outlet controls and deposition of salvaged organic soils from off-site wetland alterations.

The Use of *Spartina* Species for Natural Shoreline Management

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Shoreline management practices have typically included 'hardened' engineered approaches such as riprap placement and rock walls. However, in recent decades, using natural shoreline management practices as an alternative, such as living shorelines and salt marsh restoration and creation, have been valued for their ability to protect land and coastal infrastructure. They do this while adding ecosystem services and functions such as increasing and maintaining habitat, supporting fisheries industries and increasing usability of shorelines. All of these practices are valued for their use in climate change adaptation, particularly in regards to storm impact mitigation and sea level rise. The common theme of many of these practices is to plant intertidal vegetation in the coastal zone. The added vegetation helps to protect against wave energy, capture sediment and create habitat. This graduate thesis project evaluates the best methods for which to both store and germinate *Spartina* sp. seeds for plugs, as well as the best methods for direct planting and seeding to facilitate *Spartina* community development on two sites in Nova Scotia.

Biogeochemistry of a Recently Restored Macrotidal Salt Marsh: Cheverie Creek, NS

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Biogeochemical cycles are altered after restoring tidal water to a previously tide-restricted site. These cycles critically influence vegetation recolonization and the expected timeline for marsh platform development and stabilization. Therefore, it is necessary to have an understanding of the biogeochemical cycles within a recently restored macrotidal salt marsh to understand the implications of re-establishing tidal waters within these dynamic systems. This study strives to determine the temporal and spatial pattern of sulfide, salinity and redox potential and related aboveground biomass, sediment characteristics and hydrology at Cheverie Creek Salt Marsh Restoration Site during the spring and summer of 2014. Data analysis reveals high sulfide and salinity concentrations in poorly-drained areas partnered with redox potential values sustained at iron (III) reduction. Well-drained areas, along the upland and creek edge, were characterized by lack of sulfide concentration, low salinity levels and redox potential values sustained at nitrate/ manganese (IV) and oxygen reduction. Maximum biomass production occurred early in July for the well and moderately drained areas as compared to late July for the poorly-drained areas. Highest aboveground biomass values were identified within the well-drained areas while lowest values were found within the poorly-drained areas. It is believed that high iron levels in the sediment play a role in limiting the amount of sulfide build up and sustain the redox potential measurements around nitrate/manganese (IV) and iron (III) reduction.

Session 11 – Managing Environmental Issues

Use of Analytical Estimates and Water Balance Components to Estimate Leakage Rates Through Cover Systems Utilizing a Geomembrane

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Monitoring performance of geosynthetic cover systems is not common practice as there is an expectation of performance regardless of the site. Re-evaluating performance through a monitoring program validates the design and provides an opportunity for further knowledge to be incorporated in subsequent designs. The remediation of three coal waste rock piles located near Sydney, NS, included engineered cover systems that use geosynthetic layers. The flux of water through a geomembrane used within a cover system may occur as a result of diffusion of vapor and leakage through defects. Given that the flux through diffusion pales in comparison to that by leakage, design considerations typically include a drainage layer to minimize any head that may develop above the geomembrane. Net percolation was estimated to be in the very low range, or less than 1% of precipitation, for the cover systems that include a drainage layer. Comparatively, while the simulated results suggest that net percolation could be much higher for the cover system with no

drainage layer, field performance monitoring data would suggest, with some confidence, that it is in the low range or less than 5% of precipitation. While the estimated net percolation is in the low range there is inherently a greater risk for higher rates associated with post closure defects. The case studies highlight that management of lateral is one of the primary design considerations for cover systems using a geomembrane layer for closure of waste storage facilities.

Slope Stabilization at the Saint John Mail Processing Plant
Rob Fiander, Stantec Consulting Ltd., Saint John, NB

Canada Post commissioned a slope stabilization project to address a deteriorating timber crib retaining wall at their Rothesay Avenue mail processing plant in 2014. The original 250 m long timber crib wall was built in sections in the early to mid-1900s along the banks of Marsh Creek. Prior use of the property for creosote wood treatment resulted in its contamination. Corrective action has been ongoing since discovery of contamination in 1996. Design of the slope stabilization project was optimized to maintain continuity in mail operations and protect critical infrastructure. Approximately 8300 tonnes of creosoted timber cribbing and contaminated soil was excavated and replaced with a rip rap slope. A soil liner and groundwater drainage systems were incorporated into the slope. Waste management, environmental protection and monitoring plans were an integral part of the construction specifications. The waste management plan provided waste characterization information that led to sustainable and cost effective treatment solutions. Water level data logging and weather forecasting were instrumental in construction planning since relatively moderate precipitation can cause run-off to back up in the creek. A number of days were lost due to flooding during construction. To mitigate potential concerns associated with excavation of creosoted timbers and contaminated soils, vapour suppressing foam was used. Ambient and indoor air were monitored using real time point surveys and sample collection procedures. Survey results were used to make changes in construction procedures.

Biotic Earth Hydraulic Growth Mediums (HGM) for Vegetation Establishment
Chris Thomson, Maritime Hydroseed, Saint John, NB

After construction, soil left for revegetation is often severely degraded and lacks many of the essential organics, nutrients and microbial properties necessary to establish, grow, and sustain effective mature vegetation that can withstand the forces of erosion. Through a scientifically balanced combination of specially processed straw, flexible flax fibers, infused with Canadian Sphagnum peat moss, mycorrhizae, Triacontonal growth stimulant, soil conditioners, and micronutrients, you get the best possible soil conditioners in Biotic Earth HGM which help your soil come alive and allow vegetation to thrive even on severely degraded or poor subsoils.

Biotic Earth HGM was developed so that project owners and engineers could use an erosion control product that not only prevent erosion, but first amends the soil with the right combination of organic material, micro nutrients and growth stimulants. Fix the soil you have both efficiently and effectively with science, common sense and good old agronomic know-how and you will achieve your desired results in less time. Make poor soils grow! Biotic Earth adds the much needed organics to the mineral subsoil being amended, giving you the base for which topsoil improves and vegetation grows. Through the addition of various materials, the subsoils will start to exhibit better

aeration, reduced compaction, improved nutrient storage and transfer, improved soil solution management and other essential traits for vegetation establishment and growth. This reduces soil crusting for improved water infiltration and plant establishment. Master gardeners have used peat moss for years as an effective seed germination and growth medium. Now you can increase your vegetation growing success and reduce the need for topsoil utilizing Biotic Earth HGM.