



**RBC
Blue Water
Project™**

Protecting Drinking Water in Indigenous Communities in Canada's North

RBC Blue Water Project # 50

FINAL REPORT

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Prepared by the Institute for Watershed Science

for the RBC Blue Water Foundation

Project Director: Dr. Chris Metcalfe

705-748-1011 x 7272



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LIST OF ACRONYMS

| | |
|--------|-----------------------------------------------------|
| CAWT | Centre for Alternative Wastewater Treatment |
| EC | Environment Canada |
| ENR | Department of the Environment and Natural Resources |
| GNWT | Government of the Northwest Territories |
| IWS | Institute for Watershed Science |
| MACA | Municipal and Community Affairs |
| NTWWA | Northern Territories Water and Waste Association |
| NWT | Northwest Territories |
| SWP | Source Water Protection |
| TK | Traditional Knowledge |
| YRITWC | Yukon River Inter-Tribal Watershed Council |

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Cover photo: The Yellowknife River at Tartan Rapids, Yellowknife, NT

All photos by Leslie Collins and Craig Murray, Institute for Watershed Science unless otherwise stated.

Report compiled by Leslie Collins and Craig Murray, Institute for Watershed Science, Trent University

EXECUTIVE SUMMARY

The RBC Blue Water Project supported a 5 year (2009-2014) research and training program entitled, "Protecting Sources of Drinking Water in Indigenous Communities in Canada's North". To deliver this program, the Institute for Watershed Science (IWS) at Trent University worked in partnership with the Indigenous Environmental Studies Programme at Trent and the Centre for Alternative Wastewater Treatment (CAWT) at Fleming College. The goal of the project was to work with partners in Canada's North to protect sources of drinking water in Indigenous communities. This project had two themes:

- **Source water protection:** develop capacity in the North for management of water resources and protection of sources of drinking water in Indigenous communities through a combination of western science and Indigenous Knowledge;
- **Treatment of municipal wastewater:** provide training to wastewater managers in the North on the use of tundra wetlands to treat municipal sewage in remote Indigenous communities.



Figure 1. GNWT SWAP Planning Process (Adapted from GNWT 2012)

To accomplish these tasks, the project partners developed a research and training network that includes governmental agencies, community colleges, Indigenous organizations and individual communities in the North. Project activities took place in the Yukon, the Northwest Territories and in Nunavut. Guidance on the project was provided through annual meetings of the project partners with a Project Advisory Committee. A total of 216 people in Canada's North received training through this RBC Blue Water Project. The extent of project outreach is significant considering the small population in the three northern territories and the small number of professional land and water personnel in the North.

"Source water protection" refers to a community-based strategy to manage threats to water resources so that communities do not have to rely solely on water treatment technologies to provide good quality drinking water (Figure 1). To promote this water management strategy in Canada's north, we adopted a three-pronged approach to build capacity:

- ***Community College programs***, through curriculum development;
- ***Training of water professionals***, through "train the trainer" workshops, participation at annual meetings of professional organizations, and the development of training manuals;
- ***Community-based training***, through workshops and meetings with Indigenous communities.

Two key elements were incorporated into all aspects of the Source Water Protection program:

- ***Sustainability***. The need to develop programs that will continue after the RBC Blue Water Project funding ends.
- ***Indigenous Knowledge***. The need to bridge western science with cultural values and community-based experiences in all aspects of training.

1) **Community college programs:**

The project partners worked with both Yukon College, YT and Aurora College, NT to develop courses on water resource management and source water protection that are now being delivered at both colleges as part of their Environmental Studies programs. These post-secondary programs for northern students ensure that the concepts of source water protection will be sustained through training of the next generation of water resource managers and practitioners in the North.

2) Training of water professionals:

The project partners worked with the Government of the Northwest Territories (GNWT) to develop “train the trainer” programs for water management professionals. Training in Source Water Protection is now part of the core curriculum in Environmental Management offered by Municipal and Community Affairs department of the GNWT; ensuring that sustainable training exists for this sector beyond the life of the RBC Blue Water Project.

From 2010 to 2013, the project partners attended the annual meetings of the Northern Territories Water and Waste Association (NTWWA), which is the professional association for water and wastewater personnel in the Northwest Territories and Nunavut. In 2013, the project partners also attended the meeting of the British Columbia Water and Waste Association, which is the professional organization with which water and wastewater personnel in the Yukon are affiliated. By delivering technical presentations and short courses, and by participating in workshops at these annual meetings, the project partners ensured that Source Water Protection is now understood and valued in the North as part of a community-based strategy for water management.

The project partners at CAWT also developed technical materials for promoting the use of natural tundra wetlands for treatment of wastewater in remote Indigenous communities. This work was primarily focused on the needs of communities in Nunavut, where wastewater is typically retained in sewage lagoons during the winter and is discharged into receiving waters over the short summer season.

The CAWT:

- Developed a full technical document summarizing the research on the efficiency of tundra wetlands for treating wastewater;
- Calibrated the SubWet 2.0 wetland model to be used with natural tundra wetlands and prepared an operations manual outlining the operation and application of the SubWet program for use by wetland managers in the Far North.

These materials will provide guidance for wastewater practitioners on how to use “low-tech” solutions to treat wastewater in remote Indigenous communities under harsh northern conditions where wastewater management is technically difficult.

3) Community-based training:

The project partners worked with the Environment and Natural Resources department of the GNWT to provide community based education on Source Water Protection for several NWT communities. Highlights include participation at workshops in Inuvik and Yellowknife that included leaders from 27 of the 33 communities in the NWT, and representatives from several regional land

and water boards (Figure 2), engagement with the Yellowknives Dene First Nation to develop a Source Water Protection plan for the Yellowknife River watershed , and work with the Samba K'e Dene community of Trout Lake to develop a community Source Water Protection plan.

The project partners have also engaged with the Yukon River Intertribal Watershed Council (YRITWC), which includes First Nations communities from both the Yukon and Alaska. We attended the YRITWC Summit in 2013 to deliver a workshop on Source Water Protection to Tribal Council members and community representatives. Working with the YRITWC, we gave a workshop for representatives of communities in the watershed in Whitehorse in the spring of 2014.



Figure 2. Source Water Protection workshop, Yellowknife, 2012

PROJECT OBJECTIVES

The RBC Blue Water project supported a 5 year program (2009-14) entitled, “Protecting Sources of Drinking Water in Indigenous Communities in Canada’s North”. The project partners included the Institute for Watershed Science (IWS) at Trent University, working with the Indigenous Environmental Studies (IES) Program at Trent and the Centre for Alternative Wastewater Treatment (CAWT) at Fleming College. A full list of the project partners is provided in Appendix A. The overall objective of the project was to build capacity in Canada’s North for protecting water resources and the quality of drinking water. To support this objective, the two project goals were to:

- build capacity** in Canada’s north to develop “source water protection” (SWP) plans using approaches that bridge western science with Traditional Knowledge, and
- provide information** to northern wastewater managers on the use of tundra wetlands for treatment of municipal sewage in remote northern communities.

We developed a three-pronged strategy for achieving these objectives that is focussed on ensuring that the capacity to protect water resources will remain in Canada’s North after the project funding has ended. As illustrated in Figure 3, our strategy was to develop this capacity through: i) postsecondary programs at community colleges, ii) technical training for northern water professionals, and iii) workshops with communities and Indigenous organizations.



