January 31, 2024

Chief Wilbert Marshall, Chair

A meeting of the AFNWA Board will be held on Wednesday January 31, 2024 at 9:30 AM via Zoom.

AGENDA

In Camera Reports

1C Approval of Minutes of the In-Camera Meeting held on November 29, 2023.

2C Business Arising from Minutes

3C Third Quarter Financial Results

Motion: That the AFNWA Board approve the the recommendation as outlined in the confidential report dated January 30, 2024

4C Enterprise Risk Management – Q3 Risk Register

Motion: That the AFNWA Board approve the recommendation as outlined in the confidential report dated January 30. 2024

5C Lennox Island SCADA Owners Engineer

Motion: That the AFNWA Board approve the recommendation as outlined in the confidential report dated January 26, 2024

Regular Reports

1. a) Ratification of In-Camera Motions
   b) Approval of the Order of Business and Approval of Additions and Deletions

2. Approval of Minutes of the Meeting held on November 29, 2023.

3. Business Arising from Minutes of the Meeting.

Information Reports

1-I NSERC Alliance Grant
2-I Integrated Resource Plan
3-1 Information regarding First Nations Drinking Water Class Action

Original signed by

James MacKinnon
Board Secretary

Atlantic First Nations Water Authority
MINUTES
29 November 2023

PRESENT:

Chief Wilbert Marshall
Chief Terry Paul
Chief Leroy Denny
Chief Andrea Paul
Chief Darlene Bernard
Chief Arren Sock
Chief Ross Perley
Todd Hoskin
Tuma Young
National Chief Joanna Bernard
Dr. Shelly Denny

STAFF:

Susheel Arora, CEO
James MacKinnon, Director of Engagement and Government Relations / Board Secretary
Chantal LeBlanc, Director of Corporate Services/ CFO
John Lam, Director of Engineering
Adam Gould, Manager of Communications and Outreach

TABLE OF CONTENTS

CALL TO ORDER

James MacKinnon, upon direction from the Chair, called the regular meeting to order.

1. RATIFICATION OF IN-CAMERA MOTIONS

MOVED BY Chief Terry Paul, SECONDED by Todd Hoskins that the AFNWA Board ratify the In-Camera motions of the November 29, 2023 meeting.

MOTION PUT AND PASSED

2. APPROVAL OF MINUTES – 29 November 2023

MOVED BY Todd Hoskins, SECONDED BY Regional Chief Andrea Paul that the AFNWA Board approve the Regular Minutes from the August 27, 2023, Board Meeting.

MOTION PUT AND PASSED

3. BUSINESS ARISING FROM MINUTES

N/A

4. COMMUNICATIONS STRATEGY

In recognition of the importance of communications and outreach to the success of AFNWA, AFNWA Management has updated the Communications & Outreach Strategy originally contemplated in the Transition Implementation Plan to reflect that we are now fully operational.

For optimal, shared success, a communications and outreach strategy was necessary with long-term planning executed by best practice tactics, which are detailed in the attachment. Members of the Senior Management Team and National PR provided ideas and recommendations which have been incorporated for the Board's consideration.

The revised strategy focuses mainly on external messages to communities and residents, along with similar messaging for Chiefs and Councils, band managers and administration, and other departments such as health.

The strategy outlines communications channels to be used when providing information and updates to key stakeholders. Strategies will provide key audiences and stakeholders updates through tactics by AFNWA Senior Management. The website

provides a permanent digital home and info source for community members and Operators, including background about AFNWA service delivery, how to join AFNWA, and documents that guide our actions and milestones. Social media presence will continue as they have proven communications tools for updating First Nations community members and other key audiences.

MOVED BY Chief Terry Paul, SECONDED BY Todd Hoskins that the AFNWA Board Approve the Communications Strategy with the amendment youth be included as a primary audience.

MOTION PUT AND PASSED

INFORMATION REPORTS

1-I ELDERS ADVISORY LODGE UPDATE

The Elders Advisory lodge held their first-ever in-person meeting on October 26, 2023, in Truro. There, the members of the EAL had the opportunity to share stories and get to know one another. They also had the opportunity to provide insight and direction into several projects they oversee. Below is a synopsis of those projects:

Two-Eyed Seeing Article:

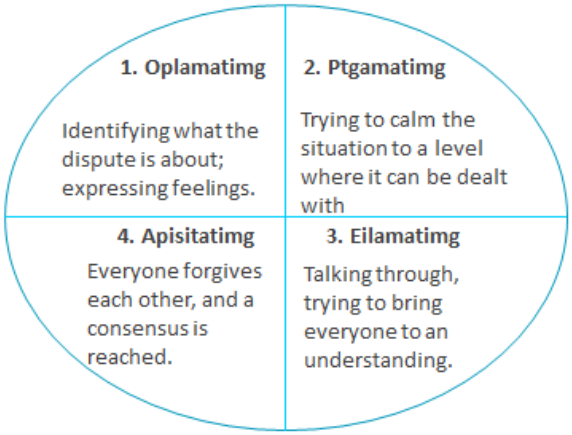
The article is being coordinated by Dalhousie University's Centre for Water Resource Studies and it tells the story of the AFNWA as one of Chiefs, Elders, and community members building their own water utility to ensure safe drinking water and clean wastewater for their communities. It explains that the formation and operation of the AFNWA is guided by Two-Eyed Seeing (Etuaptmumk) principles to deliver services in ways that honour and celebrate First Nations world views and ways of knowing.

The authors of this paper include First Nations Elders and knowledge keepers from the Elders Advisory Lodge (EAL) of the AFNWA, Indigenous and non-Indigenous staff from the AFWNA, and non-Indigenous researchers and faculty from Dalhousie University's Centre for Water Resources Studies (CWRS). The team has come together to tell part of the AFNWA story through experiences with Two-Eyed Seeing with the goal to show others how First Nations knowledge and culture can include western technical practices to build Indigenous-led utilities.

Dispute Resolution:

Our By-Laws allow the AFNWA to create its own, culturally relevant, dispute resolution process. The EAL is currently guiding AFNWA management on its development. Below are elements of the process the EAL are currently considering:

- Dispute Resolution should be organized as a talking circle where all participants are equal. The graphic below shows the four rounds of the circle.



- There should be an elder present during dispute resolution to guide the process.
- The circle should be guided by a trained facilitator.
- Ideally 6-8 People, but may go to 8-12
- Consensus and forgiveness/restoring relationships is the goal of the circle. If consensus and forgiveness/restoration of a relationship is not reached, then begin another circle.
- Circles discussions should be and remain confidential for circle participants. The resolution could be shared if the participants agree.
- Rules for conduct to be set and approved before entering the circle.
- It is critically important that respect be maintained within the circle.

Items currently being worked on:

- What should be the training and qualifications needed for the facilitator?
- How do we appropriately ensure confidentiality?

Guidance

The EAL has also provided guidance on the following AFNWA policies and initiatives:

- Muiwatmnej Etuaptmumk Conference Abstract
- International Water Association (IWA) World Water Congress abstract.
- Residential Lead Sampling
- AFNWA Staff Cultural Training
- AFNWA Fit for Duty Policy

James MacKinnon requests to motion to re-enter in camera.

MOVED BY Regional Chief Andrea Paul, SECONDED by Todd Hoskins that the meeting move in camera at 12:27pm.
MOTION PUT AND PASSED

Item #1-I
AFNWA Board
January 31, 2024

TO: Chief Wilbert Marshall, Chair and Members of the AFNWA Board

SUBMITTED BY: **Original Signed by**
James MacKinnon, Director of Engagement and Governement Relations

APPROVED: **Original Signed by**
Susheel Arora, M.A.Sc., P.Eng., Chief Executive Officer

DATE: **January 25, 2024**

SUBJECT: **NSERC Alliance Grant Award**

ORIGIN

The attached report discussed at the January 25, 2023, meeting regarding Natural Sciences and Engineering Research Council of Canada (NSERC) grant application. The report was approved at the March 29, 2023, board meeting with the following motion passed:

The AFNWA Board approve the submission to the Natural Sciences and Engineering Research Council) Alliance Grant Program, as outlined in the staff report.

BACKGROUND

The Centre for Water Resources Studies (CWRS) at Dalhousie University has provided technical and policy guidance to the Atlantic Policy Congress of First Nations Chief Secretariat (APC) since 2009 in support of the establishment of Atlantic First Nations Water Authority (AFNWA). The CWRS has maintained its role as a technical advisor and facilitator of First Nations water governance as it assisted the AFNWA in becoming operational in late 2022.

Ulnooweg Education Centre is an Indigenous-led registered charitable organization that empowers Indigenous communities through the advancement of education through collaborative research, development, and delivery of educational programs and initiatives in science & innovation, agriculture, and financial literacy through a holistic approach of traditional values in culture and

language.

DISCUSSION

The application stated that this Alliance partnership will establish a substantive and sustained relationship between the Atlantic First Nations Water Authority (AFNWA), Dalhousie University's Centre for Water Resources Studies (CWRS) and Ulnooweg Education Centre (UEC) that will facilitate First Nations-led co-generation of innovation and knowledge in the following priority areas:

- Developing appropriate optimization and innovation to improve and/or modify wastewater treatment technologies to effluent quality to meet National Performance Standards and First Nations priorities of water stewardship and caring for their relationality to Msit No'kmaq
- Expanding wastewater surveillance as a public health monitoring tool to track viruses and other species of interest
- Addressing key long standing knowledge gaps related to the interconnected relationships between drinking water and wastewater quality through longitudinal monitoring of source water, distribution system, and wastewater effluent water quality in a changing climate, particularly regarding corrosion control, disinfection by-product formation, and wastewater nutrient loading
- Improving microbiological safety of both drinking water and wastewater effluent using energy efficient UV-LED technology
- Developing Nujo'tme'k Samqwan Safety Plans/Wolankeyutomune Samaqan (translates as 'we take care of the water'), an operator-informed risk management framework that couples Water Safety Planning and Indigenous understandings of risk, as a proactive and preventive Indigenous management practice in both drinking water and wastewater systems
- Gathering and understanding community perceptions, activities, and relationships with water and wastewater services with the purpose of building a community confidence tool to be used to strengthen the relationship between community members and the AFNWA

This research partnership also has a broad goal of training future Indigenous and non-Indigenous water stewards (referenced to throughout as trainees) with a knowledge of Etuaptmumk and an appreciation for cultural and knowledge system diversity. This work will be guided by, and grounded in, a Wabanaki worldview.

In addition to solidifying our partnerships, the AFNWA had undertaken dedicated outreach to the Elders Advisory Lodge, both individually and as a group, to ensure that First Nations language and traditional knowledge is at the forefront of the research. Therefore, in addition to key staff from Dalhousie, Unlooweg and the AFNWA, the following collaborators were included in the submission:

- ***Tuma Young*** (collaborator, Cape Breton University's Marshall Institute) Assistant Professor, Mi'kmaq Studies at Cape Breton University. He was the first indigenous person to become head of the Nova Scotia Barristers' Society and as far as is known is the first Mi'kmaq speaking lawyer in Nova Scotia history. In 2020 Tuma was appointed Queen's Counsel and in 2022 received the Queen's Platinum Jubilee Medal for services to the Nova Scotia legal profession. **Tuma will provide language and culture guidance, specifically mentor ship for trainees working on Nujo'tme'k Samqwan Safety Planning with a focus on linguistics analysis for interpreting Mi'kmaq values from traditional language.**
- **The Elders Advisory Lodge** (Methilda Knockwood-Snache, Gail Tupper, Dr. David Perley, Ken Francis, Charles Doucette) (collaborators) - the Elders Advisory Lodge will provide crucial guidance to all research staff and trainees to help ground research, learning, and cultural values in Wabanaki traditions and worldviews.

Dalhousie University was informed on December 7, 2023 that the Alliand Grant application was successful for a total funding of $5,000,000. .

BUDGET AND FINANCIAL IMPLICATIONS

AFNWA committed $250,000.00 each year for 5-Years, for a total commitment of $1.25 million. NSERC has committed $750,000.00 each year for 5-years, for a total commitment of a total grant budget of $5,000,000.00.

The workplan for this project encompasses various projects or their elements which are included in AFNWA 10-year capital plan. The funding will be allocated from such projects. It should be noted that there is no line item for the Alliance Grant in the 10-year capital budget.

ALTERNATIVES

None

ATTACHMENTS

NSERC Alliance Grant – March 29, 2023 Board Report

Report Prepared By	Original Signed By James MacKinnon, MPA, Director of Engagement and Government Relations, (902)-401-3092
Financial Reviewed By:	Original Signed By Chantal LeBlanc, CPA, CMA, MBA, CFO, (902)-877-3813

Item # 5C
AFNWA Board
March 29, 2023
In-Camera

TO: Chief Wilbert Marshall, Chair and Members of the AFNWA Board

SUBMITTED BY: **original signed by**
James MacKinnon, MPA, interim Chief Operating Officer

DATE: **March 24, 2023**

SUBJECT: **NSERC ALLIANCE GRANT**

PRIVATE AND CONFIDENTIAL

ORIGIN

Report submitted discussed at the January 25, 2023, meeting.

RECOMMENDATION

It is recommended that the Board approve the submission to the Natural Sciences and Engineering Research Council of Canada's (NSERC) Alliance Grant Program, as outlined in the staff report.

BACKGROUND

The CWRS has provided technical and policy guidance to the Atlantic Policy Congress of First Nations Chief Secretariat (APC) since 2009 in support of the establishment of Atlantic First Nations Water Authority (AFNWA). The CWRS has maintained its role as a technical advisor and facilitator of First Nations water governance as it assisted the AFNWA in becoming operational in late 2022.

Ulnooweg Development Centre is an Indigenous-led registered charitable organization that empowers Indigenous communities through the advancement of education through collaborative research, development, and delivery of educational programs and initiatives in science & innovation, agriculture, and

financial literacy through a holistic approach of traditional values in culture and language.

DISCUSSION

This proposed Alliance partnership will establish a substantive and sustained relationship between the Atlantic First Nations Water Authority (AFNWA), Dalhousie University's Centre for Water Resources Studies (CWRS) and Ulnooweg Education Centre (UEC) that will facilitate First Nations-led co-generation of innovation and knowledge in the following priority areas:

- Developing appropriate optimization and innovation to improve and/or modify wastewater treatment technologies to effluent quality to meet National Performance Standards and First Nations priorities of water stewardship and caring for their relationality to Msit No'kmaq
- Expanding wastewater surveillance as a public health monitoring tool to track viruses and other species of interest
- Addressing key long standing knowledge gaps related to the interconnected relationships between drinking water and wastewater quality through longitudinal monitoring of source water, distribution system, and wastewater effluent water quality in a changing climate, particularly regarding corrosion control, disinfection by-product formation, and wastewater nutrient loading
- Improving microbiological safety of both drinking water and wastewater effluent using energy efficient UV-LED technology
- Developing Nujo'tme'k Samqwan Safety Plans/Wolankeyutomune Samaqan (translates as 'we take care of the water'), an operator-informed risk management framework that couples Water Safety Planning and Indigenous understandings of risk, as a proactive and preventive Indigenous management practice in both drinking water and wastewater systems
- Gathering and understanding community perceptions, activities, and relationships with water and wastewater services with the purpose of building a community confidence tool to be used to strengthen the relationship between community members and the AFNWA

This research partnership also has a broad goal of training future Indigenous and non-Indigenous water stewards (referenced to throughout as trainees) with a knowledge of Etuaptmumk and an appreciation for cultural and knowledge system diversity. This work will be guided by, and grounded in, a Wabanaki worldview.

In addition to solidifying our partnerships, the AFNWA has undertaken dedicated outreach to the Elders Advisory Lodge, both individually and as a group, to ensure that First Nations language and traditional knowledge is at the forefront of the research. Therefore, in addition to key staff from Dalhousie, Unlooweg and the AFNWA, we have included the following collaborators in the submission:

- ***Tuma Young*** (collaborator, Cape Breton University's Marshall Institute) Assistant Professor, Mi'kmaq Studies at Cape Breton University. He was the first indigenous person to become head of the Nova Scotia Barristers' Society and as far as is known is the first Mi'kmaq speaking lawyer in Nova Scotia history. In 2020 Tuma was appointed Queen's Counsel and in 2022 received the Queen's Platinum Jubilee Medal for services to the Nova Scotia legal profession. **Tuma will provide language and culture guidance, specifically mentor ship for trainees working on Nujo'tme'k Samqwan Safety Planning with a focus on linguistics analysis for interpreting Mi'kmaq values from traditional language.**
- **The Elders Advisory Lodge** (Methilda Knockwood-Snache, Gail Tupper, Dr. David Perley, Ken Francis, Charles Doucette) (collaborators) - the Elders Advisory Lodge will provide crucial guidance to all research staff and trainees to help ground research, learning, and cultural values in Wabanaki traditions and worldviews.

BUDGET IMPLICATIONS

A successful application will require the AFNWA to commit $250,000.00 each year for 5-Years, for a total commitment of $1.25 million. We are asking NSERC to commit 3 times this amount for a total annual budget of $1,000,000.00 for five years for a total grant budget of $5,000,000.00.