Figure 3. Strategy for the RBC Blue Water Project for “Protecting Sources of Drinking Water in Indigenous Communities in Canada’s North”.

The project was successful in developing a cohort of trained personnel and community leaders with expertise in protecting water resources in Canada's North. SWP programs were developed in the Yukon Territory and the Northwest Territories, and programs to promote the use of tundra wetlands for wastewater treatment were focussed in Nunavut Territory.

BACKGROUND

Most provinces in Canada now have programs for protecting sources of drinking water using “multi-barrier” approaches. Several incidents involving contamination of drinking water have shown Canadians that we cannot rely on technology to ensure that our water is safe to drink. Contamination of drinking water in Walkerton, ON in 2000 with a pathogenic strain of *E. coli* caused 7 deaths and thousands of illnesses. Protecting sources of drinking water was a key recommendation of the Inquiry into the Walkerton case. However, since then, there have been several other serious contamination incidents in Canada, including contamination of the water supplies of North Battleford, SK with the *Cryptosporidium* waterborne parasite in 2004, the evacuation of Kashechewan, ON First Nation as a result of high *E. coli* counts in raw drinking water in 2007, and drinking water quality problems in Attawapiskat First Nation, ON in 2012 related to excessive chlorine disinfection because of the poor quality of the source of water. Protecting the quality of water BEFORE it is treated for distribution as drinking water is a cost effective approach that reduces the reliance on expensive treatment technologies and the skills and training of the water treatment plant operators.

Protecting and managing water resources in Canada's North is a complex task, involving multiple jurisdictions, and distributed over a vast geographic area, with many isolated, small communities. Development of natural resources in the North and the expected impacts of climate change have recently highlighted the need for SWP in northern communities, including the development of policies and procedures to protect sources of drinking water, training for community leaders and operators of water treatment systems and in some cases, the development of appropriate treatment infrastructure. It is particularly difficult to deliver safe, potable water to remote communities in Canada's north as there are limited resources for infrastructure and training, and because of the technological challenges imposed by the harsh climate conditions. In the past, water resource planning in these communities has generally been out-sourced to environmental consulting firms that specialize in hydrogeology and water resource management. The reports prepared and delivered by these consulting firms to the communities contain the technical data required for the development of a SWP plan, but the communities typically do not have the technical expertise to understand the details in the report, and there is often no financial or technical support to implement the recommendations that are provided.

For this project on “Protecting Sources of Drinking Water in Indigenous Communities in Canada's North”, we used a three-pronged approach for training a cohort of “water practitioners” in Canada's North. An essential element of all of the training programs was to bridge western science with Traditional Knowledge (TK), to develop training materials that reflected the cultural values and the ex-

periences in the North. Interactions with Northerners, and particularly Indigenous peoples at community based workshops, technical training sessions for water professionals, and in the community college class room, formed the basis for incorporating TK into the training materials.

Another outcome of this project was the synthesis of the data generated on the performance of tundra wetlands in a number of communities in Nunavut to create a comprehensive manual for the use of tundra wetlands to treat the wastewater discharged seasonally from sewage lagoons. This document was summarized in a shorter companion document for broad distribution to wastewater professionals in Nunavut. These training materials are a valuable resource that will help remote communities meet new, more stringent guidelines for discharges of treated sewage that are due to be implemented by Environment Canada.

This report outlines the successes and the lessons learned during this 5 year RBC Blue Water Project, including a summary of the various training initiatives conducted in the Yukon, the Northwest Territories and Nunavut. Table 1 provides a tally of the number of individuals trained on Source Water Protection through this project using the three-pronged approach, which totals more than 1 of every 1,000 people currently living in the northern territories (i.e. 181 individuals trained from total population of 115,700). In addition 35 people attended a workshop in Iqaluit on wastewater management using tundra wetland systems. The workshop was aimed at regulatory agencies and government managers in Nunavut Territory.

Table 1: Number of people trained in the project “Protecting Sources of Drinking Water in Indigenous Communities in Canada’s North” by Territory.

| Territory | Community College Programs | Training for Gov’t and Regulatory Agencies | Training for Community Water Professionals | Total |
|--------------|----------------------------|--------------------------------------------|--------------------------------------------|------------|
| Yukon | 19 | 5 | 5 | 29 |
| NWT | 8 | 58 | 56 | 122 |
| Nunavut | n/a | 11 | 13 | 24 |
| Other* | n/a | 2 | 4 | 6 |
| Total | 27 | 66 | 78 | 181 |

* representatives from areas outside of the three Territories, namely northern Alberta and Nunavik, Quebec.

PROJECT ACCOMPLISHMENTS

Community College programs

A major accomplishment of the project was the development and now annual delivery of college-level programs in water resource management and source water protection at Yukon College (based

in Whitehorse, YT) and Aurora College (based in Fort Smith, NT). The first program was developed with Yukon College as part of the College's Environmental Studies programming. The partnership with Yukon College was facilitated by the existing linkage between the Indigenous Environmental Studies Program at Trent University and the Northern Contaminants program at Yukon College. A full 14 week "western science" based course curriculum was designed at the Institute for Watershed Science at Trent as a basis for the development of the course. Modification of the initial curriculum to include Indigenous perspectives and TK has occurred iteratively throughout the project. For instance, course materials on Indigenous Knowledge were developed with the assistance of Chief Carl Sidney of the Teslin T'lingit Council and other First Nations consultants based in Whitehorse, and an experiential learning field camp was included in the course (See Case Study 1). More recently, Randall Tetlich, resident First Nations elder, teacher, healer and counsellor, worked with the class to incorporate First Nations perspectives on water into the course curriculum. In addition, there have been presentations on western science and TK, based on work at Cape Breton University and the Mi'kmaw elder, Albert Marshall, who developed an excellent presentation, "Seeing with Two Eyes". The course material has further evolved to include Indigenous stories and student experiences, as well as laboratory and field studies. The course is designed to be offered in the future through distributed learning formats, so that students in remote communities can participate through the College's unique remote education technology, which includes two-way video links between students in remote communities and the course instructor at the Whitehorse campus. Although all past students have been based at the Whitehorse campus, marketing of the course to remote communities for student driven online training is now underway. This course is offered within the same class to 3 different academic levels from college preparation to 4th year University of Alberta Environmental Science students, where the course has been authorized for transfer credit status. A review of the model for course development at Yukon College was undertaken by the Indigenous Environmental Studies Programme. This review is appended to this report as Appendix B.



Figure 4. MACA—GNWT School of Community Government Workshop 2011

CASE STUDY 1: Yukon College Source Water Protection and Watershed Stewardship Course: Field Camp Experience

For 1 ½ days the instructors and course development team from Yukon College met with a group of 10 students from the Conservation Action Team (CAT), a Department of Environment (Yukon Government) summer program for youth at Kathleen Lake, Kluane National Park. This field course experience was developed to pilot the first lessons from the Source Water Protection curriculum being developed for a Yukon College course. Kathleen Lake is known for its beauty, with the majestic Kings' Throne mountain rising up from its shoreline. For much of the time, we sat in a circle on the shore of Kathleen Lake.

The field camp began with an introductory session exploring “ways of knowing”, particularly western science and indigenous knowledge. This was followed by an introduction to source water protection in the Yukon, what it means, the importance of it, the threats to it, what constitutes a healthy watershed, and what might be done to protect and preserve Yukon's waters.