ALTERNATIVES

None

ATTACHMENT

Draft Alliance Grant Submission

Report Prepared by: original signed by

James MacKinnon , interim COO, 902-401-3092

Financial Reviewed by: original signed by

Chantal Leblanc , CFO, 902-877-3813

Background and expected outcomes

- Outline the goals of the partnership and explain the potential outcomes and impacts.
- Describe the importance of the topic to Canada and how the expected outcomes will benefit Canada.
- Explain the new concepts or directions needed to address the topic and how this research will fill knowledge gaps related to developing new and innovative policies, standards, products, services, processes or technologies in Canada. Position the proposed project relative to other efforts by the researchers and partner organizations and to any related research.
- Outline efforts the partner organizations will invest following the project's completion to advance the results in Canada.

GOALS OF THE PARTNERSHIP & OUTCOMES AND IMPACTS

The Centre for Water Resources Studies (CWRS) has provided technical and policy guidance to the Atlantic Policy Congress Chief Secretariat (APC) since 2009 as it worked to create the first Indigenous owned and operated water utility in Canada. The Atlantic First Nations Water Authority (AFNWA) incorporated in 2018 as a One Water utility by First Nations, for First Nations. The CWRS has maintained its role as a technical advisor and facilitator of First Nations water governance as it assisted the AFNWA in becoming operational in late 2022. This proposed Alliance partnership will establish a substantive and sustained relationship between the AFNWA, Dalhousie University's CWRS and Ulnooweg Education Centre (UEC) that will facilitate First Nations-led co-generation of innovation and knowledge in the following priority areas:

i) Developing and validating appropriate optimization and innovation to improve and/or modify wastewater treatment technologies to meet National Performance Standards and First Nations priorities of water stewardship and caring for their relationality to Msit No'kmaq (Activities A1.1 & A1.2)
ii) Expanding wastewater surveillance as a public health monitoring tool to track viruses (Activity A1.3) and other species of interest (Activity A2.1)
iii) Addressing key long standing knowledge gaps related to the interconnected relationships between drinking water and wastewater quality through longitudinal monitoring of source, distribution system, and wastewater quality in a changing climate. Specific advancements will focus on corrosion control (Activity A2.1), disinfection by-product formation (Activity A2.2), and wastewater nutrient loading (A1.2)
iv) Improving microbiological safety of both drinking water and wastewater effluent using energy efficient UV LED technology (Activities A3.1 & A3.2)
v) Developing Nujo'tme'k Samqwan Safety Plans (translates as 'we take care of the water'), an operator-informed risk management framework that couples Water Safety Planning and Indigenous understandings of risk, as a proactive and preventive Indigenous management practice in both drinking water and wastewater systems (Activities related to Theme B)
vi) Gathering and understanding community perceptions, activities, and relationships with water and wastewater services with the purpose of building a community confidence tool to be used to strengthen the relationship between community members, the AFNWA, and caring for water (Activities related to Theme C).

This research partnership also has a broad goal of training future Indigenous and non-Indigenous water stewards (referenced to throughout as trainees) with a knowledge of Etuaptmumk and an appreciation for cultural and knowledge system diversity. This work will be guided by, and grounded in, a Wabanaki worldview.

BENEFITS TO FIRST NATIONS AND CANADA: Working Together in a Good Way

The formation and incorporation of the AFNWA in 2018 marks the only Indigenous owned and operated water utility in Canada (Lalonde, 2022). Governed by a Board of Directors composed predominantly of First Nations Chiefs and Regional Chiefs and funded by a ten-year business plan, the AFNWA represents a transformation in both the management of, and funding structures for, water and wastewater services in participating First Nations communities (ISC, 2022). As the AFNWA stands up and assumes operational control and legal responsibility for centralized drinking water and wastewater services in participating communities, there are significant knowledge, infrastructure, governance, and capacity gaps that exist. Most importantly, there is a lack of precedence for First Nations-led technological advancements, management practices, and capacity building at this scale in the water sector.

The purpose of this five-year research partnership between the AFNWA, CWRS, and UEC is to address these key gaps through Etuaptmumk (Two-Eyed Seeing) (Bartlett et al., 2012; Reid et al., 2020; UINR, n.d.). Purposeful continued relationship building between the CWRS and partner organizations will couple significant technical expertise with vital traditional knowledge (TK), Elders' guidance, and community contributions. This proposed research will support the AFNWA's mission of providing clean and safe drinking water and wastewater to participating communities while producing key policies, tools, and resources for First Nations communities across Canada. The AFNWA understands its role as a leader in First Nations-led water and wastewater service provision, and seeks to produce policy, practice, and precedent that can be used by other First Nations communities and organizations to move toward self-determination and celebrate First Nations relationship with water.

ADDRESSING KNOWLEDGE GAPS: Research as Self-determination

The formation of the AFNWA has created new and transformative capacity for participating communities to be partners in, and benefit from, collaborative research and development efforts in the water sector. First Nations systems suffer from lack of effective governance, with no drinking water regulations or regulator existent for these systems. The combination of inadequate treatment and lacking regulations has left First Nations communities without comparable access to safe and clean drinking water and wastewater enjoyed by their non-Indigenous neighbors. Long standing knowledge gaps and fragmented management strategies have resulted in insufficient or poorly characterized drinking water and wastewater quality. As a key first-step to addressing these issues, the AFNWA, in partnership with the CWRS, has developed an Interim Regulatory Framework and risk-management practices to elevate and standardize compliance requirements for participating systems. The AFNWA's mission is to improve the level of service, build First Nations' trust in their water, and move toward self-determination for First Nations water governance.

The proposed research partnership will support the AFNWA in achieving its mission and result in significant knowledge co-development grounded in Indigenous ways of knowing that will be shared with other First Nations communities and organizations. Each of the three research themes (A) Technological Advancement in drinking water and wastewater treatment, (B) Nujo'tme'k Samqwan Safety Planning, and (C) Community Capacity for Water Stewardship offer significant opportunities to address the long-standing water and wastewater inequities in First Nations communities through First Nations-led research grounded in Etuaptmumk.

The outcomes of this research will include development of appropriate technology for improved drinking water and wastewater treatment that is in keeping with First Nations mission of stewardship, creation of preventive risk management tools to protect public and environmental health, and community-informed communication and knowledge exchange practices to strengthen community confidence in their water.

PARTNERSHIP COMMITMENT TO KNOWLEDGE SHARING

The AFNWA is already recognized as a key leader in transforming service provision models for First Nations in Canada (APTN, 2021). Early actions of the AFNWA included developing a Supervisory Control and Data Acquisition (SCADA) Master plan to bring all systems up to a modern SCADA standard over the next five years, completing Groundwater Under Direct Influence of Surface Water (GUDI) assessments for all groundwater systems, completing Environmental Risk Assessments (ERAs) for all participating wastewater systems, conducting a risk-based Asset Management Plan for all participating communities, and developing an Interim Regulatory Framework to establish compliance standards for water and wastewater systems. The AFNWA has received the Atlantic Canada Water and Wastewater Associations' Project of the Year in 2021 for the SCADA Master Plan and the Canadian Network of Asset Managers 2022 Tereo Award for Asset Management Plan innovation. Recently, the AFNWA, in partnership with the CWRS, Dillion Consulting, and CBCL Limited were nominated for the Lieutenant Governor's Award for Excellence in Engineering in Nova Scotia for the accomplishment of forming a transformative utility for First Nations communities. The AFNWA is committed to learning and sharing as it grows and matures. The utility is a frequent presenter at the Assembly of First Nations (AFN) Annual Water Summit and a guiding voice in the development of a new Safe Drinking Water for First Nations Act.

This proposed research partnership will further equip the AFNWA with knowledge to continue in its role as a leader in First Nations water and wastewater services. The outcomes from Theme A will result in the development of appropriate treatment technologies and operational practices for First Nations water and wastewater systems and provide crucial case studies to be shared with other First Nations communities. The outcomes from Theme B will produce an operationalized, adaptable preventive risk-based management framework designed and developed for First Nations water and wastewater systems. These tangible work products will be shared with the broader First Nations community across Canada through the AFN Water Summit and through a biannual Water Stewardship Gathering to be hosted by the AFNWA, CWRS, and UEC as a part of this Alliance grant. The outcomes from Theme C will be functional survey approaches and tools that will be utilized by the AFNWA and participating communities and shared with First Nations communities for adaptation.

First Nations ways of knowing and relating are grounded in their language. The AFNWA, through its Elders Advisory Lodge, understand the role it plays to honour and celebrate language and culture. There is a commitment to drafting key articles and communications in Mi'kmaq and Wolastoqey, to be translated into English and French where appropriate.

Partnership

- List all partner organizations expected to play a key role in the activities or to make cash and/or in-kind contributions.
- Describe the core activity of the partner organizations and their experience related to the research project, such as any efforts to date that the partner organizations have invested toward addressing this problem, the need for this research project and how the topic is relevant and aligned with the partner organizations' activities.
- Explain how each partner organization will be actively involved (through cash and/or in-kind contributions) in co-designing and implementing the research program. Describe the value added through in-kind contributions and how these are important to realizing the project's intended outcomes.

- Outline each partner organization's strategy and capacity to translate the research results into practical application to achieve the desired outcomes and impacts, including any planned knowledge translation activities and integration of the research results into its operations.

PARTNER ORGANIZATIONS: Walking Together

Table 1. Organization cash and in-kind contributions.

Partner Organization	Proposal Abbreviation	Total Cash Contribution	Total In-kind Contribution
AFNWA	AFNWA	$250,000	$100,00
UEC	UEC	-	$50,000

DESCRIPTION OF PARTNER ORGANIZATIONS

Atlantic First Nations Water Authority *(Core Activity & Experience)* Currently the AFNWA is composed of eight participating First Nations but could grow to upwards of 19 communities in the coming year. These communities represent a mix of Municipal Type Service Agreements (MTSAs) and community-owned systems for drinking water and wastewater services. The AFNWA is not only a service utility, but a key step towards First Nations self-determination and an embodiment of First Nations cultural commitment to water stewardship and protection of public health of First Nations people, by First Nations people. *(Need & Relevancy)* The AFNWA has identified strategic goals to guide its work, including to improve service delivery, support effective governance, and integrate First Nation culture and tradition to achieve self-determination.

Ulnooweg Education Centre *(Core Activity & Experience)* UEC is an Indigenous organization based in Halifax, NS that is focused on holistic community education with the goal of revitalizing Indigenous culture and language for youth and all community members. UEC has extensive experience in developing teaching and learning experiences through courses, workshops, and trainings that centre on Indigenous worldviews and honouring Indigenous values. UEC recently received an NSERC PromoScience grant to fund advanced STEM capstone projects for high school students. UEC also partnered with Ocean Supercluster and the Joint Economic Development Initiative to develop the Indigenous Career Pivot Project to facilitate meaningful work placements for Indigenous peoples interested in exploring career options in Ocean Supercluster member companies. *(Need & Relevancy)* UEC will bring this experience in youth education and career path building to this research partnership. These activities will extend the mission of the UEC and strengthen STEAM innovation and capacity building in First Nations youth.

PARTNER ORGANIZATIONS: Collaboration and Co-development

Atlantic First Nations Water Authority AFNWA's in-kind contribution of $100,000 will consist of project management support and operational and engineering staff time to execute certain technical aspects of this work. The Senior Management Team will actively guide and inform the research agenda for Theme A, including site selection, engineering support, project management, technology installation, and data review. Operations and Engineering staff time will be utilized for sample collection, installation of monitoring equipment, UVLED treatment infrastructure, and data management. AFNWA's Operations Engineer will co-lead Theme B and work closely with the CWRS team on Nujo'tme'k Samqwan Safety Plan design, development, and pilot implementation. AFNWA's Communication team will support key aspects of Theme C including review and guidance on community outreach and communication. All three themes will require significant support from water and wastewater operators. Further, the Elders Advisory Lodge will play a key role in ensuring this research is grounded in, and guided by, Wabanaki knowledge and ways of knowing.

Ulnooweg Education Centre UEC's in-kind contribution of $50,000 will support the co-development and implementation of training programs, youth outreach activities, and skills-based workshops. This in-kind contribution will consist of management support, direction, and consultation at the management level, with key staff time being utilized to operationalize and deliver programs, activities, and workshops on an as-needed basis. UEC will play a central role in the knowledge mobilization and community engagement through all aspects of this project.

KNOWLEDGE TRANSLATION: Sharing our Stories

Partnership Sharing

- AFNWA – The *CEO* and *COO* of the AFNWA will prepare Board reports to communicate project progress and success to both the Board of Directors and the Elders Advisory Lodge. It is at this level that matters related to business, financial, capital approvals, etc. are discussed and approved. As needed, findings and updates may also be shared with Indigenous Services Canada (ISC), as the AFNWA continues to collaborate with ISC regarding oversight of compliance standards. The AFNWA will ensure that all community participants and community leaders are aware of the outcomes of the research. Major research progress will be shared through the AFNWA Newsletter, *Samqan/Samaqan+Sage*. The AFNWA will also share key research progress and findings with water and wastewater operators at quarterly workshops.

- UEC – The *COO* and *Director of Science & Innovation* of UEC will prepare Board reports to communicate project progress and success to the Board of Directors. *Communications Manager* will prepare team-wide updates to ensure the UEC team is kept informed about the project's progress.

Turtle Island Sharing

- **Water Stewardship Gathering -** To ensure that AFNWA's First Nations-led technical advancements in water and wastewater treatment are shared widely with other First Nations, Indigenous organizations, and researchers in the field, a Water Stewardship Gathering will be held in years 1, 3, and 5 of this grant to tell the stories and lessons learned. A one-day symposium of knowledge sharing will bring leaders and learners together to talk about successes and challenges in water and wastewater treatment, operational practices, monitoring processes, and water stewardship. This annual event will be co-planned by the CWRS, AFNWA, and UEC and held in a First Nations community participating in the AFNWA.
- **Youth Water Summit –** A key element of this research proposal is capacity building, with a focus on community engagement and pathway development to work in the water sector. In years 2 and 4 of the grant a Youth Water Summit will be held to bring together First Nations youth to highlight the importance of caring for the water. Students who worked in-community to support this project will share their stories and training and workshops will be provided for any youth interested in learning about water. This event will be held on UEC's land, Asitu'lisk. Asitu'lisk is located in the Pijnuiskaq watershed near Sin So'sepe'katik (Bridgewater, Nova Scotia). This land was recently returned to the Mi'kmaq people in the spirit of Truth and Reconciliation. UEC now cares for this land and uses it for land-based education for a variety of programs. The farm is now used to teach the meaning of Msit Nokmaq, promote Netukulimk, and is a living lab for Etuaptmumk.

Proposal

- Outline the research objectives. Detail the resources and activities needed to achieve the anticipated results.

- Indicate approximate timelines for the activities to lead to milestones and deliverables using a Gantt chart, table or diagram.
- Explain how sex, gender and diversity have been considered in the research design, if applicable.
- Identify the indicators and methods for monitoring progress during the project and for assessing the outcomes. You may include a chart or table.

RESEARCH OBJECTIVES

THEME A: TECHNOLOGICAL ADVANCEMENT

Objective A1: Improvement of wastewater treatment with low-energy and sustainable solutions

Background A.1 Wastewater Treatment and Surveillance

The AFNWA currently serves eight communities and is expected to provide service to as many as 19 First Nations communities located in the Atlantic Region. Several of these communities have MTSAs and receive services from adjacent municipalities. The majority of the community-based systems (9) use aerated or facultative lagoons for wastewater treatment while the remaining have sequencing batch reactors (SBR) (2) or rotating biological contactors (RBC) (2). Preliminary effluent characterization work has been completed by the AFNWA through the completion of Environmental Risk Assessments (ERAs) following CCME's Canada Wide Strategy for the Management of Municipal Wastewater Effluent (CWS). These studies established system-specific Effluent Discharge Objectives (EDO) recommendations based on receiving body characteristics. Preliminary characterization revealed that some systems fail to meet the National Performance Standards (NPS) set by the Wastewater System Effluent Regulations (WSER), with many exceeding nutrient and microbiological EDOs established based on receiving body vulnerability.

Additionally, the AFNWA is interested in engaging in wastewater surveillance (WWS) to address key public health concerns. During the peak of the SARS-CoV-2 pandemic ,Pictou Landing First Nation (an AFNWA founding community) participated in a New Frontiers in Research Fund (NFRF) project, *Next Generation Wastewater Surveillance: Reliability, Specificity and Equity,* awarded to researchers at the CWRS to develop passive sampling approaches to monitor for multiple pathogens of concern, including Influenza and SARS-CoV-2. The community valued the holistic and unobtrusive nature of wastewater surveillance as an early detector for infections in the community. The AFNWA and CWRS will continue this work to develop other novel surveillance protocols for a range of applications.

Activity A1.1 Achieving National Performance Standards (BOD, TSS, Unionized Ammonia)

This research will focus on lagoon treatment systems, as they represent the most common wastewater treatment system in participating communities. This work will evaluate current treatment efficacy of three selected lagoon systems and investigate optimization approaches to achieve wastewater effluent quality regulatory requirements. The selection of the systems to be studied will be prioritized i) by historical carbonaceous biochemical oxygen demand (CBOD), total suspended solids (TSS), and unionized ammonia exceedances and ii) vulnerability of the receiving environments. Following the work of Ragush et al. (2015) and Smyth et al. (2018), **Task 1** will assess lagoon functionality to characterize current treatment efficiency and understand current lagoon operation practices. Influent/effluent and inter- and intra-cell characterization studies will be completed to identify potential causes of treatment failures and possible mechanisms of treatment enhancement. **Task 2** will design optimization trials to improve wastewater treatment processes. These studies will be implemented and evaluated by a collaborative team of CWRS and AFNWA staff with a focus on developing Etuaptmumk practices that can be adapted and shared with other First Nations communities to guide engineering projects.

Lagoon study

- Influent, effluent, and intra- and inter-cell water quality will be monitored either by grab or composite sampling for key parameters including NH_4, NO_3, total suspended solids (TSS), Alkalinity, Total Nitrogen, and Total Phosphorus (this monitoring will also support Activity A1.2).
- Lagoon cell characterization will include establishing hydraulic retention times, sludge depth profile and continuous monitoring of temperature, pH, and dissolved oxygen (DO) as a function of depth.
- Determination of presence/abundance of functional bacteria through DNA sequencing and evaluation of control on bioremediation efficiency.
- Determination of treatment inefficiencies potentially caused by short-circuiting, sludge accumulation, insufficient dissolved oxygen, excess organic loading, etc., as determined by diagnostic BOD and TSS studies and hydraulics analysis.

Recent advances in lagoon optimization research include the addition of immersed media to promote biofilm formation and functionality (Anderson et al., 2020; Boutet et al., 2018; Mattson et al., 2018) and microbiological diversity analysis to inform possible bioaugmentation efforts (Pishgar et al, 2017; Pishgar et al., 2020). These emergent treatment optimizations are of particular interest because they offer relatively low-cost interventions, with minimal operational changes to the passive nature of lagoon systems. Further, these advancement options capitalize on the natural bioremediation processes possible in lagoon systems. While microbial communities within wastewater treatment processes are responsible for nutrient sequestration, reduction of BOD, and settling of TSS, lagoons are operated with limited knowledge of the make-up of these communities (USEPA, 2011). The CWRS Wastewater Technology Laboratory is equipped with an Illumina NextSeq 1000, an integrated sequencing system that supports automated generation of DNA clonal clusters by bridge amplification, sequencing, primary analysis, and secondary analysis. With this technology, sequencing of the microbial community present in lagoons can be aligned with process parameters and other biomass indicators to optimize lagoon operation. Further, community analysis may facilitate microbiological augmentation through alteration of operational conditions (altering organic loading, aeration rate, hydraulic retention time, etc.), incorporation of biofilm carriers, or microbiome engineering to improve wastewater effluent quality. The AFNWA and CWRS are well positioned to contribute to lagoon optimization research that will benefit numerous First Nations wastewater treatment systems. First Nations natural laws prioritize sustainable and low impact natural resource management practices centered on Netukulimk and Msit No'kmaq (Prosper et al., 2011). Significant consultation and co-development with First Nations wastewater operators will inform what specific interventions are selected for bench-scale and field-scale optimization studies.

Activity A1.2 Addressing Phosphorus Removal to achieve system specific EDOs

Beyond the regulatory obligations of WSER's NPS, the AFNWA is committed to following Canadian Guidance Framework for the Management of Phosphorus in Freshwater Systems and aims to control eutrophication in the receiving waters by treating effluent to below system-specific historic ambient total phosphorus status. Certain AFNWA communities that rely on lagoon systems will aim for effluent total phosphorus levels of 0.02 mg/L. Natural removal of phosphorus in lagoon systems is limited to biomass assimilation and precipitation mechanisms and is known to be particularly limited in cold climate lagoons (Smyth et al., 2018). While it is possible that the treatment enhancements studied in Activity A1.1 may result in additional total phosphorous removal through biomass sequestration, to significantly increase treatment efficiency of total phosphorous in lagoons additional technologies may need to be considered.

As in Activity A1.1, optimization studies will be co-designed in partnership with the AFNWA and community wastewater operators to investigate sustainable and operationally feasible processes to reduce total phosphorus in wastewater effluent. Significant research has been conducted on a range of treatment mechanisms for phosphorus removal in mechanical treatment systems including adsorption (Blanco et al.,

2016), chemical precipitation (Li et al., 2022), and enhanced biological removal (Zhang et al., 2022), however these processes have limitations in passive treatment systems with relatively low phosphorus concentrations (< 10 mg/L). Recent research has shown electrocoagulation to be an effective method for phosphorus removal from a range of wastewater sources (Devlin et al., 2019; Zhang et al., 2016). Electrocoagulation generates *in situ* coagulants, usually Fe^{2+} or Al^{3+} depending on the sacrificial anode material and removes phosphorus through the formation of insoluble ((oxy)hydr)oxides (Lee & Gagnon, 2014; Tegladza et al., 2021). Franco et al. (2017) found electrocoagulation with an aluminum anode capable of 99% phosphorus removal from surface waters and wastewaters with initial phosphorus concentrations less than 2 mg/L. This technology is of particular interest to the AFNWA because of its simple, efficient, and potentially sustainable nature. Nawarkar & Salkar (2019) found that solar powered electrocoagulation with aluminum electroplates capable of generating a current density appropriate for removing 92% COD and 94% turbidity in a short retention time (< 24 minutes). The use of a renewable energy source to drive nutrient capture is a key priority to the AFNWA and First Nations communities. **Task 1** of the proposed work will evaluate electrocoagulation as a feasible treatment technology for up to three select AFNWA lagoon systems by quantifying phosphorus removal under varying wastewater conditions (e.g. temperature, pH, DO) from three lagoon wastewater effluents in bench-top validation studies. **Task 2** of this work will install prototype systems in up to three AFNWA lagoons to investigate capacity for continuous operations in the field and configurations (e.g. battery, solar) to fuel electrocoagulation cells with sufficient current density to effectively remove phosphorus.

Further, per Objective C1: Understanding Community Knowledge and Needs, the AFNWA and CWRS will work to understand causes of elevated phosphorus in select wastewater systems through community surveys and knowledge gathering. In addition to the development of wastewater treatment technology to remove phosphorus from effluent, behavioural changes and conservation measures will also be considered. First Nations stewardship is guided by understanding the interconnectedness of all things (Prosper et al., 2011), so characterizing sources of phosphorus upstream of wastewater treatment processes may offer an opportunity to reduce influent phosphorus concentrations through adaptation prior to treatment.

Activity A1.3 Monitoring Viral Pathogens in Wastewater to Support Community Health

The CWRS is a leader in WWS methodologies to monitor SARS-CoV-2 in centralized wastewater systems (Hayes et al., 2021; Huang et al., 2021; Parra Guardado et al., 2021). WWS was recognized as a valuable tool for tracking community viral loads as it is an environmental monitoring technique that provides a spatially relevant, anonymous signal for viral prevalence in communities or subpopulations that is both independent of individual's medical-seeking behaviour and detects viral presence in advance of clinical indicators (Manuel et al., 2021). This non-invasive early detection monitoring strategy has provided advanced and localized knowledge to inform public health responses, but the preponderance of the data collected has been from municipalities and non-Indigenous communities. First Nations communities view the protection of public health and community action very differently than non-Indigenous communities. There is a need for First Nations-led WWS data collection and associated community health response and planning. The CWRS partnered with the AFNWA and Pictou Landing First Nation in a recent NFRF project to develop WWS techniques for monitoring other pathogens of concerns. In this **Task** the CWRS and AFNWA will continue WWS in Pictou Landing First Nation and expand the monitoring in up to five additional interested communities to monitor for pathogens of concern using the multiplexing methodology recently developed through the NFRF project. This multiplexing qRNA extraction assay monitors for Respiratory Syncytial Virus (RSV), Influenza, and SARS-CoV-2 simultaneously from a single passive sampler deployment. The NFRF collaboration with the AFNWA and Pictou Landing First Nation established deployment methods, training materials, and sampling logistics that will support the expansion of this research program. Further, this research will allow First Nations to use their own community WWS data to inform community health planning and protective actions.

Objective A2: Drinking water quality improvements to protect public health
Background A.2 Drinking Water Treatment

As with wastewater services, several AFNWA participating First Nations communities receive drinking water through MTSAs. These systems receive water treated by adjacent municipal systems, but often own and maintain certain elements of the distribution system. Of the community-based systems, all but one relies on groundwater as the drinking water source. Due to a complex history of underfunding, short-term planning, and lack of regulatory standards, many First Nation systems have poorly characterized source waters and inconsistent, and in some cases, insufficient treatment technology to achieve Health Canada's recommended 4-log reduction in viruses and 3-log reduction in enteric protozoa (Neegan Burnside Ltd., 2011; OAG, 2021).

The AFNWA partnered with the CWRS to develop its own set of compliance standards and treatment requirements to identify gaps in current water treatment facilities and establish a robust water quality monitoring program. The CWRS research team led the regulatory development process and has finalized the first regulatory framework for First Nations systems. This Interim Regulatory Framework was recently adopted by the AFNWA's Board of Directors and will serve as the utility's drinking water regulations until such time that federal legislation, regulations, and regulator come into effect. The Framework requires, among other things, source water protection plans, viral and protozoa log reductions based on source water type, and the implementation of a robust annual sampling plan to monitor treatment processes and distribution system water quality. There are significant treatment and monitoring gaps that the AFNWA needs to close in order to achieve compliance with the Interim Regulatory Framework.

Activity A2.1 Water quality assessment to inform corrosion control treatment and management optimization

Previous research conducted at the CWRS has demonstrated the presence of lead in several First Nation communities in the Atlantic Region (Lane et al., 2020). Work by Lane et al. (2020) found that some community systems in the Atlantic Region have experienced lead, manganese, or arsenic exceedances over the last 10 years, however little is known about the sampling methods associated with this historical data. The recent First Nations Food, Nutrition and Environment Study (FNFNES) found that of 1561First Nations households sampled across 91 First Nation communities, 8.4% (first draw) were found to have lead exceedances above Health Canada's Maximum Acceptable Concentration (MAC) (Schwartz et al., 2021).

Beyond these two studies, there are few data available characterizing lead in the drinking water of First Nations communities. Health Canada's *Guideline Technical Document* on lead, for instance, does not include any (Health Canada, 2019). To the AFNWA's knowledge, no participating community has a residential dwelling sampling plan for lead monitoring. The AFNWA, through the creation of the Interim Regulatory Framework have established compliance standards for corrosion monitoring for participating First Nations. This will be the first monitoring program of its kind.

The AFNWA and CWRS have conducted a preliminary survey of lead in select taps in buildings serving children in a First Nations community and 35 of the 55 taps tested had lead levels above the MAC. With improved understanding of corrosion in the distribution systems of participating communities, there may be a need for corrosion control programs to be developed. However, the challenges of phosphorus removal in many First Nations wastewater systems (Objective A1.2), and the importance of watershed stewardship, mean that the most common remedy for high lead levels—orthophosphate—may be difficult to apply. To protect both human and environmental health, the AFNWA aims to develop a comprehensive understanding of corrosion, and effective monitoring is the first step to achieving this.

Research Activities for Corrosion Monitoring

- **Sampling in homes and public buildings -** The goal of **Task 1** is to quantify drinking water lead in all AFNWA participating First Nations communities. Samples will be collected at residences according to a 30-minute stagnation sampling protocol, as detailed by Health Canada (Health Canada, 2019). Residences will be selected with the help of a community representative, conducted by community water operators and/or community research team members, and analyzed at the CWRS at Dalhousie University.
- **Copper pipe racks with lead-soldered joints - Task 2** is intended to complement sampling in homes and public buildings, yielding a high-quality dataset of lead and copper release into drinking water over time. It will allow the AFNWA to understand the impacts of water quality changes on metals release and better plan corrosion control programs. This will be a first-of-its kind monitoring approach in Atlantic region First Nations communities and will provide vital information for distribution system management.

The design will be modeled after a system currently used by Halifax Water to monitor lead release in the major systems it serves (Krkosek et al., 2022). Briefly, pipe racks will be located at various points in the distribution system and will receive water through timed valves that regulate flow and flow duration. Each rack will include four replicate copper pipe sections with lead-soldered joints along their lengths. Samples will be collected regularly by community water operators and/or community research team members and analyzed at the CWRS at Dalhousie University.

- **Wastewater monitoring of lead using passive and grab sampling -** Because there is an absence of historical residential lead monitoring data in First Nations communities, there is a need for novel, spatially comprehensive monitoring to understand lead presence within communities. Exhaustive residential sampling is a burden to community members, cost prohibitive, and may not identify sources of lead in premises plumbing, depending on sampling method used. Wastewater monitoring to establish lead presence and levels can be deployed in spatially relevant ways using the wastewater collection system to capture data at street and neighborhood resolution. The goal of **Task 3** will be to sample wastewater identify areas with relatively elevated lead levels in wastewater samples to locate homes with lead plumbing components. For instance, if lead in wastewater from a particular street is unusually high, homes on that street become good candidates for inspections to identify plumbing containing lead. While there is precedent in the literature for monitoring lead in wastewater (Roy and Edwards, 2020), we are not aware of monitoring to quantify lead in wastewater by street.

This work will compare passive sampling—where a porous container filled with adsorbent is used to concentrate lead *in situ*—with grab sampling—collecting discrete samples of wastewater in up to five First Nations communities. Passive sampling has been used recently to detect SARS-CoV-2 in wastewater (Hayes et al., 2022), and it will be tested here using standard adsorbents for lead (e.g., granular activated carbon). If possible, background lead concentrations will be estimated using wastewater discharged from homes without lead plumbing; these will be compared to concentrations representing wastewater discharged from homes with known lead plumbing. Lead will be quantified throughout using standard analytical methods (EPA 3050B, EPA 208).

Objective A2.2 – Characterize disinfection by-product formation in treated and distributed water to inform optimization and management strategies

Research conducted at the CWRS has demonstrated the occurrence widespread increases in the concentration of natural organic matter (NOM) as indicated by color, dissolved organic carbon (DOC) or total organic carbon (TOC) in surface waters throughout the Northern hemisphere (Anderson et al., 2023).

Surface drinking water supplies in the Atlantic Canada region have seen up to 4-fold increases in organic matter concentration (Anderson et al., 2017). Our team has identified declining atmospheric acid deposition and climate change pressures (Anderson et al., 2017; Redden et al., 2021; Anderson et al., 2023) as a main driver for increasing organic matter quantity in regional drinking water supplies. Such changes in surface water quality are also anticipated to impact medium and high-risk GUDI wells, which may be subjected to elevated NOM levels through surface water influences.

The CWRS research team has extensive experience in determining DBP formation potential in addition to water quality monitoring and characterization to inform operational and water quality management controls to reduce DBP concentrations in drinking water. For example, our team developed a simple model to predict DBP formation in treated drinking water using fluorescence spectroscopy (Trueman et al., 2016). We anticipate that a simplified version of this tool could be beneficial for AFNWA systems in understanding the sources and occurrence of THMs and HAAs.

The CWRS will work with the AFNWA to characterize DBP formation potential in select systems and develop treatment optimization and management strategies to reduce DBP concentrations.

- **Baseline data collection** - In **Task 1** we will conduct baseline assessments of DBPs and DBP precursor material in source and treated waters including water leaving the treatment plant and multiple points along the distribution system in up to 6 communities. This will include water quality monitoring (e.g., free chlorine residual, temperature, pH, DOC), instantaneous THMs and HAAs as well as THM and HAA formation potential. We will also use fluorescence spectroscopy to predict DBP formation which will be compared against measured samples. We will focus initially on the surface water system and the high-risk GUDI systems, with the opportunity to extend to additional locations as the Alliance progresses. Sampling will occur monthly in order to capture seasonal changes in source and treated water quality.

- **Operational monitoring -** In **Task 2,** in conjunction with samples collected in Task 1, we will also collect complimentary information on treatment plant (e.g., chemical dosing) and distribution system operations (water age, storage, rechlorination status) which will be used to help inform source and/or cause of potential THM and HAA exceedances.

- **Development of management strategy -** In **Task 3** we will use the information obtained through Tasks 1 and 2 to guide the development of treatment and/or distribution system management strategies for the AFNWA systems. As an example, such strategies could include recommendations for optimization of specific unit processes (e.g., NOM removal, chlorination). It is anticipated that this assessment will ultimately assist the AFNWA systems in becoming more resilient to climate change pressures.

Objective A3: UV LED treatment evaluation in drinking and wastewater systems
Background A3

Drinking Water: The lack of robust GUDI assessments of First Nations community drinking water systems in the Atlantic region has resulted in an over-reliance on chlorine disinfection as the only method of pathogen control in many water treatment facilities. The AFNWA is in the process of completing GUDI assessments for all ground water systems in participating communities. Preliminary findings indicate that up to five communities have medium to high-risk GUDI wells and lack necessary treatment processes. Groundwater under the direct influence of surface water has increased likelihood to transmit Cryptosporidium parvum, Giardia, and other microbiological pathogens that are resistant to chlorine disinfection. Health Canada guidelines recommend public drinking water systems with GUDI source water employ UV disinfection to inactivate enteric protozoa (Health Canada, 2012). Most conventional treatment systems rely on mercury vapor lamps that emit radiation at 254 nm. UV disinfection is highly effective in

pathogen control across a variety of water matrices, mercury-based UV disinfection poses an environmental concern as the mercury used for light generation in the lamps is toxic, the lamps operate at maximum energy efficiency between 30-35% creating a high energy demand (Ibrahim et al., 2014), and the high operating temperatures of the lamps cause issues of organic and inorganic fouling of the protective quartz lamp sleeves which decreases the efficacy of UV disinfection (Wait et al., 2005). The CWRS team led ground-breaking work in the disinfection of biofilms (Gora et al., 2019) and community wastewater (MacIsaac et al., Unpublished Manuscript) using UV LED technology and are currently investigating the feasibility of UV LED disinfection in full-scale drinking and wastewater treatment facilities.