Carl Sidney our First Nations leader emphasized the centrality of story in First Nations culture – story as a way of teaching, learning and sharing. For example, if an elder was counseling someone, they would often give them a story “to think with” for a while. We discussed the importance of direct experience, particularly of the natural world, as opposed to what some elders have called “paper learning”. The theme of respect for Mother Earth and all her inhabitants was central to the teaching. Earth itself (and its waters) is the source of all life and therefore is deserving of our respect.

Carl told the students that one elder has said “if you spit on the Earth, you spit on yourself”. Carl spoke often of the problem of source water and watershed protection as a problem of the false perception that humans are separate from nature and that we need teachings and practices that regenerate this lost connection.

The group took part in an experiential activity, introducing themselves through the scars on their bodies. Each pointed out scars they had and told the group how they got each scar. The students found that the scars on our bodies tell a story – a story that is part of our broader life story. Similarly, the group discussed that the Earth also contains innumerable scars on its lands and waters that also tell a story of human impact on the biosphere. We talked about how much humans are part and parcel of the biosphere (Earth) as we are literally constituted of the same ‘stuff’ - the same chemical constituents.

Thus we were able to explore how direct experiences become stories over time and the importance of sharing these stories with each other and how language creates the world. The students then explored how the language we use with respect to nature shapes the stories we tell about nature (and

our perceptions of it) and the human relationship with it.

The students finished this section of the course with the web-of-life activity. In this experiential activity, the group stood in a circle (outside). The circle represented the ecosystem that is Kathleen Lake. As they discussed the myriad relationships that exist there (between and among the sunlight, the phytoplankton, the zooplankton, fish, eagles, stones, plants, birds, the wind and on and on), a string would be passed to whoever was representing each natural entity and the string was wrapped around them. Eventually, the students were all connected by a strong and complex web of relationships. Each student was asked to lean back and experience the support of the rest of the web of life. Then one string was cut. The students experienced a lessening of support, a weakening of the web. As more and more strings (relationships) were broken, the web became weaker and eventually unraveled. Afterward the group debriefed this experience, discussed the various forces and actions that might weaken the web of a Yukon watershed and then discussed the jobs that some of these students will go on to – jobs that involved reweaving the web of life.

This and other experiential activities, explorations and conversations provided a good segway into the second lesson, which was more information-oriented and quantitative rather than qualitative.

We started with the fact that both the human body and the Earth are approximately $\frac{3}{4}$ water; This really reinforced how much humans are in and of the Earth. The material from the second lesson included statistics and information about source water protection, globally, in Canada, with respect to First Nations in Canada and then with respect to the north and to the Yukon.

There was a wide-ranging discussion that needed little facilitating because students were very much engaged and concerned. Without much prompting, they were able to identify threats to source water protection in the Yukon and came up with some ideas on how to deal with these threats. We ended this session with a discussion of what it means to live as part of a healthy watershed. This conversation went on for some time.



"I found this pilot delivery to be extremely valuable in reinforcing (i) the critical nature of the topic – students were very concerned about source water protection and very much engaged once they had gained a bit of knowledge, both experiential and cognitive, (ii) the value of direct experience (ex, the web-of-life activity) in reinforcing concepts and principles and (iii) the validity of both western science and indigenous knowledge as ways of knowing the world." -Larry Gray, Yukon College Instructor

Aurora College in the Northwest Territories has also worked with the project partners to develop a college elective course for their Environmental and Natural Resources Technology Program. Administrative restructuring at the college delayed course delivery, but the course has been made mandatory for 2014 and the program was piloted at Aurora Collage in October of 2014 . In each of the northern colleges, the inclusion of course curricula for northern students provides a method of sustainable training for northern water resources and environmental practitioners. As of 2014 there have been 19 students at 3 academic levels trained at Yukon College and 8 students are enrolled for the first offering of the course at Aurora College.

Training of water professionals

Government Training Programs

While delivery of college education was the initial focus for the Yukon Territory, within NWT, the initial focus of the project was to offer training programs for professionals at the Territorial government level. The School of Community Government, which is part of the Department of Municipal and Community Affairs (MACA) and the Department of Environment and Natural Resources (ENR) have been strong partners from the Government of the Northwest Territories (GNWT). Through the School of Community Government, planners, senior administrative officers, councillors and other community government personnel have access to ongoing professional training to improve their technical and professional capacity within community governments. In 2011, staff from the Institute for Watershed Science (IWS) at Trent delivered a professional workshop that was piloted to personnel from various community governments as part of the Lands Management Program, Environmental Management Course. MACA subsidized community personnel for travel to Yellowknife to take part in this workshop (Figure 4). Subsequently, based on positive results, IWS was contracted by MACA to develop a “train the trainer” manual and training materials for SWP.

In 2012, IWS staff trained 11 MACA personnel and instructors so that they can provide this training as part of future Environmental Management training programs for community and territorial government personnel. This course is being offered again in December, 2014, with the SWP training components, and this training will be part of all future Environmental Management courses. The incorporation of SWP training through the MACA School of Community Government has ensured that training will be sustained beyond the life of this RBC Blue Water Project

Conference Workshops

The Northern Territories Water and Waste Association (NTWWA) is the professional association for water and wastewater personnel working in the Northwest Territories and Nunavut, and the annual meetings of this association provide an excellent opportunity to reach out and communicate with professionals operating in the North. Project participants attended the annual NTWWA conferences from 2010 to 2013. There were two conferences in Yellow-

knife, NT and two in Iqaluit, NU (Figure 5). Involvement at these events was critical for developing a relationship with water and wastewater professionals and discussing issues of concern with this sector. This project was introduced to conference participants in 2010, with a presentation that outlined the project goals and objectives. In 2011, the IWS was invited to be part of the first full day workshop for Water Operators. IWS partnered with the ENR and MACA departments of the GNWT, as well as Aboriginal Affairs and Northern Development (AANDC) and Environment Canada (EC) to present a full day workshop on SWP planning to water operators at the conference in Iqaluit. The majority of the water operators at this session resided in Nunavut Territory. This workshop was an excellent opportunity to provide Source Water Protection training to water professionals in Nunavut. CAWT staff also provided a workshop on the development of training materials and computer software for the design and operation of tundra wetlands for treating municipal wastewater effluents.

Water and wastewater professionals in the Yukon Territory are affiliated with the British Columbia Water and Waste Association (BCWWA). In order to reach out to these professionals from the Yukon, IWS attended and presented the work of the RBC Blue Water Project to the membership at the BCWWA conference in 2013. As a follow up to this meeting, the IWS has developed a strong relationship with the Yukon River Intertribal Watershed Council (YRITWC); an Indigenous organization that includes First Nations from the Yukon and Alaska. Participation by the IWS at the YRITWC Summit (Mayo, Yukon, August 2-4, 2013) raised the profile of the project within Yukon First Nations, the Yukon Government and NGOs who were present at the Summit. We anticipate that SWP planning will be included in all future activities in the watershed to meet the objectives of the Watershed Accord of the YRITWC. The training provided by the IWS as part of this project will provide a foundation for SWP planning in Yukon communities.



Figure 5. NWWA Conference attendees, Iqaluit, 2013

Guidance Documents

The CAWT contributed to this project through their expertise with sewage treatment using natural tundra wetlands. Controlling discharges of microbiological contaminants and nutrients from sewage is an important component of the protection of sources of drinking water. Sewage lagoons are the primary sewage treatment method used in remote communities in the North. In these communities, domestic sewage is collected and trucked to the lagoons (Figure 6) and the sewage is discharged during the summer months; primarily into coastal zones. The sewage can be directed into natural tundra wetlands in order to remove a high proportion of the microbiological contaminants and nutrients prior to discharge. However, the proper design and maintenance of these wetland treatment systems requires technical training.