The CWRS and AFNWA are well positioned to support First Nations communities in leapfrogging conventional mercury lamp UV technology in GUDI systems in need of additional disinfection modalities. The integration of UV LED disinfection technology allows First Nations to contribute to research on how to scale and build climate responsive technologies. First Nations ways of knowing and guiding principles of Netukulimk and Msit No'kmaq are vital contributions to developing this novel technology that addresses two key areas of sustainable progress - SDG6 (Availability and Sustainable Management of Water and Sanitation for All) and SDG13 (Climate Action). UV light emitting diodes (LEDs) address the previously mentioned drawbacks of conventional wastewater UV disinfection, while providing a climate responsive solution (Chen et al., 2017; Sharma & Demir, 2022).

Wastewater: Improving microbiological safety in wastewater disinfection systems using energy efficient UV LEDs shows promise based on recent research from CWRS. Wastewater treatment facilities in First Nations are regulated only by the WSER standards and do not have established microbiological effluent limits. The AFNWA, following the CCME's CWS is committed to producing wastewater effluent that protects the environmental health of the receiving environment and aligns with First Nations natural laws of Netukulimk and Msit No'kmaq. The AFNWA will aim to achieve Health Canada's Guidelines for Canadian Recreational Water Quality for primary or secondary contact at the edge of the mixing zone (200 E.coli/100mL and 1000 E.coli/100mL respectively) depending on the nature of the receiving body. Currently, many of the First Nations wastewater systems under the AFNWA's care either have no disinfection process, use unoptimized conventional UV disinfection, or use chlorination, which presents risks to receiving environments. The adoption of UVLED treatment in wastewater disinfection offers a potentially more environmentally sustainable and less operationally intense approach to UV treatment for First Nations communities. Nearly all of the participating communities are in need of either UV treatment upgrades or initial installation. The CWRS research team is well positioned to support the AFNWA as a First Nations leader in the implementation of this climate responsive technology.

Activity A3.1 Drinking Water Disinfection Efficacy in Small Systems

AquiSense Technologies have flow through UV units capable of accommodating a wide range of flowrates. The LEDs supplier is consistent between scales of use which ensures smooth translation of data as each tier of flow is examined. 280nm UV LEDs as the working light source for full-scale systems as they are currently the most energy efficient UV-C LED technology.

- **Bench-scale biodosimetry -** In **Task 1** a bench-scale biodosimetry study will use challenge organisms, such as MS2, to provide accurate data on microbial inactivation from collimated beam UV LED devices. Experimental conditions will be informed from an evaluation and harmonization of existing protocols for UV disinfection bench scale studies (Bolton and Linden, 2003; Beck et al., 2017; Watanabe and Oguma, 2022). Inactivation effectiveness will be assessed in drinking water matrices from three participating AFNWA systems. Bench-scale studies will also be paired with full-scale disinfection processes such as UV and chlorine. Comparing bench-scale data to full-scale disinfection efficacy will better inform the scalability of UV LED disinfection. Furthermore, the energy usage considerations will be analyzed to contextualize how UV LED disinfection compares to conventional

systems. UV LEDs can be instantaneously cycles on or off without a warmup time whereas conventional UV disinfection systems require several minutes of warming before they are capable of effectively disinfecting influent water.

- **Full-scale feasibility of UV LED systems -** In **Task 2** the CWRS and AFNWA will install and test either 10 gpm UV LED (Deca, AquiSense Technologies) or 100 gpm 280 nm UV LED (PearlAqua, AquiSense Technologies) disinfection systems at two select GUDI drinking water systems, dependent on peak daily flow. Performance evaluation will include influent and effluent monitoring of TSS, Iron, TOC/DOC, UVT, and florescence excitation emission matrices (FEEM). The UV auditing approach that has been published by CWRS will also be used to assess how UV LED technologies compare to existing conventional UV disinfection systems (Rauch et al., 2022). The full-scale systems will also be assessed for fouling and LED failure at the end of the installation period. Understanding the robustness of these technologies is crucial as conventional UV disinfection systems require intensive cleaning and upkeep costs due to scaling and lamp breakage. Fouling will be assessed following the citric acid wash method (Nguyen et al. 2019). Fouling effluent will further be collected and analysed using a field flow fractionation method published by CWRS (Trueman et al., 2019). Characterization of scaling and foulants will provide important information for UV LED applications as there are no known publications which investigate these effects.

Activity A3.2 Wastewater Disinfection Efficacy in Small Systems

Several AFNWA wastewater systems currently have aging traditional UV treatment systems in place. Limited maintenance and problematic lamp fouling have resulted in decreased treatment efficacy over time. There are also wastewater treatment facilities that currently do not disinfect wastewater effluent before release. These systems will be prioritized in this research. UV LED systems will be installed and evaluated in several select systems.

- **UV auditing-** In **Task 1** up to five AFNWA wastewater systems will have UV auditing completed to determine LED treatment feasibility (Rauch et al., 2022). UV auditing will identify system and matrix limitations for water matrices and provide an estimate of the delivered fluences for full scale UV LED applications.
- **Full-scale feasibility of UV LED systems - Task 2** will evaluate full-scale disinfection capability using a long-term monitoring program. The monitoring program will also consider the effects of fouling and scaling on disinfection performance. Conventional UV disinfection lamps are hot on the surface and induce scale formation via minerals which are present in influent wastewater. These scales impede the emittance of UV light over time and require laborious maintenance to remove foulants. UV LED panels are cool on the emitting side and therefore are not anticipated to foul as easily as conventional lamps. The study of fouling in full-scale UV LED reactors has not been conducted by any other research group and presents itself as an immense opportunity for CWRS and AFNWA to be leaders in understanding this technology. CWRS and AFNWA researchers and staff will install appropriate UV LED units in select systems and monitor bacteriological inactivation using Colilert analysis (most probably number, MPN per 100 mL), turbidity, TOC, chemical oxygen demand (COD), TSS, alkalinity, UVT, and Iron (total, dissolved, ferric, and ferrous). This research will contribute to the CWRS's ongoing challenge testing to establish EV LED technology as an industry standard for wastewater disinfection at full-scale facilities.

<u>THEME B: Nujo'tme'k Samqwan Safety Planning –</u> *<u>Water Safety Planning</u>*

Background B.

Building First Nations water and wastewater operational capacity and competency through training and investment in human capital have been identified as key challenges that have been largely unaddressed or under-funded by federal programs (Patrick et al., 2011; Hrudey, 2013). The AFNWA is the first legally responsible First Nations organization of this kind with the mission to produce safe drinking water and

clean wastewater for First Nations, by First Nations. The AFNWA's mandate is clear - to provide safe drinking water and clean wastewater to participating communities through management grounded in First Nations traditional knowledge and culture, including environmental stewardship, the spiritual aspects of water and Two–Eyed Seeing. AFNWA's central method of embedding First Nations ways of knowing and cultural values into water management is the development of a preventive risk management approach to water stewardship, modeled after the World Health Organization's Water Safety Plans (WSP). The AFNWA has partnered with the CWRS to co-develop this management framework, Nujo'tme'k Samqwan Safety Planning (NSSP; translates to we take care of the water). The CWRS has significant experience in Water Safety Planning research, including evaluating the implementation of WSPs in Alberta, the only Canadian jurisdiction to regulate the use of WSP in drinking water management (Reid et al., 2014). Perrier et al. (2014) documented key barriers and valuable benefits of WSPs in small communities in Alberta and found that WSPs served as important communication tools for the multiple stakeholders in drinking water systems (Perrier et al., 2014). Work by Kot et al. (2015) considered the role of community readiness, non-technical operational and human factors in WSP adoption and success. Work by Lane et al. (2022) was coauthored by a First Nations community water operator and presents the co-development of a web-based application to generate operator-informed risk assessments to assist in risk reduction management decisions. The CWRS, AFNWA, and APC recently completed 2020 NSERC Alliance Grant [*Water Safety Planning in Partnership with the Atlantic First Nations Water Authority: A Strategy for Water Regulation*], which has resulted in frameworks and tools to guide an Indigenous water safety planning process, named by AFNWA Elders Advisory Lodge, Nujo'tme'k Samqwan (we take care of the water) (Lane et al., 2021; Lane et al., 2022).

Objective B1: Understanding Hazards and Risks through Two-Eyed Seeing

This research objective aims to further co-develop and operationalize the NSSP framework for participating communities. While there is a wealth of research, information, and guidance on creating WSPs for rural and urban systems in both developed and developing countries, there are limited examples of risk management built on Indigenous knowledge systems and traditional ecological knowledge (TEK) (Black et al., 2017). Figure 1 shows the medicine wheel NSSP framework, co-developed by the AFNWA Elder Advisory Lodge and CWRS researchers. This graphic depicts the hazard identification and risk reduction process and the cycle of incremental improvement. Central in the medicine wheel are key Wabanaki worldview tenets (participating Mi'kmaq and Wolastoqey communities are located in the broader Wabanaki Confederacy in what is now known as the Atlantic region of Canada). These principals are meant to guide the four stages of NSSP in a good way. The NSSP approach was shared at the International Water Association (IWA) and WHO Water Safety Conference 2022 and represents one of the few WSP-based water management programs in North America (Yates et al., 2022).

Objective B1: Understanding Hazards and Risks through Two-Eyed Seeing

This research objective aims to further co-develop and operationalize the NSSP framework for participating communities. While there is a wealth of research, information, and guidance on creating WSPs for rural and urban systems in both developed and developing countries, there are limited examples of risk management built on Indigenous knowledge systems and traditional ecological knowledge (TEK) (Black et al., 2017). Figure 1 shows the medicine wheel NSSP framework, co-developed by the AFNWA Elder Advisory Lodge and CWRS researchers. This graphic depicts the hazard identification and risk reduction process and the cycle of incremental improvement. Central in the medicine wheel are key Wabanaki worldview tenets (participating Mi'kmaq and Wolastoqey communities are located in the broader Wabanaki Confederacy in what is now known as the Atlantic region of Canada). These principals are meant to guide the four stages of NSSP in a good way. The NSSP approach was shared at the International Water Association (IWA) and WHO Water Safety

Conference 2022 and represents one of the few WSP-based water management programs in North America (Yates et al., 2022).

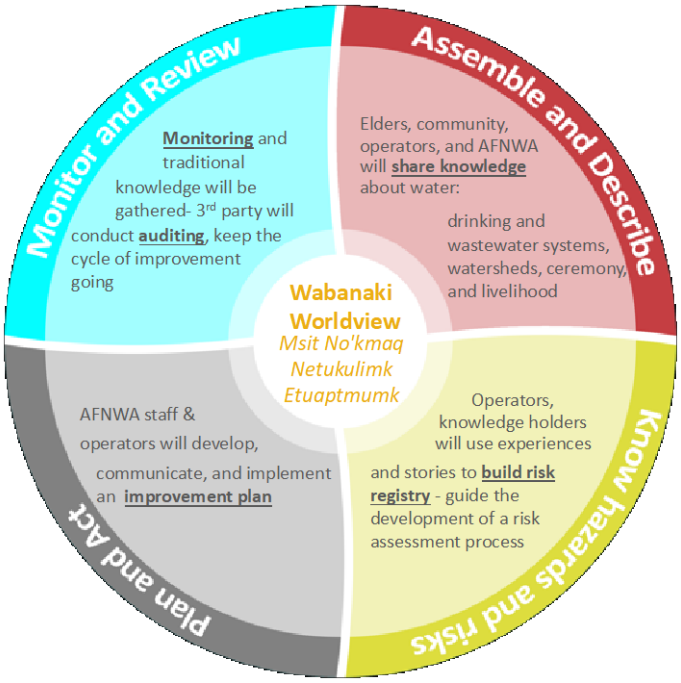


Figure 1. NSSP framework co-designed by AFNWA Elders Advisory Lodge and CWRS research team (Yates et al., 2022).

In **Task 1** a process of documenting storytelling and knowledge gathering will be developed by CWRS researchers and AFNWA staff, guided by the Elders Advisory Lodge and other community elders and leaders. Semi-structured interviews with water and wastewater operators, community members, and water stakeholders will be conducted to share both western and Indigenous perspective on hazards to safe drinking water and clean wastewater. In recognition that typical western research paradigms are not capable of attending to Indigenous ways of knowing, values, ceremonies, and diverse relations (Kurtz, 2013), no formal methodological approach will be prescribed to this work. The Elders Advisory Lodge will work closely with the AFNWA Senior Management Team and the CWRS to guide the gathering and sharing of knowledge. Also, because culture and knowledge are inextricably linked to language, linguistics analysis will be done in Mi'kmaq and Wolastoqey to better understand First Nations values and relationships to water and water stewardship. **Task 2** will use themes and lessons learned from Task 1 to develop a guidance document, translated into Mi'kmaw and Wolastoqey languages, to serve as a tool to conduct Two-Eyed Seeing hazard identification and risk assessments for drinking water and wastewater systems, through the lens of water stewardship (Hurley & Jackson, 2020). The outcomes from these interviews and storytelling sessions will inform Objective B2. It is the goal of this collaborative research to produce resources, pathways, and tools that will be of benefit to other First Nations across the country to develop and implement system-specific hazard and risk assessment processes to guide operational and infrastructure improvement and investment. All appropriate research ethics guidelines will be followed including the Tri Council Policy on Research Ethics, Mi'kmaq Ethics Watch, Maliseet Nation Conservation Council's Maliseet Research Review Board, L'nuey and Mi'kmaq Confederacy of PEI Research Ethics Board and First Nations Information Governance Centre's OCAP Principles.

Objective B2: Building an Operator-informed Digital Framework for Risk Management for Nujo'tme'k Samqwan

Building on past development efforts of CWRS researchers (Lane et al., 2021 & 2022), the knowledge gathered in Objective B2 will serve as the foundation for an accessible and adaptable digital tool to facilitate the continuous improvement cycle central to NSSP. Collection, organization, and utilization of system knowledge, data, and system performance status are needed to monitor and verify control measures aimed at reducing the risk of unsafe water and wastewater. The digital framework to be designed by the CWRS and AFNWA will synthesize multiple data sets with diverse knowledge inputs, including SCADA data, manual monitoring data, and inspection and observational information. The framework will support AFNWA staff and senior management in identifying and prioritizing risks from source to tap, and from tap to watershed. Building on the survey-based application developed by Lane et al. (2022), this digital framework will aim to streamline operator and staff knowledge with water quality data, source water conditions, and maintenance and operation practices to produce actionable risk reduction measures to

protect public and environmental health. The AFNWA and CWRS see the need for an Indigenous-led development process to create a tool made by First Nations, for First Nations that will be shared with other communities and First Nations organizations working to take care of water.

This work will require the development of data collection tools, cloud-housed databases, and data retrieval/data processing tools. It is critical that these tools be created with the operators and AFNWA staff to ensure they are accessible, applicable, and ultimately beneficial to the operation of the AFNWA water and wastewater systems. Extensive experience in data management through UEC will be leveraged to develop a data management approach grounded in First Nations ways of knowing. Currently, there is no comprehensive and universal data or record keeping approach in Atlantic region First Nations for water and wastewater operation and water quality monitoring. This Task will establish a standard, First Nations-led, knowledge collection and mobilization tool to inform risk management practices for the AFNWA.

THEME C: COMMUNITY CAPACITY FOR WATER STEWARDSHIP

Objective C1: Understanding Community Knowledge and Needs

The AFNWA is owned by the First Nations communities that participate in the utility and is governed by a Board of Directors composed largely of Chiefs from said communities. Based on recent conversations and our experience in this area, it is clear that it is in the best interest of the AFNWA and the communities to build a relationship based on trust, respect, and knowledge sharing. A major barrier standing in the way of this kind of relationship are longstanding and continued inequities in water quality in First Nations communities (Castleden et al., 2017; Sanderson et al., 2015) – a collective lived experience that informs trust, and relationships to water and health. The persistent failures to address water and wastewater services for First Nations peoples on reserves is well documented (OAG, 2021; White et al., 2012), and the AFNWA recognizes the need to provide new approaches and solutions. The AFNWA also understands the need to engage with community members in a 'good way', grounded in traditional knowledge, with the acknowledgement that all people hold both the responsibility and the ability to care for the water (Kimmerer, 2012; Johnson et al., 2016; Bozhkov et al., 2020). The AFNWA understands that western modes of research have been used as tools of extraction and control (see research as a 'dirty word' in Smith, 2021) and that this First Nations-led knowledge exchange with community members must be co-designed and collaboratively implemented. This work will draw on a growing field of research in Indigenous-led energy autonomy to learn and apply lessons to developing water autonomy (Rezaei and Dowlatabadi, 2016; Stefanelli et al., 2018; Hoicka et al., 2021). Following work by Zurba et al. (2021), the AFNWA and CWRS team will work with communities to develop a shared understanding of the purpose of the work and empowerment of all knowledge holders to contribute to, and design, knowledge exchange processes.

Key areas of knowledge exchange are likely to focus on:

- Water usage and aquifer (or surface water) protection
- Use of in-home products that impact water and wastewater services
  - Soaps, cleaning agents, and other products that contain phosphorus
  - "Flushable" wipes and other items that could harm the wastewater treatment infrastructure
- Employment opportunities in the water sector, including high school internships, scholarships, training programs, and the role of citizen science/community science to help guide the AFNWA
- Other topics for knowledge exchange will be identified by community members and incorporated into this work.