CAWT developed a comprehensive document describing the current state of knowledge on the use of natural tundra wetlands for treatment of discharges from sewage lagoon systems in the Far North, with a focus on Nunavut Territory. It is unlikely that remote communities in Nunavut will be able to meet new regulations from Environment Canada (EC) for sewage effluents, unless there is a strategy implemented to treat sewage prior to discharge. This regulatory issue is of high importance to the Nunavut Government, as well as the Water Boards and hamlet wastewater treatment personnel. The documentation developed through CAWT provides evidence that tundra wetlands associated with existing lagoon systems can effectively remove contaminants and nutrients prior to discharge.



Figure 6. Sewage truck discharges in Ulukhaktok, NT

The CAWT also adapted existing software for designing engineered wetlands so that this predictive tool can be used to design tundra wetlands that function effectively for sewage treatment. This “SubWet 2.0” software and an accompanying step-by-step user manual has been made available to wastewater personnel in the North and can be used to predict the efficacy of an existing natural wetland for removal of certain wastewater contaminants, such as ammonia and total suspended solids. These materials are targeted to assist wastewater personnel in the North to use tundra wetlands as a treatment option to meet the new EC guidelines for effluent quality. A summary of the documentation is appended to this report as Appendix C. The full science brief and SubWet 2.0 software will be available on both the CAWT and IWS websites for personnel in the North who want to utilize these tools.

Community-based training

The beginning of the Blue Water Project coincided with the development of a new initiative by the GNWT to introduce programs for SWP planning to the NWT. This facilitated the development of a partnership between IWS and Environment and Natural Resources - GNWT to collaborate on community based education on SWP planning for several communities in the NWT. Community-based and driven water quality monitoring programs were being developed at this time and community-based SWP planning was a priority objective for the department. Relationships built with communities throughout the Territory between ENR staff and community members facilitated participation by the IWS in community-based projects.

The IWS had the opportunity to attend the biennial YRITWC Summit in August of 2013 where 70 Tribes and First Nations were signing a Yukon River Water Quality Accord, imposing strict limits to the discharge of contaminants into the Yukon River watershed. This opportunity allowed the IWS to speak directly to community leaders about how community-based SWP could help them meet their water accord objectives (See Case Study 2). As a follow up to this meeting, IWS collaborated with staff from the YRITWC to hold a workshop for community representatives in Whitehorse in the spring of 2014 on water quality monitoring.

Appendix D identifies the communities that were represented at workshops on SWP training as part of the RBC Blue Water Project (Figure 7). These workshops were conducted in partnership with various agencies in both the Northwest Territories, Yukon Territory and Nunavut. The smaller number of First Nations from the Yukon listed in this table can be attributed to the focus on developing college based curriculum in that Territory. However, the Yukon Government recently released the Yukon Water Strategy (February, 2014) and within this document, SWP is a priority strategy. Future SWP training through the YRITWC and Yukon College will allow the members of Yukon First Nations communities to undertake SWP planning at the community level if funding for these projects is provided by the Yukon Government through the Water Strategy initiative.



Figure 7. Communities from which participants have come to take SWP planning workshops





CASE STUDY 2: Yukon River Inter-Tribal Watershed Council Summit, Mayo YT, August 2-4, 2013



Figure 8. Photographs of Yukon River Intertribal Watershed Council Summit, Mayo YT. (Source YRI TWC)

“We, the Indigenous Tribes/First Nations from the headwaters to the mouth of the Yukon River, having been placed here by our Creator, do hereby agree to initiate and continue the clean up and preservation of the Yukon river for the protection of our own and future generations of our Tribes/First Nations and for the continuation of our traditional Native way of life” (YRITWC 2014)

The Yukon River Inter-Tribal Watershed Council (YRITWC) is a unique First Nations non-profit organizations dedicated to protect the Yukon River Watershed. The YRITWC was created in 1997, and today consists of 70 signatory Tribes and First Nations governments in the Yukon River Watershed, from Yukon Territory, Alaska and British Columbia. The aim of the YRITWC is to preserve and protect the Yukon River through coordination and assistance in bringing the 70 signatory First Nation/Tribes together to collectively work to their common goals surrounding the protection of the watershed.

The Council hosts a biennial Summit to bring together delegates from the 70 signatory First Nations and Tribal governments for 3 days of training, workshops and speakers. One of the main goals of the Summit is to train community members in the collection of water samples for analysis from the Yukon River and tributaries in their communities. The water samples are analyzed at the USGS labs in Boulder Colorado for many parameters including nutrients, metals, and bacterial contaminants. Community-based data on permafrost conditions in various locations in the watershed is also collected for the Indigenous Observation Network, a joint initiative of the YRITWC and the US Geological Survey. Training workshops on water, fish health, wildlife, and governance are all a part of the summit experience.

The 2013 Summit was hosted by the First Nation of Na-Cho Nyak Dun in Mayo, YT from August 2-4th. For 3 days approximately 300 people gathered on the banks of the Stewart River to create a detailed water management Accord for the Yukon River. This Accord sets stringent water quality standards for all users of the Yukon River, to preserve and protect this water source for people and nature. The Institute for Watershed Science was invited by the YRITWC to give a full day workshop on Source Water Protection at the Summit. This provided the Institute with an opportunity to educate Yukon River Watershed community leaders on the importance of Source Water Protection planning, and how this planning will help them meet the overall goals of the Accord. This workshop ultimately led to the IWS partnering with the YRITWC to provide a second training day to community members during a joint water quality and Source Water Protection workshop held in Whitehorse in April, 2014. The IWS has continued to partner with The YRITWC toward securing further funding for Source Water Protection initiatives in Yukon Territory.

NEW OPPORTUNITIES

Through this unique project, the project partners have gained a reputation for expertise in water resource management in Canada's North. The CAWT at Fleming College is recognized for their expertise in the use of tundra wetlands for treatment of sewage in Indigenous communities in Canada's North, and this has contributed to the development of a proposal submitted to ArcticNet for a project on solid waste and wastewater management in northern coastal communities (Table 2). The IWS and the IES at Trent have gained a reputation for working with First Nations on SWP planning, and this has led to several community-based initiatives. (Table 2). For example, RBC funding initially supported IWS staff to attend a source water protection planning and community based monitoring workshop with GNWT-ENR and the Yellowknives Dene First Nation (Figure 9). This initial planning workshop came out of the ENR Watershed Strategy, and interest in assisting First Nations with SWP planning. There have subsequently been two further workshops partially supported by RBC toward the Yellowknives Dene watershed protection planning initiative. Table 3 outlines further initiatives subsequent to the RBC Blue Water Project.



Figure 9. Yellowknives Dene First Nation Source Water Protection Workshop field visit

Table 2: New initiatives directly related to expertise and networks developed through the RBC Blue Water project.

| Source Water Protection Plans |
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| <p><u>Northwest Territories SWP Planning:</u></p> <p>Recently, IWS staff were asked to participate on the technical advisory committee for Samba K'e First Nation (Trout Lake) as they begin the process of developing a community SWP plan. This opportunity, along with the work with the Yellowknives Dene have arisen from the excellent partnership developed over the course of the RBC Blue Water Project with the GNWT, which led to the recommendation of the IWS to the two First Nations communities. In the event that further funding can be secured by the First Nations or the GNWT to help NWT communities toward the development of SWP plans, the IWS will be able to further the foundational work from this project.</p> |
| <p><u>Ontario SWP Planning:</u></p> <p>In Ontario, the RBC Blue Water project has been highlighted through invited presentations about our work at three conferences organized by the Ontario First Nations Technical Services Corporation (OFNTSC). Many remote First Nations in Ontario face the same challenges as those in Canada's North with respect to managing drinking water and wastewater. Currently the IWS is working with the OFNTSC as a technical advisor on for the development of a SWP plan for the M'Chigeeng First Nation on Manitoulin Island, ON. This project is being considered a pilot project on SWP plan development, with the intent of developing a template for other Ontario First Nations communities to follow.</p> |
| Academic Program |
| <p><u>CREATE H2O Program:</u></p> <p>Trent University has partnered with the University of Manitoba to develop a graduate level training program that has been funded for 6 years (2013-2019) through the CREATE program administered by the Natural Sciences and Engineering Research Council (NSERC) of Canada. CREATE H2O is designed to train water practitioners with the capacity to work with First Nations in Ontario and Manitoba to address problems with drinking water security and sanitation. The program will support training programs coordinated at Trent by the IWS in partnership with the Indigenous Environmental Studies Program, and by the University of Manitoba, and the University College of the North. CREATE H2O is the first training program in Canada to combine technical water and wastewater management training with capacity building in Indigenous culture, law and policy. Program trainees at the undergraduate and graduate levels will be offered excellent opportunities to transition into the workforce following work-study projects in association with tribal councils, First Nations organizations, engineering firms, environmental consulting services, non-profit organizations, and governments. The foundation of expertise developed at Trent University through the RBC Blue Water Project was critical to NSERC approval of this program.</p> |

Funding Proposals

[Belmont Forum proposal for water security in the North](#)

There is a strong need to continue with the task of building capacity for the protection of water resources in the Far North. Recently, the IWS partnered with the YRITWC, along with other academic partners from Canada, the USA and China to prepare a proposal submitted to the Belmont Forum. This agency is an international organization that supports global change research, and the proposal was submitted in response to a call from the Belmont Forum for proposals on Arctic Observing and Research for Sustainability. The project proposes to use remote sensing of permafrost thaw as a tool to indicate where water and wastewater is at risk in the watershed from the effects of climate change. Where this may be the case in the Yukon and Alaska, the IWS and partners will work with the affected community to develop SWP plans to mitigate the effects of permafrost thaw on their water and wastewater infrastructure. If funded, the project will allow expertise gained through the RBC Blue Water Project to be applied to helping First Nations communities in both Alaska and the Yukon to adapt to climate change and the associated risks to their drinking water sources.

[ArcticNet proposal for solid waste and wastewater management in Northern coastal communities](#)

ArcticNet is a federally funded Network of Centres of Excellence that integrates the work of academics and professionals from the fields of natural, human health and social sciences with partners from Inuit organizations, northern communities, federal and provincial agencies and the private sector. The objective of ArcticNet research is to study the impacts of climate change and modernization in the coastal Canadian Arctic. Under the 4th and final call for proposals, Trent and Fleming College have partnered with academic partners at Dalhousie University, government agencies in both NWT and Nunavut, and with two Indigenous coastal communities (i.e. Tuktoyaktuk, NT; Pond Inlet, NU) to develop a proposal to identify both microbial and chemical contaminants from solid waste and wastewater infrastructure, and track the movement of these contaminants into the environment. We propose to work with the communities to mitigate the hazards to the environment from these sources of contamination. The networks developed through the RBC Blue Water project was instrumental in establishing the expertise and partnerships for this proposed project. Planning for waste and wastewater management under changing climate conditions is imperative for the protection of both water and food security in the North.

CONCLUSIONS

Through a three-pronged approach that leveraged opportunities and events developing in Canada's North, along with the careful development of relationships and networks, this RBC Blue Water project has had a positive impact on protecting sources of drinking water in Canada's North. Both Yukon and Northwest Territories now have *sustainable educational opportunities* to train northern Indigenous and non-Indigenous personnel through materials developed as part of this project. The courses offered by Community Colleges and the training materials available for professionals will ensure that this program will continue to build capacity within the next generation of water professionals in Canada's North.

The number of people reached throughout this project is significant considering the relatively small population of land and water personnel in the North. This approach addressed the current and future needs for training in the North on SWP planning, using approaches that bridge western science and Traditional Knowledge. With the development of government initiatives through the NWT and Yukon Water Strategies, SWP has become a priority within both Territories. The training enabled through this project will help Northern communities protect their sources of drinking water and manage their water resources. Source water protection planning in the Far North has gained significant momentum since this project began. With the development of the NWT community guidance documentation and workbook, the tools are available for NWT communities to undertake development of source water protection plans provided sources of funding become available. Source water protection planning is a priority in the Yukon Water Strategy, however funding for this initiative has yet to be determined. Community concern over protection of drinking water sources is also increasing in Nunavut. Treatment of sewage utilizing natural tundra wetlands associated with municipal sewage lagoons may be a low cost solution so that small, remote communities in Nunavut, and in the other Territories can comply with more stringent sewage effluent criteria.

APPENDIX A

PROJECT PARTNERS

- Trent University
 - Institute for Watershed Science
 - Indigenous Environmental Studies Program
- Fleming College
 - Centre for Alternative Wastewater Treatment
- Yukon College
- Aurora College
- United Nations Universities
 - International Network on Water, Environment and Health (UNU-INWEH)
 - International Environmental Technology Centre
- Centre for Indigenous Environmental Resources (CIER)
- Assembly of First Nations (AFN)
- Northern Territories Water and Waste Association (NTWWA)

APPENDIX B

REVIEW OF THE COURSE CURRICULUM DEVELOPMENT AT YUKON COLLEGE TO COMBINE TK AND WESTERN SCIENCE

Prepared by: Brigitte Evering, Chris Furgal, Larry Gray, Katelyn Friendship

Introduction

Concerns about ecosystem, especially water, contamination along with the importance of protecting and conserving the environment to support healthy and viable communities are on the rise. Some feel that we are more likely to be successful in understanding and addressing these issues if we are able to draw upon the best of available knowledges (Green 2008). In Canada and globally, Indigenous ways of knowing are recognized as offering both insights and practices that help address complex environmental problems (McGregor 2004). National and international policies and legislation already recognize that both Indigenous and non-Indigenous knowledges make important contributions to decision-making about such topics as environmental assessment, wildlife management and the maintenance of biodiversity. Legislation such as the Species At Risk Act, the Canadian Environmental Assessment Act and policies such as resource Co-management agreements and the UN Convention on Biological Diversity already require, where possible, the consideration of multiple, including Indigenous, knowledges in their decision-making. However, these policies and processes assume that we know of or can find ways to effectively work with diverse knowledges. Evidence from research in the Canadian North, for example, suggests that this is not yet consistently the case (Huntington et al. 2004). A recent literature review (Bohensky and Maru 2011) indicates both confusion around terminology and a practice that is often limited to 'box ticking.' This lack of clarity has implications not only for law and policy implementation but also for educational efforts to develop knowledge integration skills to address environmental concerns such as source water protection.