Primary knowledge collection/exchange methods will be shaped by ongoing conversations but could include written or oral surveys, group interviews and forums, photovoice or art production, and/or other knowledge-bridging methods grounded in Etuaptmumk (or Two-Eyed Seeing; Bartlett et al., 2012; McGregor et al., 2018; Schott et al., 2020). Following the tenets of Indigenous Community-Based

Participatory Research (ICBPR; see Castleden et al., 2012; Castleden et al., 2017; Lewis et al., 2016; UINR, n.d.) sharing circles, facilitated workshops or scenario planning, and other methods that promote intergenerational knowledge transfer will all be considered and ultimately, the community members, AFNWA Elders Advisory Lodge, and research team members will work together to decide the right way forward. All appropriate research ethics guidelines will be followed including the Tri Council Policy on Research Ethics, Mi'kmaq Ethics Watch, Maliseet Nation Conservation Council's Maliseet Research Review Board, L'nuey and Mi'kmaq Confederacy of PEI Research Ethics Board and First Nations Information Governance Centre's OCAP Principles.

Objective C2: Building a Community Samqwan Engagement and Confidence Tool

First Nations communities have limited opportunities to communicate their experiences and concerns with drinking water and wastewater services in a formal way (Baijius and Patrick, 2019), and current funding and operational structures do not incorporate consumer feedback. A recent report from the Office of the Auditor General (OAG, 2021) evaluating ISC's performance found that long-term solutions to drinking water advisories have not been fully implemented in many systems, recurring short-term drinking water advisories are addressed with temporary solutions, and in general conditions of certain water systems have not improved (see also Galway, 2016). Annual risk ratings for First Nations communities have shown significant improvement between 2014-2015 and 2019-2020 fiscal years. These deficiencies, coupled with the lack of communication pathways for communities, have resulted in a profound lack of trust in drinking water services (Patrick, 2011; Spicer et al., 2020). The creation of the AFNWA, while a significant step toward addressing this erosion of trust, is not itself sufficient to build confidence in community water and wastewater systems. As is clearly stated in the Indigenous clean energy literature (Stefanelli et al., 2019; Walker et al., 2021), the OAG report concludes that the implementation of sustainable water solutions will require meaningful relationships with First Nations. Our conversations with the AFNWA makes it clear that codeveloping a formal Community Confidence Tool will help support transparent communication from the community to the utility and begin to forge a path toward trust and respect.

ACTIVITY TIMELINE

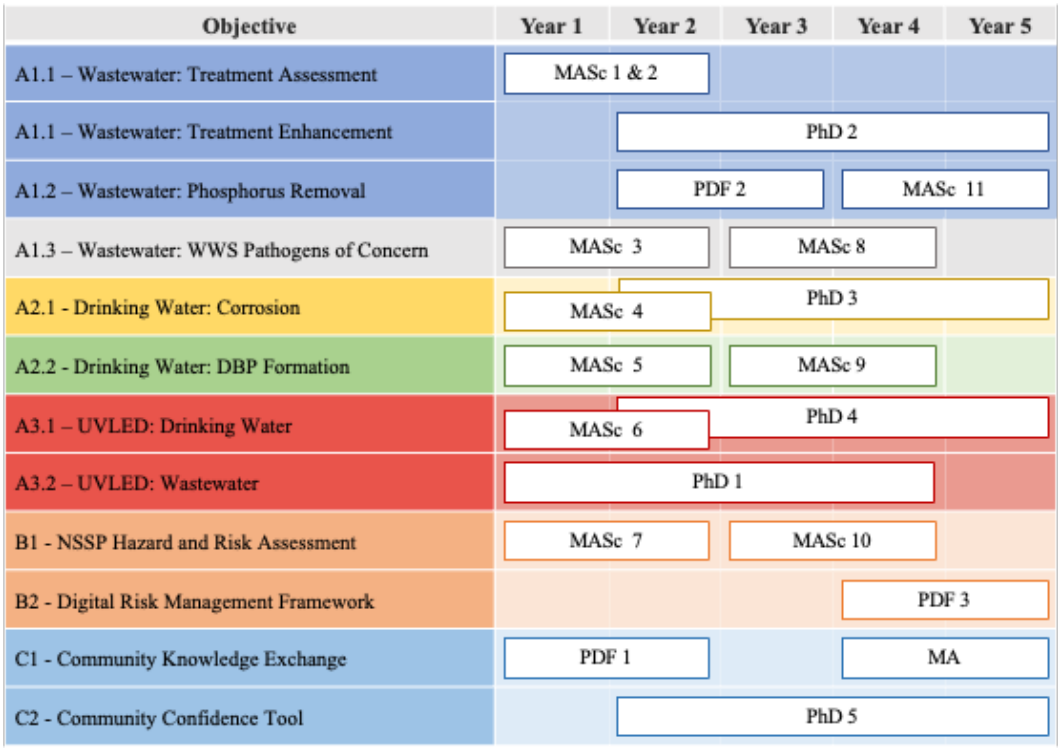


Table 2. All research themes and objectives will extend across the five-year grant period. Trainee hiring will be aligned as to the left.

SEX, GENDER, & DIVERSITY IN RESEARCH DESIGN

Both western and First Nations relationships to sex, gender, and diversity (see Sanchez-Pimienta et al., 2021) have been considered in this research design. The three research themes intersect with sex and gender in nuanced ways. Themes A and B are grounded in technical water and wastewater treatment advances and digital framework development, respectively. From a western perspective, the water and technology sectors tend to be dominated by a male workforce, with recent small shifts in demographics due to efforts to improve diversity and inclusion. From a First Nations perspectives, women are thought of as water protectors and stewards with the responsibility to care for the water (Dennis and Bell, 2020; Lindstrom, 2020). To support the growth of women in Engineering and STEM and to honour the role of First Nations women in caring for water, recruitment efforts will include outreach to women specifically through key organizations such as the Women in Engineering Society and UEC's Science & Innovation Initiative to build a research team well-balanced for this work. Further, tools created for the digital NSSP framework will be designed to be gender neutral and acknowledge the important role of women as water stewards. Theme C, the development of a Community Confidence Tool for water services and stewardship, will require substantial community involvement. To ensure this research design aligns with individual First Nations communities' values and needs, it will be co-developed with First Nations community leaders and knowledge holders. Who we survey, what information we gather and share, and how we collect stories will be directed the Elders Advisory Lodge and other community leaders (public health directors, school directors, public works managers, etc.) following all appropriate research ethics protocols, to ensure Wabanaki knowledge is preeminent in research design and outcomes and western knowledge and priorities provide a supporting role where appropriate.

The CWRS research team, including Applicant and Co-Applicants are all non-Indigenous, which represents a common power imbalance in academic research. Thoughtful effort will be made to collaborate with First Nations knowledge holders and leaders through the partner organizations and avoid unnecessary power hierarchies in the research team. Guidance will be provided by the AFNWA's Elders Advisory Lodge through monthly standing meetings to ensure research design is grounded in Etuaptmumk and reflects First Nations values and worldviews.

INDICATORS AND METHODS FOR MONITORING PROGRESS

Table 3. Metrics and indicators for progress over the 5-year grant period.

Indicator	Description	5-Year Output
Regular Meetings	Meetings between senior researchers and partners staff will occur monthly or as needed via MS Teams.	>60 calls
Site Visits	Senior researchers and trainees will conduct site visits to monitor safety, design work and operations.	>20 site visits
Operator Workshops	Senior researchers and trainees will present research progress and key findings at quarterly Operator Workshops held by the AFNWA.	20 workshops 80% of participating communities attend
Trainees Recruited/ Trained	Community youth hired, Co-op students hired per term, graduate students enrolled and defended per year, and PDFs and staff hired will be inventoried regularly to support research progress. Community youth will be mentored on career paths and training/education programs in the water field, including scholarship application workshops to assist high school students or non-traditional applicants in seeking financial support for continuing education,	> 20 Community youth; 10 co-ops; 12 MASc; 5 PhDs; 3 PDFs 10 scholarships
Two- Eyed Seeing: Knowledge Mobilization	The AFNWA Board of Directors prioritizes the sharing of information through Indigenous news organizations. Further, Powwows serve as important community gatherings to build relationships and learn from others. As such, it is important to share knowledge through these activities and this partnership will: • Produce informational articles written for First Nations in First languages and shared through Indigenous outlets.	> 15 papers > 20 abstracts > 15 First Nations publications > 10 community presentations

	• Attend Powwows with the AFNWA and UEC to share knowledge gathered through this work. Western activities of knowledge mobilization will include: • Scholarly items (e.g., journal papers, abstracts submitted to conferences and scholarships received) • Community presentations and workshops	> 25 Powwows attended
Two-Eyed Seeing: Water Quality Advancement	Data sets for drinking and wastewater quality will be built for select systems and specific treatment technology advancements. Validation of water and wastewater treatment and monitoring technologies (immersed media biofilm treatment, Electrocoagulation for phosphorus removal; WWS passive sampling pathogen detection; UV LED water and wastewater treatment; copper pipe rack monitoring; wastewater lead monitoring, etc.) A digital Nujo'tme'k Samqwan Safety Plan framework will be developed and delivered, and a Community Confidence Tool will be designed, evaluated, and shared with the AFNWA.	> 10 water quality data sets > 5 First Nations appropriate technologies validated 1 digital NSSP Framework 1 Community Confidence Tool

Team

- List the applicant, any co-applicants and key staff of the partner organizations.
- Explain how the knowledge, experience and achievements of these individuals provide the expertise needed to accomplish the project objectives. Discuss the role of each individual and how their contributions, including those of staff from the partner organizations, will be integrated into the project.
- Explain how equity, diversity and inclusion have been considered in the academic team composition.
- For large (average of more than $300,000 per year requested from NSERC) multi-party projects (multiple universities and/or partner organizations), it may be appropriate to provide a description of up to three additional pages detailing university support, governance structure and project management. If applicable, please detail the project manager's qualifications, involvement, role and responsibilities.

APPLICANT, CO-APPLICANT AND PARTNER ORGNIZATIONS KEY STAFF

Dr. Graham Gagnon (Nominated PI), Dalhousie University, Halifax, NS, CA
Dr. Amina Stoddart (Co-Applicant), Dalhousie University, Halifax, NS, CA
Dr. Chad Walker (Co-Applicant), Dalhousie University, Halifax, NS, CA

Partner Organization Key Staff
Carl Yates, CEO (Interim), AFNWA, Truro, NS, CA
John Lam, Manager of Engineering, AFNWA, Truro, NS, CA
Chris Googoo, COO, UEC, Halifax, NS, CA
Holly Griffiths, Director (Science & Innovation), UEC, Halifax, NS, CA

KNOWLEDGE, EXPERIENCE, AND ACHIEVEMENTS OF KEY INDIVIDUALS

Applicant, Co-Applicants, Collaborators:

Dr. Graham Gagnon (applicant) is the Director and Professor for the Centre for Water Resources Studies in the Department of Civil and Resource Engineering. Dr. Gagnon is also the Dean of Faculty of Architecture and Planning at Dalhousie University. Department. In 2016, Dr. Gagnon became the first engineering professor at Dalhousie University to be awarded a University Research Professorship and in 2019 he was awarded the Professional of Distinction Award for his research contributions including the

successful launch of the Atlantic First Nations Water Authority and his commitment to equity, diversity, and inclusion in research programming.

As an environmental researcher, Dr. Gagnon has worked closely with the APC for more than 15 years to address clean water concerns in Canada's First Nations Communities. In partnership with the APC, Dr. Gagnon and his research team have provided training courses for First Nations Operators, regularly updated First Nations Chiefs on drinking water research and policy, met with Canada's sub-committee in Senate and the House of Commons about safe water in First Nations Communities, visited and inspected water systems in First Nations Communities, and written regulations for First Nations water. Dr. Gagnon has published impact research for over a decade on water safety plans and risk management approaches to drinking water. As PI, **Dr. Gagnon will oversee the entire research team and all activities** as well as ensure that the team has impact for the AFNWA and First Nations water and wastewater treatment and governance across Canada.

Dr. Amina Stoddart (co-applicant) is an Assistant Professor and early career researcher in the Department of Civil and Resource Engineering at Dalhousie University. As a faculty member in the Centre for Water Resources Studies (CWRS), Dr. Stoddart's research focuses on the optimization of treatment and monitoring technologies for the water and wastewater industry. Dr. Stoddart has partnered directly with municipalities and other industry partners to address wastewater treatment and surveillance challenges. In March 2020, Dr. Stoddart was awarded a highly competitive 3-year, ~$1M NSERC Collaborative Research and Development (CRD) grant in collaboration with Halifax Water focused on wastewater treatment optimization and wastewater surveillance. Dr. Stoddart has also led and co-led numerous wastewater surveillance projects, including a ~$1M SARS-CoV-2 wastewater surveillance project with Dr. Gagnon that established wastewater surveillance practices in Nova Scotia. In 2021 Dr Stoddart was awarded the L.A. White Young Engineers Award from Engineers Nova Scotia and was a finalist for a Discovery Award in the Emerging Professional category in 2022 for these contributions. **Dr. Stoddart will be involved in Activities related to Objectives A1 (Wastewater technology advancement and WWS pathogen detection) and Objectives A3 (UV LED treatment of drinking water and wastewater).**

Dr. Chad Walker (co-applicant) is an Assistant Professor in the School of Planning at Dalhousie University. He is a broadly trained interdisciplinary social scientist with degrees in Environmental Policy and Geography and five years of further research experience as Postdoctoral Research Fellow across four universities in the UK and Canada. His research program focuses on elements of social justice, equity and support for a range of sustainability initiatives and movements – including smart grid development, improvements in First Nations water governance, and Indigenous-led renewable energy projects. He brings a wealth of experience working within Indigenous research contexts. This includes his work at Queen's University, with a CIHR-funded research program called Achieving Strength, Health and Autonomy through Renewable Energy Development for the Future (A SHARED Future), and at the University of Saskatchewan and the SSHRC-funded Community Appropriate Sustainable Energy Partnership. Both programs partnered with Indigenous communities from across Canada. In particular, Dr. Walker developed a relationship, and continues to work with leaders at Tobique First Nation, one of the founding communities of the AFNWA and this proposed project. **Dr. Walker will be primarily involved in leading Activities associated with Objectives C1 (Understanding Community Knowledge and Needs) and C2 (Building a Community Samqwan Engagement and Confidence Tool).**

Tuma Young (collaborator, Cape Breton University's Marshall Institute) Assistant Professor, Mi'kmaq Studies at Cape Breton University. He was the first indigenous person to become head of the Nova Scotia Barristers' Society and as far as is known is the first Mi'kmaq speaking lawyer in Nova Scotia history. In 2020 Tuma was appointed Queen's Counsel and in 2022 received the Queen's Platinum Jubilee Medal for services to the Nova Scotia legal profession. **Tuma will provide language and culture guidance,**

specifically mentor ship for trainees working on Theme B with a focus on linguistics analysis for interpreting Mi'kmaq values from traditional language.

The Elders Advisory Lodge *(Methilda Knockwood-Snache*, *Gail Tupper*, *Dr. David Perley*, *Ken Francis*, *Charles Doucette)* (collaborators) - the Elders Advisory Lodge will provide crucial guidance to all research staff and trainees to help ground research, learning, and cultural values in Wabanaki traditions and worldviews.

Partner Organization Team Members:

Atlantic First Nations Water Authority Key Personnel
Carl Yates is interim Chief Executive Officer for the AFNWA, bringing extensive experience in the water utility profession from his time as Project Engineer, Chief Engineer and General Manager of the Halifax Water Commission. Carl oversees the Authority and reports to the Board of Directors and Elders Advisory Lodge.
James MacKinnon is the interim Chief Operating Officer of the AFNWA and will work closely with the CWRS and UEC teams to coordinate community-based activities, organize internal support for AFNWA staffing and execution of research activities, and align AFWNA activities to ensure completion of research objectives.
John Lam is Manager of Engineering for the AFNWA and is responsible for asset management, master planning, capital improvement planning, and provision of technical services that support the short and long-term management of the water and wastewater assets.
Ulnooweg Education Centre Key personnel
Chris Googoo is a proud member of the We'koqma'q First Nation and Chief Operating Officer of Ulnooweg. His work has advanced economic development for Mi'kmaq communities and has led the development of "Digital Mi'kmaq", an enriched education program aimed at closing STEM gaps in First Nations communities.
Holly Griffiths is Director of Science & Innovation for Ulnooweg with extensive experience in multidisciplinary technology innovation and STEM curriculum development for First Nations youth. Her work directly supports Ulnooweg's mission to empower Indigenous communities through the advancement of education and access to culturally grounded learning experiences.

EQUITY, DIVERSITY, AND INCLUSION: THE ACADEMIC TEAM

Msit No'kmaq, translates to "all of my relations", is a central tenant of Mi'kmaq Ecological Knowledge (MEK) and broader governance and knowledge systems. Warrior et al. (2022) explains Msit No'kmaq as "an epistemological concept whereby all living and non-living components are interconnected, and all beings are considered kin." It is a term that communicates First Nations fundamental principal of all things being valuable, an apt parallel to non-Indigenous people's equity, diversity, and inclusion efforts.