As part of the RBC funded project *Protecting Drinking Water in Indigenous Communities in Canada's North*, a case study was conducted of the Yukon College Source Water Protection and Watershed Stewardship course that was cooperatively developed by individuals from Trent University in Peterborough ON and Yukon College in Whitehorse, YT. The primary goal of the case study was to examine the conditions and factors influencing a course that attempts to bring together Traditional Knowledge and science for learning on water management and protection. It is hoped that the results of this research will have implications for curriculum design and delivery models and processes that facilitate the bringing together or integration of science and Traditional Knowledge based information for learning and capacity enhancement to address source water protection and environmental concerns in general.

Case Study Details

As part of the Renewable Resources Management program, Yukon College has been delivering a Source Water Protection (SWP) and Watershed Stewardship course since the fall term of 2011. Early thinking about the course grew out of existing relationships between instructors at Trent and Yukon College who had worked together in the context of the Northern Contaminants Program as well as between practitioners in Ontario and Yukon, who had developed science-focussed instructional materials to support capacity building around source water protection. While putting together an application to the Royal Bank of Canada Blue Water program, a faculty member in Trent's Indigenous Environmental Studies (IES) program and the project leader from the Institute for Watershed Science (IWS) approached Yukon College to work on course development and an inter-institutional agreement was negotiated.

The initial materials were revised from existing science course material developed at the IWS. These were in the form of PowerPoint (PPT) presentations, media clips and a plastic model of ground water transport. It was understood that these materials would be science-based and would be further refined to include regional and relevant Traditional Knowledge by a course development group working in Whitehorse. Early meetings between IES faculty and IWS staff established the importance of bringing together multiple, including Indigenous, knowledges in a course about source water protection. After these meetings, one of the IES faculty members continued in an advisory role with the Whitehorse team throughout the initial course development to support revising the material to not only include Traditional Knowledge, but also to emphasize the bringing together of knowledges and to keep records in anticipation of describing the course development and revision process. The Whitehorse group included a First Nations Knowledge Holder, the eventual course instructor and an individual who had been associated with the IES program while doing her Master's degree at Trent. The work of this group to turn these initial materials into a course is described in greater detail in the full report. As revisions were suggested/requested, the IWS staff continued to be involved iteratively until these particular materials were considered to be ready for delivery to college students.

The Source Water Protection and Watershed Stewardship (SWP & WS) course has now been offered three times in Fall 2011, Winter 2012 and most recently in Winter 2014 and the materials continue to be revised. As a 'blended' course, meaning it is simultaneously offered at the technical, college and university levels, it has had from 5-10 students registered, with a distance component involving 1-2 students in remote communities. The College has an extensive network of equipment in place to allow for real time access to courses that was seen as an advantage for building capacity to address SWP in Yukon communities. A pilot presentation of the first two lessons of the course (introducing students to 'ways of knowing' particularly western science and Indigenous Knowledge as well as to Yukon source water protection) was done with 10 First Nation and non-First Nation youth as part of the Conservation Action Team program at Kathleen Lake, Kluane National Park in the summer of 2011. The blended nature of the SWP & WS course, the distance component, and the desire to make the course relevant to Yukon First Nations and non-First Nation students have all influenced the process of developing the course.

Case Study Process and Method

The project used a narrative analysis approach and an additional focus in the case study on the experiences and perspectives of the course instructor to gain further insight into course development and delivery. The case study employed interviews, document review and coherent conversations to gather data. Semi-structured interviews were conducted with course developers, faculty advisors, guest speakers and one former student. One of the course developers was also the course instructor and one course development team members was a First Nations advisor. Interview questions focused on the details of course development and delivery including: Intended audience and learning objectives, what changes were made, how and why materials were changed, and if participants thought the course worked and why they thought that, and finally what they thought did not work and still needed adaptation. Participants were only asked to respond to questions on topics that they had direct experience with and felt comfortable answering. Course curriculum related materials and meeting notes from the development team meetings were reviewed to examine the evolution of ideas and approaches to bringing together science and Traditional Knowledge in the course, barriers or challenges faced and how they were addressed and goals and objectives of the course. In addition to interviews, a series of coherent conversations between the course instructor and primary researcher (B Evering) as well as between C Furgal (involved in course development) and B Evering were conducted. As a way of generating narrative text, 'coherent conversations' have certain characteristics that are similar and different to other interview techniques. Kuhn (2009, 86) describes coherent conversations as having the following characteristics. They

- Are permissive not agenda bound, allowing people's priorities and own agendas to emerge;
- May reveal the way people think, as much as what they say;
- Make the conversational dynamics and relationships as apparent as everything that is being said;
- Are self-reflective of the conversational process;
- Are both intuitive and logical.

Finally, one other source of insight in this emphasis in the case study on the instructor (or 'case study within the case study') came from classroom observation by B Evering while in Whitehorse. Since the phenomenon under study was the course, we placed greater emphasis on the instructor and the classroom in this cooperative exploration of his actions and his thinking around curriculum development and course delivery.

An important aspect of this case study is the particular understanding of 'validity' that we are using. Our understanding comes from Marsden's (Mississaugas of Scugog FN) (2004, 55-56) work on convergences between different kinds of knowing. Marsden reflects on a spectrum of validity from 'concrete, discrete or absolute' validity at one end and relational validity at another:

...if many people agree that something is important, then it probably is. Relational validity, in this example, is different from quantitative validity if we understand that the key word in the previous

sentence is agree rather than the word many. Working with this concept has led me to consider three kinds of relational validity: personal, internal, and external. These correspond to domains of knowledge generation and issues of property, which are rooted in the individual and private, moving through the community and communal to the academic and public domains.

Personal relational validity involves an ongoing process of “questioning the resonance between the knowledge being received and the knowledge already gained during prior experiences” (Marsden 2004, 56). In this case study, L Gray’s experiences throughout the course, B Evinger’s prior experiences in education and in her dissertation research, K Friendship’s experiences as an IES-affiliated graduate student and subsequently as a consultant working on Yukon environmental issues and C Furgal’s experiences as an associate professor at Trent and in the IES program will form the basis for each one’s personal relational validity. For example, when someone responds to a statement with ‘I agree’ this indicates that there is resonance with their previous experience. The second form of relational validity that we are incorporating is that of internal relational validity. Marsden (2004, 55-56) comments that this is established when there is resonance within the community or the group. This form of relational validity will be incorporated among case study team members during the writing and editing of this report. Marsden’s third form of validity is external relational validity. Marsden sees this as occurring by checking for resonance with the ‘academic and public domains.’ Resonance in the published domain will be ascertained by referring to the relevant literature. Checking for resonance with cultural knowledge and traditional teachings could involve the inclusion of Elders/Knowledge Holders, which we were not able to do outside of the Knowledge Holders we interviewed.

Themed Stories of the Course as Results

Interpretations of case study participants’ insights into how this particular northern college course is teaching about water management and protection using an approach that brings knowledges together are shared in the form of ‘themed stories’. A full case study report from this project includes the themed stories with quotes from participants. What is presented below is a summary of findings from this analysis along with recommendations for the general topic of the development and delivery of curriculum for bringing together knowledges around water management and source water protection.