The nature of this Two-Eyed Seeing research program asks everyone participating in this work to reflect on their positionality and relationship to knowledge legitimization and prioritization. All researchers and trainees will actively welcome diverse and difference ways of knowing and learning.

Recruitment of Indigenous trainees will be prioritized through selected outreach to First Nations communities, Indigenous Centers at colleges and universities, and through relationship building with Indigenous organizations in the environmental and water sectors. This project will also seek trainees from a range of disciplines and career stages to ensure there is diversity of thought. There is a particular need for both STEM and social science trainees as Themes B and C require a holistic and transdisciplinary approach. The PIs will work with Dalhousie University's Human Rights and Equity Services in developing recruitment and retention strategies. The team has worked with First Nations representatives and engineers to ensure trainee selection is considered from many dimensions, beyond a typical western academic approach. However, the team recognizes that there will be a need to recruit non-Indigenous trainees as

well and understands the value of training western Engineers to more meaningfully collaborate and learn with/from First Nations people (McGregor et al., 2018). The PIs will ensure that all researchers and trainees receive appropriate training relevant to First Nations self-determination and Truth and Reconciliation. More detail is provided in the Training Plan section.

Furthermore, the Academic Team will proactively seek and train individuals from other underrepresented groups (e.g., racialized persons, and persons with disabilities) because we understand diversity of thought and lived experiences to be a crucial strength in all research programs. The recruitment posters will be carefully worded to express our commitment to inclusion.

UNIVERSITY SUPPORT, GOVERNANCE STRUCTURE AND PROJECT MANAGEMENT

The co-management structure for the proposed 5-year project is outlined in **Figure 2**. Teams and Committees are described below.

Dalhousie Leadership. Dalhousie Leadership will consist of the Dean of Engineering, Dr. John Newhook, the Civil and Resource Engineering department Head, Dr. Yi Liu, and personnel from the Office of Research Services. Furthermore, research efforts at Dalhousie University focus on five Signature Research Clusters that are designed to align with the United Nations' 2030 Agenda for Sustainable Development, which includes 17 Sustainable Development Goals (SDGs). The proposed research aligns with Dalhousie's Clean Tech, Energy, the Environment and Culture, Society, Community Development research clusters and the Clean Water and Sanitation. Further, this research proposal provides actionable progress towards the UN Declaration on the Rights of Indigenous Peoples (UNDRIP), Article 25. As the project applicant, Dr. Gagnon will report to the Dean of Engineering for financial and administrative reporting. In addition to financial support, Dalhousie will provide office space for trainees to study, meet, and collaborate. The Faculty of Engineering has allocated significant resources for this research program: dedicating more than 5000 ft^2 for research space; providing support for safety training for researchers; providing financial review and assistance of materials.

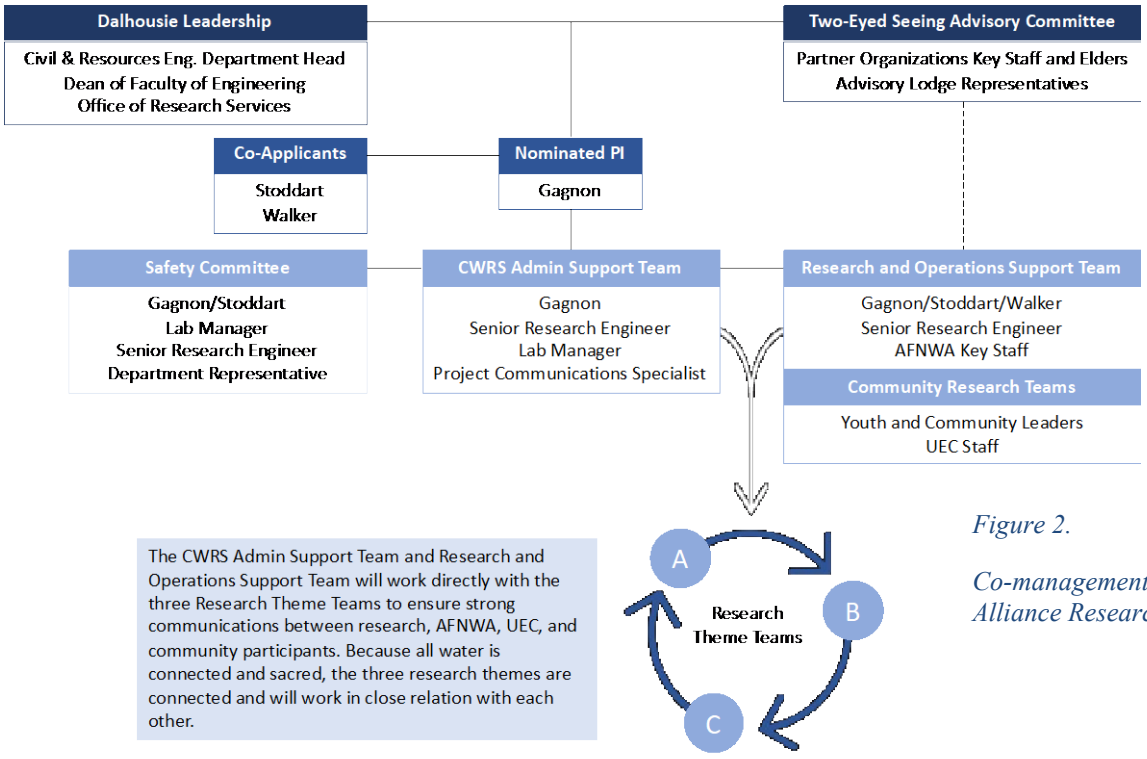


Figure 2.

Co-management for the Alliance Research Team.

Two-Eyed Seeing Advisory Committee. A collaborative guidance committee will be established that is comprised of key staff from the CWRS, partner organizations (described above), and members from the AFNWA Elders Advisory Lodge. The committee will meet regularly to review research progress, establish priorities and goals, and make decisions concerning future directions of the research program. A mandate of this committee will be to ensure Etuaptmumk and Indigenous Knowledge guides the work and how it is completed. This committee will also provide leadership on community and youth engagement and the development of Community Research Teams. Drs. Gagnon, Stoddart, and Walker will report to the Advisory Committee monthly or as needed.

CWRS Admin Support Team. An Administrative Support Team will be established which will be comprised of Drs. Gagnon, Stoddart, and Walker as well as the Senior Research Engineer, Research Assistant, Lab Manager, and Project Communications Specialist. The Admin Support Team will meet regularly (e.g., weekly) and will be responsible for reviewing laboratory purchases, scheduling meetings, reporting and other activities as required. The role of each Administrative Support Team member is further described herein:

Senior Research Engineer and Project Manager – Dr. Megan Fuller will serve as the Senior Research Engineer and Project Manager for this Alliance grant. Dr. Fuller has been a Research Engineer at the CWRS since 2019 with a PhD in Environmental Engineering and a research background in environmental fate and transport of emerging aqueous contaminants. Dr. Fuller joined the CWRS to assist in policy and governance development for the AFNWA. She supported the co-development of the Interim Regulatory Framework and has worked closely with the Elders Advisory Lodge in the development of NSSP. In her role as Senior Research Engineer and Project Manager she will provide specialized engineering support for Themes A and B throughout the project duration. She will support coordination and preparation of research reports, provide peer review of graduate student project methodologies and results, and provide project planning for the various research themes. This role will also serve as the key liaison for project management and coordination across the partner organizations, community research teams, and thematic research personnel.

Lab Manager – The overall responsibility of the Lab Manager is to oversee all operations in the Clean Water Technology Laboratory and Wastewater Technology Laboratory. The Lab Manager is responsible for maintaining a rigorous QA/QC program on analytical equipment, ordering new equipment and supplies, and providing support and training to graduate students with respect to experimental design, set-up, and execution in a safe manner consistent with Dalhousie University's Environmental Health and Safety. It is anticipated that the Lab Manager will have a Bachelor of Science degree (e.g., analytical chemistry, environmental science, etc.) with significant experience in a laboratory environment.

Project Communications Specialist – The overall responsibility of this role is to ensure integrated coordination of communication related to all research activities throughout the five-year project duration and timely delivery of research milestones and results to the industry partner organizations. Specific tasks may include liaising with partner organizations, setting or coordinating meetings and community visits, and preparing and disseminating reports. It is anticipated that the Project Communications Specialist will be from an Atlantic region First Nation community with significant work experience (e.g., >5 years) managing multistakeholder projects.

Research and Operations Support Team. The Research Support Team will consist of all PIs and Co-Applicants as well as the Lab Manager and Senior Research Engineer and partner organization key staff. The Research and Operations Support Team will provide student trainees (including community research team members), postdoctoral fellows (PDF), and all other personnel with guidance and support throughout all research activities at Dalhousie University and AFNWA sites (e.g., W&WWTPs). Specifically, this

Team will help with experimental planning and implementation, field installation of technology, sampling logistics, data management and visualization, publishing, and all other research activities as required.

Community Research Teams - In select communities with an interest in youth engagement and career development, community members (high school students and/or non-traditional learners) will be hired to provide in-community capacity for key research activities (i.e. sample collection, community communication, survey/interview development, etc.). These Community Research Team members will be invited to join in key trainee opportunities (OCAP training, Elders Advisory Lodge mentoring meetings, etc.) and will be included in the Annual Youth Summit and broader UEC initiatives.

Safety Committee. The CWRS has an established Safety Committee that is inclusive of PI's, Lab Manager, Senior Research Engineer, and a Department Representative. A student representative (i.e., PhD, MASc) also sits on the Safety Committee. The NPI is responsible for ensuring the effective functioning of the Committee sits on the Committee as an observer. The CWRS Safety Committee is responsible for initiating, promoting, and monitoring safe work practices with respect to the research activities proposed herein. The Safety Committee will recommend practices deemed necessary for all work to be carried out in a healthy and safe manner. Further, the safety committee will ensure trainees undergo appropriate safety training described below in the training plan.

Thematic Research Personnel. As described in the proposal, there are three key research themes. Each research theme will have specific PI(s), Co-Applicant(s), and the Senior Research Engineer to help guide graduate, undergraduate, and community research team trainees. The Senior Research Engineer will be responsible for having a scientific role associated with their respective theme but also have a role in project management ensuring that goals are being met within their respective research projects, in addition to their scientific/technical skills gained. The Senior Research Engineer will also play an active role in mentoring MASc and PhD students in the research, in research planning and experimentation, as well as manuscript writing for publication in high impact peer reviewed journals.

Training plan

- Indicate how the knowledge and experience gained by research trainees and the partners' staff members are relevant to the advancement of the field, to applying knowledge or to strengthening the partners' sectors.
- Describe how the project and the partnership offer opportunities for enriched training experiences that will allow research trainees (undergraduates, graduates and postdoctoral fellows) to develop relevant technical skills as well as professional skills, such as leadership, communication, collaboration and entrepreneurship. Include the nature of the planned interactions with the partners and other relevant activities.
- Explain how equity, diversity and inclusion are considered in the training plan (see here for guidance).

RESEARCH TRAINEE & STAFF KNOWLEDGE

This research partnership provides substantial collaborative learning for both the CWRS and partner organizations. Each research theme aims to augment Two-Eyed Seeing knowledge generation and sharing across all participating organizations.

Theme A - Technological Advancement for drinking and wastewater systems- A range of water and wastewater technologies and related operational and management plans will be developed in Theme A to support and markedly advance treatment processes in First Nations communities. Trainees and partner organizations will be receiving training on water and wastewater quality monitoring practices, data analysis, operational response plans, and system optimization for a range of source water, distribution system, collection system, and wastewater effluent water quality issues. Trainees will learn how to

meaningfully incorporate Netukulimk into engineering solutions and to consider the relationship of all things to water and develop climate responsive treatment processes in both water and wastewater systems.

Theme B - Nujo'tme'k Samqwan Safety Planning- Trainees and partner organization staff will be trained on hazard and risk assessments in water and wastewater systems. As global water system management frameworks continue to shift towards a Water Safety Planning approach, trainees will be prepared to be leaders in this emerging field in North America. Protection of public and environmental health will guide the prioritization of risk mitigation practices and trainees and AFNWA operational staff will learn how to see with both a western and First Nation eye in developing mitigation efforts.

Theme C - Community Capacity for Water Stewardship- Trainees, partner organization staff, and participating community members will learn communication methodologies and knowledge gathering practices that will guide Indigenous utility-community relationships. Both Indigenous and non-Indigenous trainees and partner organization staff will gain an understanding of relationship and trust building, which is central to all utility and engineering applications.

RESEARCH TRAINEE AND STAFF SKILLS DEVELOPMENT AND INTERACTIONS

Technical Skills: Operations/Field Training Experiences. Through both field and laboratory research, trainees will gain experience on appropriate monitoring, sampling, and testing techniques needed to accomplish the tasks in Theme A. Training specific to research needs, such as Confined Space Training, will also be provided. Trainees involved in full- and bench-scale research will gain an understanding and knowledge of principles of treatment, operations and maintenance, and safety requirements specific to the community facilities where they are conducting research and/or collecting samples. ***Partner Interactions:*** Trainees involved in objectives related to Theme A will receive specific training by AFNWA staff connected to the project to prepare them to safely work in the select community facilities. All Trainees interested in doing so will be given the opportunity to receive Operator-in-Training certification through training offered by the AFNWA in partnership with Nova Scotia Environment and Climate Change Canada. **Laboratory/Analytical Experience.** All trainees who conduct laboratory work will be required to complete a general laboratory orientation which includes safety orientation, WHMIS, MSDS, and chemical and waste orientation. Trainees will also gain specific skills, outside the classic water quality equipment (e.g., pH, turbidity, and UV/VIS-spectrophotometry) to their area of research, such as analytical skills (e.g., ICP-MS, LC-MS/MS), microbiological (Biosafety Level) and wastewater skills (e.g., plating methods, aseptic and sterile techniques). **Data Management/Visualization.** Theme B will require generating and managing large quantities of data, often complex in nature where trainees will then use advanced computing software (e.g., R-Studio, Power BI, etc.) to generate high quality visuals and analytics for inclusion in the Nujo'tme'k Samqwan Safety Planning Framework digital tool. Trainees will gain data management and visualization skills through trainee led training sessions or formal directed studies. ***Partner interactions:*** Trainees will further their data management skills by collaborating with UEC partners to accompany their research and digital tool development. UEC has significant experience in training and workshops in animation, creative computing, and coding. **Mixed Methods Participatory Research**. Trainees supporting Theme C will work with co-Applicant Dr. Chad Walker to be trained in mixed methods research approaches that incorporate a range of Indigenous research practices to develop the Community Confidence Tool. Appropriate statistical skills will be learned through trainee led training sessions or formal directed studies.

Cultural Competency Skills: All trainees will receive Ownership, Control, Access, and Possession (OCAP) Principles training from the First Nations Information Governance Centre. This training provides key context about the historical extractive and damaging relationship Indigenous people have suffered through past research practices. OCAP training also offers specific and actionable steps to be taken to protect First Nations community data. All non-Indigenous trainees will complete Truth and Reconciliation

education offered by Dalhousie University. Educational systems in Canada predominantly benefit non-Indigenous populations, but the 94 Calls to Action provide guidance on acknowledging the damaging history and creating systems to prevent this damage moving forward. All trainees will receive Gender-Based Analysis Plus (GBA+) training available through the Canadian Federal Government Department for Women and Gender Equality to foster an inclusive learning environment. Trainees involved in Theme C will also complete the Tri-Council's Course on Research Ethics (CORE-2022), which includes specific training on research involving Indigenous Peoples.

EQUITY, DIVERSITY AND INCLUSION CONSIDERATION IN THE TRAINING PLAN

The recruitment and training of all trainees associated with this Alliance partnership, both Indigenous and non-Indigenous, will be done with a focus on unbiased and transparent knowledge sharing to ensure equitable learning and advancement opportunities for all involved. The CWRS has an established IDEA committee whose purpose is to ensure that equity, diversity, inclusion, and accessibility are central to the CWRS's decision-making, student/trainee support, and research initiatives. The Committee provides a structure to offer discussion and guidance for staff, leadership, and trainees on the development, implementation, and ongoing improvement of IDEA support in the CWRS Water and Wastewater Research Groups. Through this committee semester-based IDEA training activities and initiatives are planned for all CWRS trainees, i.e., OCAP training, communication and collegiality, leadership skills, and unconscious bias training.

In addition to the broader CWRS IDEA initiatives, trainees participating in this Alliance partnership research will complete the trainings detailed in the Cultural Competency section above and attend and contribute to Two-Eyed Seeing Research training offered by the AFNWA's Elders Advisory Lodge and UEC representatives. Monthly group meetings (following the Mi'kmaq 13 Moons calendar) will be held to share Indigenous Knowledge, discuss learning and research from a Wabanaki perspective, and ensure that ceremony and the sacredness of water is central to this research project. Lastly, an Introduction to Wabanaki Worldview course will be developed and delivered for all trainees to build a foundational knowledge of the spiritual importance of water to First Nations and to understand ceremony as a way of establishing a relationship with water.

This project takes a holistic approach to IDEA principles through research design, team recruitment, and training principles grounded in First Nations 7 Grandfather Teachings (Love, Respect, Bravery, Truth, Honesty, Humility & Wisdom**)** and recognition of the importance of Msit No'kmaq. We believe a training path guided by Etuaptmumk will produce the next generation of Indigenous and non-Indigenous water stewards, utility staff, and engineers equipped to work together for clean drinking and safe wastewater for First Nation communities.