Case Study Summary of Findings and Recommendations

Programming for SWP & WS—Summary of Findings

The evolving development of this Source Water Protection and Watershed Stewardship course is consistent with the intentions of the original team members. The instructor continues to find ways to include Traditional Knowledge in the course, make the course relevant in space (Yukon and glob-

al) and time (historical, current, future generations), and be suitable for this multi-level blended class. One of the key findings was that the Whitehorse group used as a guiding principle whether a particular topic in the PPT presentations was going to help bring forward Traditional or Indigenous Knowledge. As some of the literature suggests, it is not enough just to 'insert' this knowledge into an existing science curriculum (Hauser, Howlett, and Matthews 2009). The Whitehorse group foregrounded their understanding of Traditional Knowledge and looked for science content that would be compatible. Another unique element of offering such a course in a northern context is that students either directly or from family members are able to share lived experiences with Traditional Knowledge. Effective course planning includes ways to facilitate this sharing including class discussions and assignments in which students can bring their world into the classroom using methods like PhotoVoice along with technology like a course website. Not surprisingly, what is happening in the classroom turned out to be critical for students to be comfortable encountering less-familiar-to-them knowledges. The role of the teacher in creating a calm, open and accountable space with room for lots of interaction between class members cannot be overemphasised. Finally, the instructor is aware that the limited number of students from remote communities is not yet meeting expectations. The instructor felt that both he and the College needed to do a better job of promoting the course to communities. There are community campus instructors or coordinators who could be engaged to help with this promotion.

Programming for SWP & WS—Recommendations

Based on our findings and the internal relational validity we established amongst ourselves, we recommend the following when programming for Source Water Protection and Watershed Stewardship type courses:

When developing materials for courses that are intended to include Traditional Knowledge, beginning with a discussion of the desired Traditional Knowledge and then looking for compatible and relevant science content.

Especially when such a course is intended for a blended class of students at different academic levels, attending to making content accessible and focussing on most relevant concepts without excessive reliance on formulas/math.

When preparing materials such as PowerPoint presentations for a specific region, called in this case 'Yukonizing' them, making them relevant involves the inclusion of Yukon-specific Traditional Knowledge, case studies/ examples, policies/regulations, concerns and visuals. It also means contextualizing the course in time (with historical, current and future possible events) and in space (in the relationship between local and global water related issues). Finally, it involves the incorporation of assignments that invite students to bring in personal and community examples.

Paying attention to not just written materials but the multiple components of preparing to deliver a course and especially focussing on ways to include orality either directly or indirectly. This could include, but not be limited to, bringing in guest speakers (esp FN Knowledge Holders when the instructor is not FN), showing relevant DVDs, and discussing with students existing FN documents on

oral histories especially in regard to related environmental impact assessments;

Facilitating multiple avenues for student involvement and interaction in the course. This would serve multiple purposes including inviting students to bring in Traditional Knowledge either from their own lived experience or from talking with family members as well as ways to share first hand experiences with course content such as work experience in water monitoring or on water issues. Avenues could include, for example, classroom discussions and sharing circles and also technology-supported ways of interacting such as through a class website and through sharing of personal and community photographs.

Attending to the key role of the instructor in course delivery especially in creating a classroom atmosphere that encourages and supports student learning. Important instructor attributes include being calm, tracking on individual student interests/experiences and demonstrating the importance of lived experience through the telling of personal stories especially in relation to Traditional Knowledge. Valuable skills include making content accessible and making the philosophical perspective explicit.

Such a course could be considered to be 'working' when it does more than engage students affectively as well as cognitively. In addition to the desire for personal transformation in students, the instructor's own excitement and interest supports student learning. At the same time, there is an opportunity to make the assessment of affective engagement more deliberate.

Looking for those local individuals in key positions, like the guest speaker we interviewed from the Yukon Environmental and Socio-Economic Assessment Board, who may have insights and resources that can be drawn upon for course planning. Providing guest speakers with an outline of the course, program context and a brief profile of students would facilitate their ability to address course and class specifics should they wish to do so.

Programming for Bringing Knowledges Together—Summary of Findings

One of the key dynamics that we articulate in this case study is how the instructor has developed a repository of experiences or building blocks to support student learning that he accesses as needed or as opportunities present themselves. As already discussed, the preferred building blocks are those in which students can experience knowledges and bring them together firsthand, ideally outdoors or on other experiential field trips. Then in order of preference, this instructor includes speakers (either guests or students) with direct experience, films of such speakers, PPTs or other visual demonstrations of content that he can speak to, and lastly reading materials. We acknowledge the limitations of day to day teaching including the length of a class and access to field experiences. We were aware of the evolution of this repository from its beginnings in which the PPT presentations played a greater role to the current iteration in which lived experience or hearing from those with such experience occurred more often. New instructors may have to begin similarly while building their own repositories over time.

The notion of 'conditions for emergence' was useful for considering those elements of the classroom environment that supported the learning outcome of bringing knowledges together.

These included the more widely discussed and literature supported conditions for the emergence of an ethical and accountable classroom space in which all students are comfortable to learn about knowledges that are less familiar. These conditions provide an important foundation for students to then also engage in bringing together multiple, including Indigenous, knowledges. Another key finding of this case study is the identification of four additional conditions of emergence that may be essential in this kind of course and that are not currently being discussed in the literature about bringing knowledges together as a learning outcome. As discussed these are:

Distinguishing between the informative and decisive dimensions of bringing knowledges together when discussing this phenomenon in the classroom;

Communicating to students the importance of finding some concept like the notion of knowledge constellations that facilitates the inclusion and valuing of different knowledges and skills for new knowledge or solution creation;

Making explicit the relational validity inherent in different knowledge constellations; and

Paying attention to the contribution of narrative to facilitating the bringing together of multiple, including Indigenous, knowledges and the role that place-based problems like watershed stewardship have in providing a container for knowledge conversations in the classroom.

The final key finding to come out of this case study is the importance of keeping the focus on the evolving teaching process and not looking for a 'recipe' that can be directly transferred to other courses. The identification of this dynamic is another new contribution to the literature about this kind of course development.

Programming for Bringing Knowledges Together—Recommendations

Based on our findings and the internal relational validity we established amongst ourselves, we recommend the following when programming for courses with an intended learning outcomes of bringing together multiple, including Indigenous, knowledges:

Ongoing development of a repository of resources or 'building blocks' that can be drawn upon during course delivery. In order of preference, resources to be developed include: 1-Arranging for first hand outdoor experiences with an amalgamation of activities from different knowledge constellations (water sampling, listening to an Elder speak about the importance of water, spending time near a river, learning how to use a data logger); 2-Preparing a list of individuals who can speak to and interact with the class from first hand experiences; 3-Preparing a list of DVDs so students can listen to speakers; 4-Lecture material such as PowerPoint presentations or other visual demonstrations of content; and 5-Reading materials. We concluded that it is desirable throughout each iteration of a course to continually move towards the more preferred building blocks as time and other constraints allow.

Paying attention to developing the conditions for an ethical and accountable classroom in which students are comfortable encountering less familiar knowledges. We suggest that instructors then also

need to attend to the 'conditions for emergence' reiterated above for students to be able to engage in bringing knowledges together.

In learning about this process phenomenon, students need to see their instructor engaging in the active, iterative and purposeful process of learning and teaching about bringing knowledges together. This transparency may be an essential part of demonstrating for students what this can look like.

Finally, based on our own experience as instructors in courses in this area, we emphasize again the importance of ongoing reflexivity when learning about, teaching and doing this work.