Budget Justification

Research program Costs

The research program has a total estimated budget of $4,932,143 direct costs over the five-year period. A budget breakdown is summarized below.

Table 4. Proposed Budget Breakdown by Category.

	Year 1	Year 2	Year 3	Year 4	Year 5
1) Salaries and benefits	$604,016	$688,875	$620,762	$692,821	$604,013
2) Equipment or facility	$165,000	$45,000	$65,000	$35,000	$35,000
3) Materials and supplies	$60,000	$105,000	$105,000	$105,000	$105,000
4)Travel	$60,160	$47,112	$70,160	$52,112	$62,112
5) Dissemination Costs		$5,000	$10,000	$5,000	$15,000
6) Technology Transfer Activities	$108,000	$108,000	$123,000	$108,000	$123,000
Total Proposed Expenditures	**$997,176**	**$998,987**	**$993,922**	**$997,933**	**$944,125**
TOTAL 5 YEAR PROJECT COST	**$4,932,143**				

1) Salaries and Benefits. It is estimated that the research program will fund 17 undergraduate students at $11,917 per four-month term, 12 Master's students (11 MASc. and 1 MA) at $25,000 per annum, five Doctoral students at $30,000 per annum, and three Postdoctoral Fellows at $70,000 per annum. It is anticipated that 41 high school students will be hired through the project as well at $5,018 per eight-week term (e.g., summer). Salary for Dr. Megan Fuller has been allocated in the project at $128,800 per year (including benefits), indexed at 3% per year. Salary for a Project Communications Specialist has been allocated (100% Year 1 and 50% Years 2-5) at $53,760 (including benefits), indexed at 3% per year. A detailed schedule of trainees is shown in Table 5.

2) Equipment or Facility. Approximately $165,000 is allocated for equipment or facility in Year 1, $45,000 in Year 2, $65,000 in Year 3, and $35,000 in Years 4 & 5. This cost includes funds to purchase equipment such as (e.g., sondes, field meters), operations and maintenance costs of the analytical equipment, and user fees. It is anticipated that the CWRS will send samples (e.g., biofilm, corrosion) for scanning electron microscopy (SEM) analysis. The academic rate for SEM (including both equipment and any technical support) at the Institute for Research in Materials at Dalhousie University is $45/hr. It is anticipated that research work packages will generate samples for approximately 125 hours of SEM time at a total cost of approximately $5,000 per annum.

3) Materials and Supplies. Approximately $60,000 is allocated for materials and supplies in Year 1 and $105,000 for Years 2 through 5 each. These costs will cover lab and field consumables for sampling programs as well shipping costs for samples.

4) Travel. Approximately $60,160 is allocated for travel in Year 1, $47,112 in Year 2, $70,160 in Year 3, $52,112 in Year 4, and $62,112 in Year 5. It is anticipated that travel for the project will begin immediately and involve several visits to communities across Nova Scotia and New

Brunswick. More funds are allocated in Year 3 (middle of project) as it is anticipated that conference travel will increase based on program deliverables. Travel costs include hotels (estimated at $200 per night rate), mileage as per Dalhousie rates ($0.52 per km), and per diem ($52 per day) as per Dalhousie rates.

5) Dissemination Costs. Approximately $5,000 is allocated per year for Year 2, $10,000 in Year 3, and $5,000 in Year 4, and $15,000 in Year 5. It is anticipated that publications will begin in Year 2. As well, based on previous open access fees, each publication is estimated between $3,000 to $5,000 per issue.

6) Technology Transfer Activities. Approximately $108,000 is allocated in Years 1, 2 and 4 and $123,000 is allocated in Years 3 and 5 for symposia, community events, and honoraria for Elders. Years 3 and 5 include $15,000 for document translation services.

Table 5. Number of Trainees Per Year and Schedule.

	Year 1	Year 2	Year 3	Year 4	Year 5
Total Highschool Students / year	6	9	9	7	10
Total UG Students / year	3	3	3	3	5
MASc 1					
MASc 2					
MASc 3					
MASc 4					
MASc 5					
MASc 6					
MASc 7					
MASc 8					
MASc 9					
MASc 10					
MASc 11					
MASc 12					
Total MASc / year	6	6	3	6	3
PhD 1					
PhD 2					
PhD 3					
PhD 4					
PhD 5					
Total PhD / year	2	5	5	5	3
PDF 1					
PDF 2					
PDF 3					
Total PDF / year	1	2	1	1	1

References

- Use this section to provide a list of the most relevant literature references. Do not refer readers to websites for additional information on your proposal. Do not introduce hyperlinks in your list of references.
- These pages are not included in the page count.

Anderson, J. C., Jabari, P., Parajas, A., Loeb, E., Luong, K. H., Vahedi, A., & Wong, C. S. (2020). Evaluation of cold-weather wastewater nitrification technology for removal of polar chemicals of emerging concern from rural Manitoba wastewaters. *Chemosphere*, 253.

Anderson, L. E., DeMont, I., Dunnington, D. D., Bjorndahl, P., Redden, D. J., Brophy, M. J., & Gagnon, G. A. (2023). A review of long-term change in surface water natural organic matter concentration in the northern hemisphere and the implications for drinking water treatment. *The Science of the Total Environment*, *858*(Pt 1), 159699.

Anderson, L. E., Krkošek, W. H., Stoddart, A. K., Trueman, B. F., & Gagnon, G. A. (2017). Lake Recovery Through Reduced Sulfate Deposition: A New Paradigm for Drinking Water Treatment. *Environmental Science & Technology*, *51*(3), 1414–1422.

APTN. (2021). Overworked, underpaid: Ottawa's chronic lack of funding leaves First Nations water operators behind. Aboriginal Peoples Television Network National News. February 22, 2021.

Baijius, W., & Patrick, R. J. (2019). "We don't drink the water here": the reproduction of undrinkable water for First Nations in Canada. *Water*, *11*(5), 1079.

Bartlett, C., Marshall, M., & Marshall, A. (2012). Two-Eyed Seeing and other lessons learned within a co-learning journey of bringing together indigenous and mainstream knowledges and ways of knowing. *Journal of Environmental Studies and Sciences*, *2*(4), 331–340. https://doi.org/10.1007/s13412-012-0086-8APTN.

Beck, S. E., Ryu, H., Boczek, L. A., Cashdollar, J. L., Jeanis, K. M., Rosenblum, J. S., Lawal, O. R., & Linden, K. G. (2017). Evaluating UV-C LED disinfection performance and investigating potential dual-wavelength synergy. *Water Research*, *109*, 207–216.

Black, K., & McBean, E. (2017). First Nations' water sustainability and Security Strategy: Tools and methodologies for community-driven processes for water treatment in Indigenous communities. *Technology in Society, 50*, 57–65. https://doi.org/10.1016/j.techsoc.2017.04.004.

Blanco, I., Molle, P., Sáenz de Miera, L. E., & Ansola, G. (2016). Basic Oxygen Furnace steel slag aggregates for phosphorus treatment. Evaluation of its potential use as a substrate in constructed wetlands. *Water Research*, *89*, 355–365.

Bolton, J. R., & Linden, K. G. (2003). Standardization of Methods for Fluence (UV Dose) Determination in Bench-Scale UV Experiments. Journal of Environmental Engineering, 129(3), 209–215. https://doi.org/10.1061/(asce)0733-9372(2003)129:3(209)

Boutet, E., Baillargeon, S., Patry, B., & Lessard, P. (2018). Simultaneous organic matter removal and nitrification of an inert self-supporting immersed media to upgrade aerated

lagoons. *Water Science and Technology: A Journal of the International Association on Water Pollution Research*, *77*(1-2), 51–59.

Bozhkov, E., Walker, C., McCourt, V., & Castleden, H. (2020). Are the natural sciences ready for truth, healing, and reconciliation with Indigenous peoples in Canada? Exploring 'settler readiness' at a world-class freshwater research station. *Journal of environmental studies and sciences*, *10*(3), 226-241.

Castleden, H., Bennett, E., Lewis, D., & Martin, D. (2017). " Put It Near the Indians": Indigenous Perspectives on Pulp Mill Contaminants in Their Traditional Territories (Pictou Landing First Nation, Canada). *Progress in community health partnerships: research, education, and action*, *11*(1), 25-33.

Castleden, H., Hart, C., Cunsolo, A., Harper, S., & Martin, D. (2017). Reconciliation and relationality in water research and management in Canada: Implementing indigenous ontologies, epistemologies, and methodologies. In *Water policy and governance in Canada* (pp. 69-95). Springer, Cham.

Castleden, H., Morgan, V. S., & Lamb, C. (2012). "I spent the first year drinking tea": Exploring Canadian university researchers' perspectives on community-based participatory research involving Indigenous peoples. *The Canadian Geographer/Le Géographe canadien*, *56*(2), 160-179.

Chapman, J. M., & Schott, S. (2020). Knowledge coevolution: generating new understanding through bridging and strengthening distinct knowledge systems and empowering local knowledge holders. *Sustainability Science*, (3), 931–943. https://doi.org/10.1007/s11625-020-00781-2.

Chen, J., Loeb, S., & Kim, J.-H. (2017). LED revolution: fundamentals and prospects for UV disinfection applications. *Environmental Science: Water Research & Technology, 3*(2),188–202. https://doi.org/10.1039/c6ew00241b

Dennis, M. K., & Bell, F. M. (2020). Indigenous women, water protectors, and reciprocal responsibilities. *Social Work*, *65*(4), 378-386.

Devlin, T. R., Kowalski, M. S., Pagaduan, E., Zhang, X., Wei, V., & Oleszkiewicz, J. A. (2019). Electrocoagulation of wastewater using aluminum, iron, and magnesium electrodes. *Journal of Hazardous Materials, 368*, 862–868.

EPA. (2011). Principles of Design and Operations of Wastewater Treatment Pond Systems for Plant Operators, Engineers, and Managers. EPA/600/R-11/088. August 2011.

EPA. Method 200.8: Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma-Mass Spectrometry, Revision 5.4, EPA/600/R-94/111; Environmental Monitoring Systems Laboratory, Office of Research and Development: Cincinnati, OH, 1994.

EPA. SW-846 Test Method 3050B: Acid Digestion of Sediments, Sludges, and Soils, Revision 2, 1996.

Franco, D., Lee, J., Arbelaez, S., Cohen, N., & Kim, J.-Y. (2017). Removal of phosphate from surface and wastewater via electrocoagulation. *Ecological Engineering, 108*, 589–596. https://doi.org/10.1016/j.ecoleng.2017.07.031.

Galway, L. P. (2016). Boiling over: A descriptive analysis of drinking water advisories in First Nations communities in Ontario, Canada. *International Journal of Environmental Research and Public Health*, *13*(5), 505.

Gora, S. L., Rauch, K. D., Ontiveros, C. C., Stoddart, A. K., & Gagnon, G. A. (2019). Inactivation of biofilm-bound Pseudomonas aeruginosa bacteria using UVC light emitting diodes (UVC LEDs). *Water Research, 151*, 193–202.

Hayes, E. K., Stoddart, A. K., & Gagnon, G. A. (2022). Adsorption of SARS-CoV-2 onto granular activated carbon (GAC) in wastewater: Implications for improvements in passive sampling. *Science of the Total Environment, 847*, 157548.

Hayes, E. K., Sweeney, C. L., Anderson, L. E., Li, B., Erjavec, G. B., Gouthro, M. T., Krkosek, W. H., Stoddart, A. K., & Gagnon, G. A. (2021). A novel passive sampling approach for SARS-CoV-2 in wastewater in a Canadian province with low prevalence of COVID-19. *Environmental Science: Water Research & Technology, 7*(9), 1576–1586. https://doi.org/10.1039/d1ew00207d.

Health Canada (2012). Guidelines for Canadian Drinking Water Quality: Guideline Technical Document — Enteric protozoa: Giardia and Cryptosporidium. Water and Air Quality Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario. (Catalogue No H129-23/2013E-PDF).

Health Canada (2019). Guidelines for Canadian Drinking Water Quality: Guideline Technical Document — Lead. Water and Air Quality Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario. (Catalogue No H144-13/11-2018E-PDF).

Hoicka, C. E., Savic, K., & Campney, A. (2021). Reconciliation through renewable energy? A survey of Indigenous communities, involvement, and peoples in Canada. In *Energy Research & Social Science*, 74, 101897. https://doi.org/10.1016/j.erss.2020.101897.

Hrudey, S. (2013). Testimony on Bill S-8 to Standing Committee on Aboriginal Peoples on May 23rd, 2013. 41st Parliament, 1st Session

Huang, Y., Johnston, L., Parra, A., Sweeney, C., Hayes, E., Hansen, L. T., Gagnon, G., Stoddart, A., & Jamieson, R. (2021). Detection of SARS-CoV-2 in wastewater in Halifax, Nova Scotia, Canada, using four RT-qPCR assays. *FACETS*, *6*, 959–965. https://doi.org/10.1139/facets-2021-0026.

Hurley, E. S., & Jackson, M. (2020). Msit No'kmaq: An Exploration of Positionality and Identity in Indigenous Research. *Witness: The Canadian Journal of Critical Nursing Discourse*, *2*(1), 39–50. https://doi.org/10.25071/2291-5796.43.

ISC. (2022). Atlantic First Nations Water Authority and Government of Canada to sign historic water and wastewater transfer agreement. *Indigenous Services Canada*. November 7, 2022.

Johnson, J. T., Howitt, R., Cajete, G., Berkes, F., Louis, R. P., & Kliskey, A. (2016). Weaving Indigenous and sustainability sciences to diversify our methods. *Sustainability Science*, *11*(1), 1-11.

Kimmerer, R. W. (2012). Searching for synergy: Integrating traditional and scientific ecological knowledge in environmental science education. *Journal of Environmental Studies and Sciences*, *2*(4), 317-323.

Kot, M., Castleden, H., & Gagnon, G. A. (2015). The human dimension of water safety plans: a critical review of literature and information gaps. *Environmental Reviews, 23*(1), 24–29. https://doi.org/10.1139/er-2014-0030.

Krkosek, K., Healey, M., Sampson, C., & McKnight, A. Halifax Water's Lead Service Line Replacement Program Gets the Lead Out. *Journal of AWWA, 114*(2), 10-19. https://doi-org.ezproxy.library.dal.ca/10.1002/awwa.1862.

Kurtz, D.L.M. (2013). Indigenous Methodologies: Traversing Indigenous and Western worldviews in research. *AlterNative: An International Journal of Indigenous Peoples, 9*(3). https://doi.org/10.1177/117718011300900303.

Lalonde, M. (2022). Atlantic First Nations Water Authority becomes Canada's first Indigenous water utility. *Turtle Island News*. November 10, 2022.

Lane, K., Fuller, M., Dyment, T., & Gagnon, G. (2022). Co-development of a risk assessment tool for use in First Nations water supply systems: A key step to water safety plan implementation. *International Journal of Hygiene and Environmental Health, 240*, 113916.

Lane, K., Fuller, M., Stanhope, T., & Stoddart, A. (2021). Exploring the Use of a Sanitation Safety Plan Framework to Identify Key Hazards in First Nations Wastewater Systems. *Water, 13*(11),1454. https://doi.org/10.3390/w13111454.

Lane, K., Trueman, B. F., Locsin, J., & Gagnon, G. A. (2020). Inorganic contaminants in Canadian First Nation community water systems. *Journal of Water and Health, 18*(5), 728–740.

Lee, S. Y., & Gagnon, G. A. (2014). Review of the factors relevant to the design and operation of an electrocoagulation system for wastewater treatment. *Environmental Reviews*, 22(4), 421–429. https://doi.org/10.1139/er-2014-0009

Lewis, D., Castleden, H., Francis, S., Strickland, K., & Denny, C. (2016). Increasing response rates on face-to-face surveys with Indigenous communities in Canada: Lessons from Pictou Landing. *Progress in Community Health Partnerships: Research, Education, and Action*, *10*(2), 197-205.

Li, M., Zhang, H., Sun, H., Mohammed, A., Liu, Y., & Lu, Q. (2022). Effect of phosphate and ammonium concentrations, total suspended solids and alkalinity on lignin-induced struvite precipitation. *Scientific Reports*, *12*(1), 2901.

Lindstrom, C. (2020). *We are water protectors*. Roaring Brook Press.

Manuel, D. G., Delatolla, R., Fisman, D. N., Fuzzen, M., Graber, T., Katz, G. M., Kim, J., Landgraff, C., MacKenzie, A., Maltsev, A., Majury, A., Michael McKay, R., Minnery, J.,

Servos, M., Scott Weese, J., McGeer, A., Born, K. B., Barrett, K., Schwartz, B., & Jüni, P. (2021). The Role of Wastewater Testing for SARS-CoV-2 Surveillance. UWSpace. https://doi.org/10.47326/ocsat.2021.02.40.1.0.

Mattson, R. R., Wildman, M., & Just, C. (2018). Submerged attached-growth reactors as lagoon retrofits for cold-weather ammonia removal: performance and sizing. *Water Science and Technology: A Journal of the International Association on Water Pollution Research*, *78*(8), 1625–1632.

McGregor, D., Restoule, J.-P., & Johnston, R. (2018). *Indigenous Research: Theories, Practices, and Relationships*. Canadian Scholars' Press.