Final Thoughts

The findings from this case study can support the development of enhanced educational programming for students to develop their ability to bring knowledges together on topics such as source water protection and watershed stewardship, among others. This has the possibility to lead to improvements in the practice of bringing together knowledges by these future environmental practitioners as they work not only in source water protection and watershed stewardship but in any area that would benefit from effective knowledge interactions. In this way, our research has the potential to help to facilitate collaborations between individuals using multiple, including Indigenous, knowledges looking for new solutions to environmental issues, helping overcome a hurdle that has hindered cross-cultural environmental cooperation and decision making in Canada and elsewhere.

References

- Bohensky, Erin L., and Yiheyis Maru. 2011. "Indigenous knowledge, Science, and Resilience: What Have We Learned from a Decade of International Literature on 'Integration'?" *Ecology and Society* 16 (4):1-15. doi: 10.5751/es-04342-160406.
- Green, Lesley J. F. 2008. "'Indigenous Knowledge' and 'Science': Reframing the Debate on Knowledge Diversity." *Archaeologies* 4 (1):144-163. doi: 10.1007/s11759-008-9057-9.
- Hauser, Vivian , Catherine Howlett, and Chris Matthews. 2009. "The Place of Indigenous Knowledge in Tertiary Science Education: A Case Study of Canadian Practices in Indigenising the Curriculum." *Australian Journal of Indigenous Education* 38 (S):46-57.
- Huntington, Henry, Terry Callaghan, Shari Fox, and Igor Krupnik. 2004. "Matching Traditional and Scientific Observations to Detect Environmental Change: A Discussion on Arctic Terrestrial Ecosystems." *Ambio* Special Report 13:18-23.
- Kuhn, Lesley. 2009. *Adventures in Complexity: For Organisations Near the Edge of Chaos*. Axminster, UK: Triarchy.
- Marsden, Dawn. 2004. "Expanding Knowledge Through Dreaming, Wampum and Visual Arts." *Pimatisiwin* 2 (2):53-73.
- McGregor, Deborah. 2004. "Coming Full Circle: Indigenous Knowledge, Environment, and Our Future." *American Indian Quarterly* 28:385-410. doi: 10.1353/aiq.2004.0101.

APPENDIX C

CENTRE FOR ALTERNATIVE WASTEWATER TREATMENT DOCUMENT ON TUNDRA WETLANDS FOR WASTEWATER TREATMENT

The introduction to the summary report is included below. Full documentation for the research and science synthesis on tundra wetlands for treatment of municipal wastewater in Canada's North can be found on the website of the CAWT at this link:

<http://cawt.ca/resources/tundra-treatment-wetlands/>

The following document focuses on the use of natural wetlands in the treatment of domestic sewage and / or effluent in Canada's far north. The intent of this paper is to provide a summary of current knowledge regarding the efficacy of these lands in the treatment of municipal wastewater and an overview of existing data gaps and science needs that still persist. Funding provided by the federal government of Canada through the International Polar Year programme and Environment Canada was awarded to the Centre for Alternative Wastewater Treatment (CAWT) to conduct site investigation at 13 tundra treatment wetland sites located in Nunavut and the Northwest Territories. This companion document along with the full report (e.g., Tundra Wetlands: the treatment of municipal wastewater – performance and operational tools, 374 pages) summarizes the findings of the site investigations and from that data has generated a guidance document concerning operational tools and management considerations for tundra treatment wetlands. The generation of this companion document along with the full report was funded by the Royal Bank of Canada (RBC) Blue Water Project in partnership with the Institute for Watershed Science (IWS), Trent University. The RBC Blue Water Project funding was awarded to the IWS who in turn subcontracted the CAWT to produce the performance and operational tools document to serve as a wastewater guidance document for indigenous communities of Canada's far north.

In many northern communities, the retention of the wastewaters in lagoons alone is not sufficient to produce municipal effluents that meet the Canadian Council of Ministers of the Environment (CCME) proposed National Performance Standards (NPS) for carbonaceous biochemical oxygen demand (cBOD), total suspended solids (TSS) or un-ionized ammonia ($\text{NH}_3\cdot\text{HOH-N}$). Natural wetlands that have either naturally existed or serendipitously developed downstream of sewage lagoons are viewed by some as key contributors to the overall treatment of municipal wastewaters. However, until recently, the data to support this claim has been generally lacking or at best very sparse. The lack of solid scientific evidence has hampered the ability of regulatory agencies and governments in

their ability to come to firm conclusions regarding the efficacy of natural wetlands and the role they may play in the treatment of municipal wastewaters in Canada's far north.

Because of this need, the Centre for Alternative Wastewater Treatment (CAWT) developed and established a research program in Canada's far north to examine the contribution that natural wetlands afforded in the treatment of municipal wastewaters and the level of treatment plausible when using a lagoon / wetland hybrid treatment process. A high level summary of the key findings from this study are presented below. Funding for the wetland studies was awarded to the CAWT by the federal government of Canada in their support of the International Polar Year program and more recently by Environment Canada in their support of the Canadian Council of Ministers of the Environment (CCME) implementation of a Canada-wide strategy for the management of municipal wastewater effluents.

The intent of this companion report is to provide a brief overview of the finding and to direct those wishing to learn more about this work to the larger concluding reports that are available on the websites for the CAWT and the Institute for Watershed Science (IWS) for viewing and/or download. Funding for the compilation of the wetland research findings into summary documents was provided from the RBC Blue Water Project awarded to the IWS, Trent University and its project partner: the Centre for Alternative Wastewater Treatment (CAWT), an applied research facility located at Fleming College. The focus of the RBC award was to develop teaching materials and tools dedicated to the protection of drinking water within indigenous communities of Canada's north. The CAWT's contribution to this work was focussed on the treatment of domestic sewage in the belief that the proper treatment is an important component in the overall protection of source waters used for drinking purposes.

This companion document provides an overview of the key findings generated from the CAWT studies and a commentary on data gaps, science needs and regulatory consideration surrounding the use and management of natural wetlands dedicated to the treatment of municipal

APPENDIX D

COMMUNITIES FROM WHICH PARTICIPANTS HAVE COME TO TAKE SWP PLANNING WORKSHOPS

| Communities represented at Source Water Protection Workshops by Territory | | | | |
|---------------------------------------------------------------------------|-----------------------|---------------|---------------|--------------------|
| Yukon Territory | Northwest Territories | | Nunavut | Other |
| Dawson City | Aklavik | Kugluktuk | Arctic Bay | Fort Chipewyan, AB |
| Mayo | Behchoko | LutselK'e | Arviat | Aupaluk, QC |
| Ross River | Coville Lake | Nahanni Butte | Cambridge Bay | Kangiqsujaq, QC |
| Whitehorse | Deline | Norman Wells | Cape Dorset | Kuujuuaq, QC |
| | Enterprise | Paulatuk | Coral Harbour | Quaqtaq, QC |
| | Fort Good Hope | Sachs Harbour | Gjoa Haven | |
| | Fort Liard | Salt River | Igloolik | |
| | Fort McPherson | Tuktoyaktuk | Iqaluit | |
| | Fort Providence | Tulita | Kimmirut | |
| | Fort Resolution | Trout Lake | Pangnirtung | |
| | Fort Smith | Ulukhaktok | Pond Inlet | |
| | Gameti | Wekweeti | Qikiqtarjuaq | |
| | Hay River | Wrigley | Rankin Inlet | |
| | Inuvik | Yellowknife | | |
| | Kakisa | | | |