Nawarkar, C. J., & Salkar, V. D. (2019). Solar powered Electrocoagulation system for municipal wastewater treatment. *Fuel*, *237*, 222–226. https://doi.org/10.1016/j.fuel.2018.09.140.

Neegan Burnside Ltd. (2011). National Assessment of First Nations Water and Wastewater Systems—National Roll-Up Report—Final, 2011 Department of Aboriginal Affairs and Northern Development Canada, Ottawa, Canada.

Nguyen, T. M. H., Suwan, P., Koottatep, T., & Beck, S. E. (2019). Application of a novel, continuous-feeding ultraviolet light emitting diode (UV-LED) system to disinfect domestic wastewater for discharge or agricultural reuse. *Water Research, 153*, 53–62. https://doi.org/10.1016/j.watres.2019.01.006

Office of the Auditor General of Canada [OAG]. (2021). Report 3: Access to Safe Drinking Water in First Nations Communities – Indigenous Services Canada.

Parra-Guardado, A.L., Sweeney, C.L., Hayes, E. K., Trueman, B.F., Huang, Y., Jamieson, R.C., Rand, J.L., Gagnon, G.A., & Stoddart, A.K. (2022). Development of a rapid pre-concentration protocol and a magnetic beads-based RNA extraction method for SARS-CoV-2 detection in raw municipal wastewater. *Environmental Science: Water Research & Technology, 8*. https://doi.org/10.1039/D1EW00539A.

Patrick, R. J. (2011). Uneven access to safe drinking water for First Nations in Canada: Connecting health and place through source water protection. *Health & Place, 17*(1), 386–389. https://doi.org/10.1016/j.healthplace.2010.10.005

Perrier, E., Kot, M., Castleden, H., & Gagnon, G. A. (2014). Drinking water safety plans: barriers and bridges for small systems in Alberta, Canada. *Water Policy, 16*(6), 1140–1154. https://doi.org/10.2166/wp.2014.207.

Pishgar, R., Hamza, R. A., & Tay, J. H. (2017). Augmenting Lagoon Process Using Reactivated Freeze-dried Biogranules. *Applied Biochemistry and Biotechnology*, *183*(1), 137–154. https://doi.org/10.1007/s12010-017-2435-2.

Pishgar, R., Lee, J., Dominic, J. A., Hosseini, S., Tay, J. H., & Chu, A. (2020). Augmentation of Biogranules for Enhanced Performance of Full-Scale Lagoon-Based Municipal Wastewater Treatment Plants. *Applied Biochemistry and Biotechnology*, *191*(1), 426–443.

Prosper, K., Jane McMillan, L., Davis, A. A., & Moffitt, M. (2011). Returning to Netukulimk: Mi'kmaq cultural and spiritual connections with resource stewardship and self-governance. *International Indigenous Policy Journal, 2*(4). https://doi.org/10.18584/iipj.2011.2.4.7.

Ragush, C. M., Schmidt, J. J., Krkosek, W. H., Gagnon, G. A., Truelstrup-Hansen, L., & Jamieson, R. C. (2015). Performance of municipal waste stabilization ponds in the Canadian Arctic. *Ecological Engineering*, *83*, 413–421. https://doi.org/10.1016/j.ecoleng.2015.07.008.

Rauch, K. D., MacIsaac, S. A., Stoddart, A. K., & Gagnon, G. A. (2022). UV disinfection audit of water resource recovery facilities identifies system and matrix limitations. *Journal of Water Process Engineering, 50*, 103167. https://doi.org/10.1016/j.jwpe.2022.103167

Redden, D., Trueman, B. F., Dunnington, D. W., Anderson, L. E., & Gagnon, G. A. (2021). Chemical recovery and browning of Nova Scotia surface waters in response to declining acid deposition. *Environmental Science. Processes & Impacts*, *23*(3), 446–456.

Reid, A. J., Eckert, L. E., Lane, J., Young, N., Hinch, S. G., Darimont, C. T., Cooke, S. J., Ban, N. C., & Marshall, A. (2021). "Two-Eyed Seeing": An Indigenous framework to transform fisheries research and management. *Fish and Fisheries, 22*(2), 243–261. https://doi.org/10.1111/faf.12516.

Reid, D. C., Abramowski, K., Beier, A., Janzen, A., Lok, D., Mack, H., ... & Vatcher, R. (2014). Implementation of Alberta's drinking water safety plans. *Water Quality Research Journal of Canada*, *49*(1), 5-9.

Rezaei, M., & Dowlatabadi, H. (2016). Off-grid: community energy and the pursuit of self-sufficiency in British Columbia's remote and First Nations communities. *Local Environment*, *21*(7), 789-807.

Roy, S., & Edwards, M. A. (2020). Efficacy of corrosion control and pipe replacement in reducing citywide lead exposure during the Flint, MI water system recovery. *Environmental Science: Water Research & Technology, 6(11)*, 3024-3031.

Sanchez-Pimienta, C. E., Masuda, J. R., Doucette, M. B., Lewis, D., Rotz, S., Neufeld, H. T., & Castleden, H. (2021). Implementing Indigenous gender-based analysis in research: principles, practices and lessons learned. *International Journal of Environmental Research and Public Health*, *18*(21), 11572.

Sanderson, D., Picketts, I. M., Déry, S. J., Fell, B., Baker, S., Lee-Johnson, E., & Auger, M. (2015). Climate change and water at Stellat'en First Nation, British Columbia, Canada: Insights from western science and traditional knowledge. *The Canadian Geographer/Le Géographe canadien*, *59*(2), 136-150.

Schwartz, H., Marushka, L., Chan, H. M., Batal, M., Sadik, T., Ing, A., Fediuk, K., & Tikhonov, C. (2021). Metals in the drinking water of First Nations across Canada. *Canadian Journal of Public Health. Revue Canadienne de Sante Publique*, *112*(Suppl 1), 113–132.

Sharma, V. K., & Demir, H. V. (2022). Bright Future of Deep-Ultraviolet Photonics: Emerging UVC Chip-Scale Light-Source Technology Platforms, Benchmarking,

Challenges, and Outlook for UV Disinfection. *ACS Photonics*, *9*(5), 1513–1521. https://doi.org/10.1021/acsphotonics.2c00041

Smith, L. T. (2021). *Decolonizing methodologies: Research and indigenous peoples*. Bloomsbury Publishing.

Smyth, K., Vendramelli, R., Dankewich, D., & Yuan, Q. (2018). Seasonal variations in cold climate nutrient removal: A comparison of facultative and aerated lagoons. *Journal of Environmental Management, 214*, 224–231.

Spicer, N., Parlee, B., Chisaakay, M., & Lamalice, D. (2020). Drinking water consumption patterns: an exploration of risk perception and governance in two first nations communities. *Sustainability*, *12*(17), 6851.

Stefanelli, R. D., Walker, C., Kornelsen, D., Lewis, D., Martin, D. H., Masuda, J., Richmond, C. A. M., Root, E., Neufeld, H. T., & Castleden, H. (2019). Renewable energy and energy autonomy: how Indigenous peoples in Canada are shaping an energy future. *Environmental Reviews*, *27*(1), 95–105. https://doi.org/10.1139/er-2018-0024.

Tegladza, I. D., Xu, Q., Xu, K., Lv, G., & Lu, J. (2021). Electrocoagulation processes: A general review about role of electro-generated flocs in pollutant removal. *Process Safety and Environmental Protection*, *146*,169–189.

Trueman, B. F., Anaviapik-Soucie, T., L'Hérault, V., & Gagnon, G. A. (2019). Characterizing colloidal metals in drinking water by field flow fractionation. *Environmental Science: Water Research & Technology, 5*(12), 2202-2209. https://doi.org/10.1039/c9ew00560a

Trueman, B. F., MacIsaac, S. A., Stoddart, A. K., & Gagnon, G. A. (2016). Prediction of disinfection by-product formation in drinking water via fluorescence spectroscopy. *Environmental Science: Water Research & Technology*, *2*(2), 383–389. https://doi.org/10.1039/c5ew00285k

Unama'ki Institute of Natural Resources (n.d.) Partnership Tenets. https://www.uinr.ca/wp-content/uploads/2021/05/UINR-Partnership-Tenets.pdf (accessed Jan 15, 2023)

Wait, I.W. (2005). Fouling of quartz surfaces in potable water ultraviolet disinfection reactors (Order No. 3191577). Available from ProQuest Dissertations & Theses Global. (305388963).

Watanabe, S., & Oguma, K. (2022). A Simple and Practical Method for Fluence Determination in Bench-Scale UV-LED Setups. *Photochemistry and Photobiology*. https://doi.org/10.1111/php.13668

White, J. P., Murphy, L., & Spence, N. (2012). Water and Indigenous peoples: Canada's paradox. *International Indigenous Policy Journal*, *3*(3).

Yates, C., Fuller, M., Tiannie, P., & Gagnon, G. (2022, June 22 - 34). *Two-Eyed Seeing Development of One Water Safety Plans: A path forward for the Atlantic First Nations Water Authority* [Conference session]. Water Safety Conference, Narvik, Norway.

Zhang, C., Guisasola, A., & Baeza, J. A. (2022). A review on the integration of mainstream P-recovery strategies with enhanced biological phosphorus removal. *Water Research, 212*. https://doi.org/10.1016/j.watres.2022.118102

Zhang, X., Lin, H., & Hu, B. (2016). Phosphorus removal and recovery from dairy manure by electrocoagulation. *RSC Advances*, *6*(63), 57960–57968. https://doi.org/10.1039/c6ra06568f

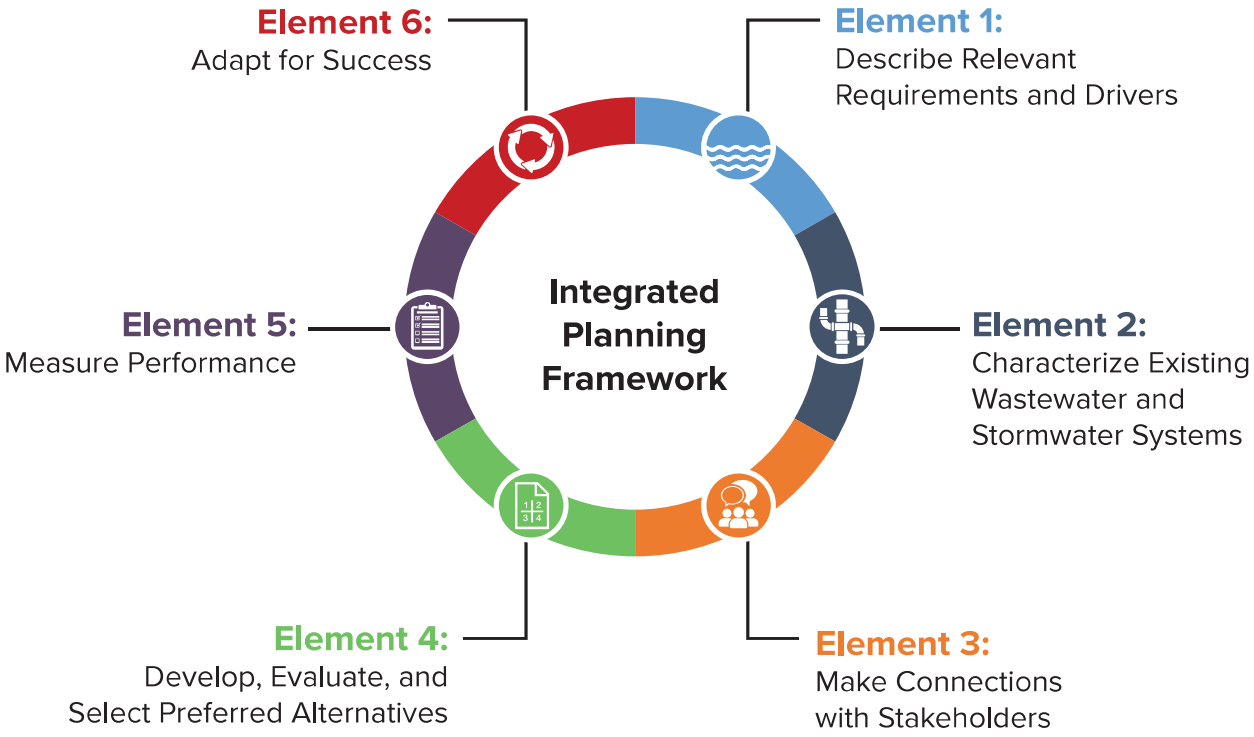
Zurba, M., & Papadopoulos, A. (2021). Indigenous Participation and the Incorporation of Indigenous Knowledge and Perspectives in Global Environmental Governance Forums: a Systematic Review. *Environmental Management*.

Integrated Planning in Action

The Basics

Integrated planning is a process for utilities to achieve clean water and human health goals while addressing aging water, wastewater and stormwater infrastructure, changing population and rainfall patterns, and competing priorities for funding.

EPA developed the 2012 Integrated Municipal Stormwater and Wastewater Planning Framework to help municipalities maximize their benefits through integrated planning while meeting Clean Water Act requirements. The Framework describes six elements that should be included in any integrated plan.



Item 2-1
AFNWA Board
January 31, 2024

TO: Chief Wilbert Marshall, Chair and Members of the AFNWA Board

SUBMITTED BY: **Original Signed by**
John Lam, Director of Engineering

APPROVED: **Original Signed by**
Susheel Arora, M.A.Sc., P.Eng., Chief Executive Officer

DATE: **January 26, 2024**

SUBJECT: **Integrated Resource Plan Development**

ORIGIN

Ten Year Business Plan approved by AFNWA Board at meeting of February 10, 2022. This report is presented for information.

BACKGROUND

As part of its mandate and services, AFNWA continuously undertakes initiatives and programs to maintain and operate its water and wastewater systems while striving to provide a high level of service to its users and protect the environment. These initiatives and programs require integration into an enhanced single capital program that identifies the long-term resource needs and financial expenditures.

AFNWA completed an Asset Management Plan (AMP) and SCADA Master Plan for all participating communities that were at that time exploring membership with AFNWA. These documents identified the current inventory and condition of the water and wastewater assets, and developed a budget for capital works to maintain the infrastructure. The capital plan used a planning horizon of 10 years to match and coincide with the application to the Treasury Board of the Government of Canada for funding for AFNWA.

In most progressive municipalities in Canada, long-range planning is undertaken to define its program and resource needs over a 25-year or longer planning horizon. This planning document, called the Integrated Resource Plan (IRP) responds to the combined requirements of community growth (including residential, industrial, commercial and institutional), current and expected

regulatory compliance and asset renewal. The attached graphic provides a basic framework.

DISCUSSION

The IRP will apply the considerations of asset renewal, compliance and growth drivers to ensure the integrated recommendations achieve the desired service delivery goals, as well as identify any additional gaps and programs required in the long-term plan. The IRP will create one holistic project and study program that will inform AFNWA activities for the next 5 years and provide a guide for the next 25 to 30 years. The IRP will analyze and report on infrastructure requirements at the community level, however, the integrated capital plan will be singular across all AFNWA managed communities.

The IRP will also provide direction on fiscal requirements for capital investment critical to business planning and funding arrangements with the federal government.

One of the key tasks in the IRP is the development or enhancement of input data on the capital investment for the individual assets. Drivers for the IRP include:

- Asset Renewal Driver:
    - Characterize current condition of assets and identify prioritized asset renewal requirements.
- Growth Driver:
    - Develop community growth scenarios for residential, industrial/commercial/institutional (ICI) sectors and resultant demand forecasts.
    - Document existing capacity of infrastructure assets.
    - Identify projects required to meet water and wastewater demands from growth scenarios.
- Compliance Driver:
    - Identify current regulatory requirements and anticipated changes.
    - Develop listing of current and potential future areas of non-compliance, and required projects or programs to bring into compliance.
    - Review and enhance levels of service requirements.
- Supply Side Management and Demand Side Management opportunities:
    - Management of water and wastewater demand/generation.
    - Identification of initiatives that may impact utility effectiveness and efficiency.
- Integration of Capital Requirements:
    - Analyze, coordinate, align and integrate the prioritized needs for optimal efficiency and effectiveness of capital project delivery.
    - Provide preliminary long-range capital infrastructure program.
- Integrated Resource Plan:
    - Five Year list of prioritized integrated initiatives.

- Long Term capital plan.

The IRP will start as a pilot project in one or two communities initially, to ensure the scope and level of effort are appropriate. Selection of the pilot communities are underway, based on the availability of existing land-use or master plan programs.

BUDGET AND FINANCIAL IMPLICATIONS

The budget for the IRP will be covered by the funds in the AFNWA Business Plan for this purpose.

ALTERNATIVES

There are no alternatives for this project.

ATTACHMENTS

Integrated Planning Basic Framework

Report Prepared By	Original Signed By John Lam, P.Eng., Director of Engineering, (902) 603-0312
Financial Reviewed By:	Original Signed By Susheel Arora, M.A.Sc., P.Eng., CEO, (782) 414-6628

Integrated Planning in Action

The Basics

Integrated planning is a process for utilities to achieve clean water and human health goals while addressing aging water, wastewater and stormwater infrastructure, changing population and rainfall patterns, and competing priorities for funding.

EPA developed the 2012 Integrated Municipal Stormwater and Wastewater Planning Framework to help municipalities maximize their benefits through integrated planning while meeting Clean Water Act requirements. The Framework describes six elements that should be included in any integrated plan.